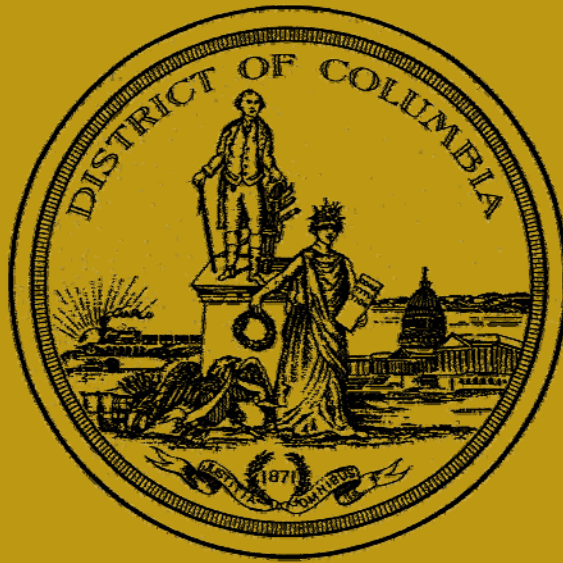


**DISTRICT OF COLUMBIA**  
**DEPARTMENT OF TRANSPORTATION**

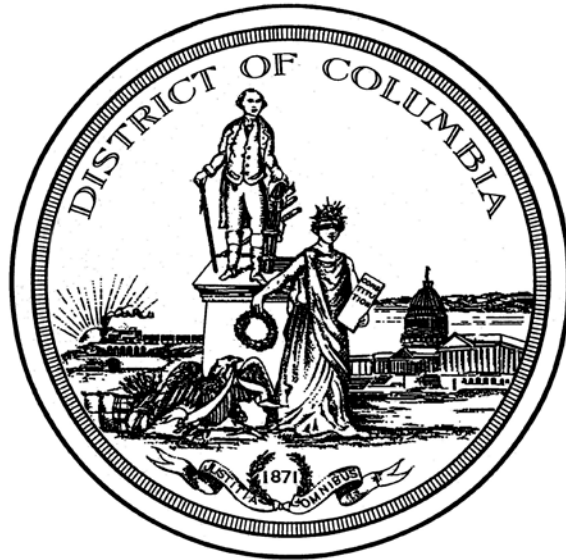


**STANDARD SPECIFICATIONS**  
**FOR**  
**HIGHWAYS AND STRUCTURES**

**2013**



**DISTRICT OF COLUMBIA**  
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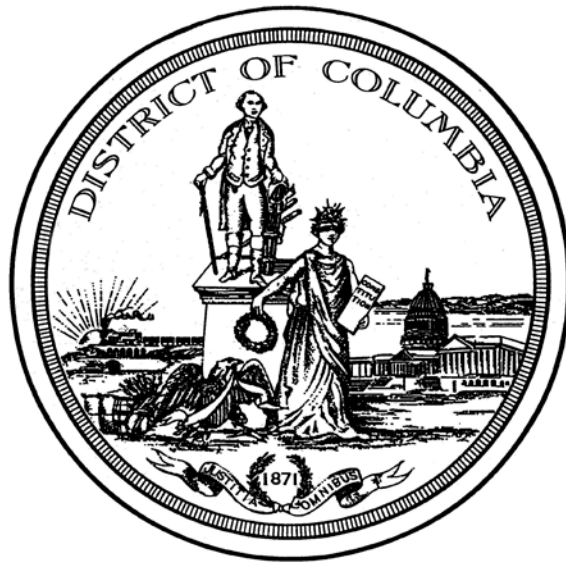
**STANDARD SPECIFICATIONS**  
**FOR**  
**HIGHWAYS AND STRUCTURES**

**2013**



# **DISTRICT OF COLUMBIA**

## **DEPARTMENT OF TRANSPORTATION**



**TERRY BELLAMY, DIRECTOR**

**RONALDO T. NICHOLSON, P.E., CHIEF ENGINEER**

**MUHAMMED KHALID, P.E., DEPUTY CHIEF ENGINEER**

**RAVINDRA GANVIR, P.E., DEPUTY CHIEF ENGINEER**

**WASI KHAN, P.E., CHIEF QA/QC DIVISION**

## **Specifications Task Force**

**Wasi Khan, P.E.**

**Rezene Medhani, P.E.**

**Abdullahi Mohamed**

**Dawit Muluneh, P.E.**

**Larry Chung**

**Konjit Eskender, P.E.**

**Keith Foxx, P.E.**

**Albert Ladipoh**

**Cherwin Baga**

**Bill McGuirk**

**James Cheeks, FITE**

**Rahul Jain**

**Ray Robbins, P.E., DC Water**

# INTRODUCTION

These Standard Specifications for Highways and Structures are standard for all District Department of Transportation contracts awarded by the Mayor of the District of Columbia, the Council of the District of Columbia, and/or the Contracting Officer. The requirements stated herein may be revised or amended from time to time, but only to the extent specified under a supplemental specification or special provision included in the specific contract.

These Standard Specifications shall further be the standard specifications for all the construction activities and material control within the Public Space of the District of Columbia. Reference by date and title shall be made to these specifications with the Plans or other Contract Documents as notification of their application to those documents.

A handwritten signature in blue ink, appearing to read 'R. Nicholson', with a large, stylized flourish extending to the right.

Ronaldo T. Nicholson, P.E.

Chief Engineer





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## 101 DEFINITIONS AND TERMS

### 101.01 GENERAL

Unless the intent is clearly otherwise apparent, words, clauses and phrases used in the Department's projects shall be construed according to rules of grammar and approved usage contained in Webster's Third New International Dictionary, Unabridged.

### 101.02 ABBREVIATIONS

Whenever the following abbreviations are used in these specifications or on the plans, the intent and meaning shall be interpreted as follows:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ABS	Acrylonitrile-Butadiene-Styrene
AC	Asphalt Concrete
ACI	American Concrete Institute
AGC	Associated General Contractors of America, Inc.
AGMA	American Gear Manufacturers Association
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ANSI	American Iron and Steel Institute
ANSI	American National Standards Institute
APA	American Plywood Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWS	American Welding Society
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration, U.S. Department of Transportation
FS	Federal Supply Standards
FSS	Federal Supply Standards, (General Services Administration)
IEEE	Institute of Electrical and Electronic Engineers, Inc.

MIL	Military Specifications
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NPS	National Park Service, U.S. Department of the Interior
NPT	National Pipe Thread
OSHA	Occupational Safety and Health Administration, U.S. Department of Labor
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PTFE	Polytetrafluoroethylene
PVC	Polyvinylchloride
SAE	Society of Automotive Engineers
SP	Special Provision
SSPC	Steel Structures Painting Council
TAI	The Asphalt Institute
TCP	Traffic Control Plan
UL	Underwriter's Laboratories Incorporated
USS Gage	United States Standard Gage
WSP	Working Steam Pressure

When reference is made to specifications of any organization listed above, or to any additional referenced specifications, the specifications shall be the current edition in effect on the date of advertising of the Contract.

### 101.03 DEFINITIONS

Whenever the following terms are used, intent and meaning shall be interpreted as follows:

**Addendum** – Change in Contract Documents issued in writing prior to opening of bids.

**Advertisement** – A public announcement, as required by law, inviting bids for work to be performed, materials to be furnished, or proposals to be developed. Such Advertisements will indicate with reasonable accuracy the quantity and location of the Work to be done or the character and quantity of the material to be furnished and the time and place of the opening of Proposals.

**Alley** – Public passageway for vehicles, pedestrians, drainage purposes, or any combination thereof, which connects with a street and which usually affords a means of access to the rear of properties abutting streets or highways.

**Award** – The decision of the Contracting Officer to accept the Proposal of the lowest responsible Bidder for the Work, subject to the execution and approval of a satisfactory contract thereof and bond to secure the performance thereof, and to such other conditions as may be specified or required by law.

**Base Course** – The layer or layers of specified or selected material of designated thickness placed on a subbase or subgrade and used as a foundation to support an intermediate and/or surface course.

**Bid Bond** – A guarantee by a Surety company that the Contractor who submitted a bid on a project will not withdraw his bid for a specified period.

**Bidder** – Any individual, firm, partnership, corporation or joint venture submitting a proposal for the Work contemplated, acting directly or through a duly authorized representative.

**Bridge** – A single or multiple span structure, including supports, erected over a depression or an obstacle such as water, highway or railway, and having a passageway for carrying traffic or other moving loads and having an opening measured along the center of the passageway of more than 20 feet.

**Bridge Length** – The greater dimension of a structure as measured along the center of the roadway between backs of abutment backwalls or between ends of bridge deck.

**Bridge Roadway Width** – The clear width of the superstructure measured at right angles to the center of the Roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

**Calendar Day** – Each day shown on the calendar.

**Certified Minority Business Enterprise** – A business enterprise that has been issued a certification of registration by the District of Columbia, Minority Business Opportunity Commission qualifying it to perform certain categories of work.

**Change Order** – A written order issued by the Contracting Officer to the Contractor covering changes in the Contract.

**Chief Engineer** – Chief Engineer of the Department acting directly, or through and within authority of an authorized representative.

**Completion Date** – The date on which the Contract is specified to be completed.

**Construction Completion Time** – The number of days, stated either in Calendar Days or as a Completion Date, allowed for completion of the Contract, including authorized time extensions.

**Contract** – The binding agreement between the District of Columbia and another party or parties.

**Contract Documents** – Addenda, Contract Form, General Provisions, Labor Provision, Performance and Payment Bonds, Specifications, Special Provisions, Contract Drawings, approved written Change Orders, and Agreements required to acceptably complete the Contract including authorized extensions thereof.

**Contract Drawings** – All drawings, often referenced as Drawings or Plans (i.e., project drawings, Office Manual Drawings and other standard drawings) including reproductions of revisions thereof but exclusive of shop and Working Drawings and reference drawings, which show the location, character and dimensions of the prescribed Work, including layouts, profiles, cross sections and other details.

**Contracting Officer** – The Department representative authorized to execute and administrate the Contract on behalf of the District and shall include his duly appointed successor and his authorized representative.

**Contract Price** – The price stated in the Schedule of Prices.

**Contract Time** – The number of Calendar Days allotted in the Contract Documents for the duration of the Project.

**Contractor** – The individual, firm, partnership, corporation or joint venture under Contract with the District for execution of prescribed Work, acting directly or through a duly authorized representative.

**Culvert** – A Structure other than a Bridge which provides an opening under a Roadway for drainage or other uses.

**Current** – As used in reference to specifications or methods of test, shall refer to those in effect at the time of Advertisement for bids.

**Department** – The Department of Transportation, District of Columbia.

**Director** – The executive officer of the Department of Transportation.

**District** – The District of Columbia, a municipal corporation.

**Earth** – The word “earth”, wherever used as the name of the excavated material or material to be excavated, shall mean all kinds of material other than rock as defined herein.

**Elevation** – The figures given on the Drawings or in the other Contract Documents after the word “elevation” or abbreviation of it shall mean the distance in feet above the standard datum used by the District.

**Embankment** – A raised Structure of soil, soil aggregates, or rock below the Subgrade.

**Engineer** – The Chief Engineer or a designated representative.

**FHWA** – Federal Highway Administration of the United States Department of Transportation.

**Final Acceptance** – The occurrence of all the events and satisfaction of all the conditions with respect to the Work for completion of all aspects of the Contract as set forth in Section 108.09.

**Final Acceptance Certificate** – The letter issued by the Department in accordance with Section 108.09 evidencing the Department's determination that Final Acceptance has occurred.

**Final Acceptance Date** – The date on which Final Acceptance is achieved, as indicated on the Final Acceptance Certificate.

**Highway, Street or Road** – The entire Right-of-Way reserved for use in constructing or maintaining the Roadway and its appurtenances.

**Holidays** – The following days are recognized as legal holidays:

New Year's Day	Independence Day
Inauguration Day	Labor Day
Martin Luther King Jr. Birthday	Columbus Day
Presidents Day	Veterans Day
Memorial Day	Thanksgiving Day
Emancipation Day	Christmas Day

Any day declared a holiday by the District shall be observed. When a holiday falls on a Sunday, the following Monday will be observed as a Holiday. When a holiday falls on a Saturday, the preceding Friday will be observed.

**Inspector** – The Engineer's authorized representative assigned to make any inspection of Work performed and materials furnished.

**Invitation for Bids** – See Advertisement.

**Laboratory** – The established testing laboratory or other testing laboratories which may be designated by the Engineer for the performance of tests.

**Liquidated Damages** – The amount to be deducted from monies due the Contractor for failure to complete the Work in the specified time.

**Mayor** – The elected head of the District of Columbia as set forth in Public Law 93-198, dated December 24, 1973, Title 4, Part B, Section 422(1).

**Notice to Proceed** – A written notice to the Contractor from the Contracting Officer stating the date on which the Contractor shall begin prosecution of Work under Contract, or to begin a phase of the Work.

**Office Manual Drawings** – Detail Drawings of the Department of Transportation of general application.

**Pavement Structure** – The combination of base courses, intermediate course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

**Pay Item (Bid Item, Item)** – An item of work specifically described and for which a price, either unit or lump sum, is provided.

**Pay Item Schedule (Schedule of Prices)** – A schedule showing the pay item number, the approximate quantity of each pay item, the price bid by the Contractor to be paid for each item of work performed under the Contract, the total cost of each item, and the total amount bid by the Contractor.

**Performance and Payment Bond** – A guarantee by a Surety company that the Contractor will be responsible for the performance and fulfillment of the Contract and will pay all bills and accounts for materials and labor used in the Work.

**Plans** – The Contract Drawings which show the location, character, and dimensions of the prescribed Work, including layouts, profiles, cross sections and other details.

**Plant** – All physical resources, facilities, machinery, equipment, staging, forms, tools, work and storage space other than provided by the Contract, together with subsidiary essentials and necessary maintenance for proper construction and acceptable completion of the Project.

**Project** – The entire Work to be completed under the Contract.

**Proposal** – The offer of a Bidder on the prescribed form, to perform stated construction work at the prices quoted.

**Proposal Form** – The prescribed form on which the offer of a Bidder is to be submitted.

**Proposal Guaranty** – The security furnished with a bid to assure that the Bidder will enter into the Contract if his offer is accepted.

**Public Space** – All publically owned property located between the property lines on a street and includes, but is not limited to, the roadway, tree spaces, sidewalks and alleys.

**Registered Professional Engineer** – Registered Professional Engineer in the fields of civil, structural, mechanical or electrical engineering, who is registered with the District's Board of Registration for Professional Engineers.

**Right-of-Way** – Land, property or interest therein acquired for or devoted to the District's highway purposes.

**Roadbed** – Graded portions of highway upon which soils base, pavement or base, surface, shoulder, sidewalk, and median are constructed.

**Roadway** – The portion of the Right-of-Way intended for vehicular use.

**Rock** – Rock, wherever used as the name of an excavated material, shall mean only boulders and pieces of concrete or masonry exceeding 1 cubic yard in volume, and solid ledge rock which, in the Engineer's opinion, requires for its removal, drilling and blasting, wedging, sledging, barring or breaking up with power-operated tools. No soft or disintegrated rock which can be removed with a hand pick or power operated excavator or shovel, or loose or previously blasted rock or broken stone in rock fillings or elsewhere, and no rock exterior to the maximum limits of measurement allowed, which may fall into the excavation, will be measured or allowed as rock.

**Set Aside** – Designated projects procured in accordance with 49 CFR Part 26.39 for which bids from only qualified small business enterprises may be considered for Award.

**Sheltered Market** – Designated projects procured in accordance with the provisions of D.C. Law 1-95 (Minority Contracting Act of 1976) and on which only bids from minority business enterprises prequalified by the District of Columbia Minority Business Opportunity Commission will be accepted.

**Shop Drawings** – Drawings prepared by the fabricator or supplier showing the layout and details of components fabricated in a shop for inclusion in the permanent facility e.g., structural steel, reinforcing steel, railing, etc.

**Shoulder** – The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles for emergency use, and for lateral support of base and surface courses.

**Sidewalk** – The portion of the Right-of-Way intended for pedestrian use.

**Site** – The area upon or in which the Contractor's operations are carried on and such other areas adjacent thereto as may be designated by the Engineer.

**Special Provisions (Designated as S.P.)** – Special directions and requirements peculiar to a project not otherwise thoroughly set forth in Standard Contract Provisions and Standard Specifications

**Specifications** – All the directions, provisions and requirements contained in the Standard Specifications, Supplemental Specifications, and Special Provisions which are necessary for the proper performance of the Contract.

**Standard Contract Provisions** – Standard Instructions to Bidders, General Provisions, Labor Provisions, Bid and Contract Forms as amended, for use with District of Columbia construction projects.

**Standard Specifications** – This book of provisions, the 2013 Standard Specifications for Highway and Structures.

**Structures** – Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, end walls, buildings, sign supports, and appurtenant features encountered in the Work and not otherwise classed herein.

**Subcontractor** – Any individual, partnership, firm, corporation or any acceptable combination thereof, or joint venture, to which the Contractor, with the consent of the Department, sublets part of the Contract.

**Subgrade** – The top surface of a roadbed upon which the pavement structure and appurtenances are constructed.

**Substantial Completion** – the satisfaction of the criteria for completion of construction of the Project set forth in Section 108.09, and as defined by the Department, and as and when confirmed by the Department's issuance of the Substantial Completion Certificate.

**Substantial Completion Certificate** – The letter issued by the Department in accordance with Section 108.09 evidencing the Department's determination that Substantial Completion has occurred.

**Substantial Completion Date** – The date on which Substantial Completion is achieved, as indicated on the Substantial Completion Certificate.

**Substructure** – All of that part of a bridge below the bearings of simple or continuous spans, skewbacks of arches and tops of footings of rigid frames, including backwalls.

**Superintendent** – The Contractor’s authorized representative in responsible charge of the Work.

**Supplemental Specifications** – Approved additions and revisions to the Standard Specifications.

**Surety** – The corporation, partnership or individual, other than the Contractor, executing a bond furnished by the Contractor.

**Surface Course** – The top layer of a pavement structure; Also referred to as wearing course or top course.

**Traffic Control Plan** – A formal plan prepared by the Department or by the Contractor indicating how traffic is to be managed through a construction project. The Traffic Control Plan (TCP) shall comply with the current edition of MUTCD.

**Tree Space** – The portion of the public Right-of-Way used or reserved for trees.

**Work** – The furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the Project and the carrying out of the duties and obligations imposed by the Contract.

**Working Drawings** – Drawings furnished by the Contractor showing the layout and details of temporary construction, procedures and methods of construction, and data for construction equipment which are to be employed in the construction of the permanent facility (e.g., form drawings, erection drawings, load test pile procedures, pile hammer data, catalog cuts, performance data).

In order to avoid cumbersome and confusing repetition of expressions in these Specifications, and unless context clearly indicates another meaning supplementing the intended written requirements, the words “as approved by the Engineer” or “to/by the Engineer” are applied to the following terms:

Acceptable	Directed	Rejected
Accepted	Disapproved	Required
Appropriate	Equivalent	Reserved
Approved	Given	Significant
Authorized	Indicated	Specified
Comparable	Insufficient	Sufficient
Contemplated	Needed	Suitable
Designated	Ordered	Suspended
Determined	Permitted	Unacceptable

When drawings or plans are not a part of the Contract, the words “per the drawings” shall mean “as directed by the Engineer”.

**102 BIDDING REQUIREMENTS GOVERNMENT OF THE DISTRICT OF COLUMBIA STANDARD  
CONTRACT PROVISIONS FOR USE WITH SPECIFICATIONS FOR DISTRICT OF COLUMBIA  
GOVERNMENT CONSTRUCTION PROJECTS 1973, AS AMENDED**

**102.01 INSTRUCTIONS TO BIDDERS (CONSTRUCTION)**

**ARTICLE 1 QUALIFICATIONS OF BIDDERS**

Bidders shall have the capability to perform classes of work contemplated, have the necessary Plant and sufficient capital to execute the Work properly within specified time.

Any Bidder who has not performed comparable work for the District within the last five (5) years shall submit, at the Contracting Officer's discretion, a certified statement of his organization, Plant, manpower, financial resources, and construction experience that he considers will qualify him for proposed Contract. This information shall be certified by a Certified Public Accountant for contracts over \$25,000. This requirement is not needed if the Bidder has submitted such a statement to the District within a year prior to bid opening date, but will be required if Bidder has previously submitted such a statement under one company name or organization or joint venture and is now bidding under another company name or organization or joint venture. A certified statement of prequalification approval by another jurisdiction may be considered as an alternative to foregoing procedure. A Bidder shall submit a supplemental statement if requested by the District.

**ARTICLE 2 BID DOCUMENTS**

The Specifications (including all documents referenced therein and all documents attached thereto), drawings, and addenda which form the basis of any bid shall be considered as part thereof and will form part of the bid. Copies of these documents will be furnished to or made available for the inspection of prospective Bidders by that office indicated in the Advertisement or invitation.

**ARTICLE 3 EXAMINATION OF BID DOCUMENTS AND SITE OF WORK**

Each Bidder shall carefully examine the Site of the proposed Work and the bid documents and fully acquaint himself with conditions relating to construction and labor so that he may fully understand the facilities, difficulties, and restrictions attending the execution of the Work under the bid documents, and he shall judge for and satisfy himself as to conditions to be encountered affecting the character, quality and quantity of the Work to be performed and materials to be furnished and to the requirements of the bid documents. Failure to do so will be at the Bidder's own risk and shall not relieve him from any obligation under his bid or Contract.

**ARTICLE 4 PREPARATION OF BIDS**

The bid form furnished in the bid Proposal and Specifications shall be used in strict compliance with the requirements of the Invitation and Supplemental Instructions to Bidders in the Specifications. Special care shall be exercised in the preparation of bids. Bidders must make their own estimates of the facilities and difficulties to be anticipated upon execution of the Contract, including local conditions, uncertainty of weather and all other contingencies. All designations and prices shall be fully and clearly set forth in the bid submission. ALL PRICES SHALL BE INSERTED IN FIGURES TYPED OR PRINTED LEGIBLY ON THE BID FORM. All corrections on the bid documents must be initialed by the person signing the form.

**ARTICLE 5 ERROR IN BIDS**

Bidders or their authorized agents are expected to examine all bid documents and any addenda thereto, and all other instructions pertaining to the Work which will be open to their inspection. Failure to do so will be at the Bidder's own risk, and will not constitute reason for relief on plea of error in the bid. IN CASE OF ERROR IN THE EXTENSION OF PRICES IN THE BID, UNIT PRICES WILL GOVERN.

The Bidder must submit his plea of error in writing to the Contracting Officer and must be prepared to document and prove his error.

**ARTICLE 6 LABOR AND MATERIAL NOT FURNISHED BY DISTRICT**

The District will not furnish any labor, material, or supplies unless a provision to do so is included in the Contract Documents.

**ARTICLE 7 ADDENDA AND INTERPRETATIONS**

No oral interpretations of the meaning of the drawings, Specifications, or other bid documents will be made to any Bidder. Verbal clarification will not be binding on the District. All requests must be in writing and addressed to the Contracting Officer responsible for administering the Contract. Requests for interpretations of bid documents must be received by the Contracting Officer not later than ten (10) days prior to bid opening date. All changes to the bid documents will be made by addenda mailed to all prospective Bidders, who have obtained copies of the bid documents, not later than seven (7) days before bid opening date. In case of discrepancy among addenda, a later dated Addendum has priority over earlier dated addenda. It shall be the Bidder's responsibility to make inquiry as to any or all addenda issued, and failure of any prospective Bidder to receive any such addenda issued by the Contracting Officer shall not relieve the Bidder from any obligation under his bid as submitted. Bidder must acknowledge receipt of all addenda on the Bid Form; failure to do so may result in rejection of bid. All addenda issued shall become part of the bid and Contract Documents.

**ARTICLE 8 ALTERNATE BIDS**

Alternate bids will not be considered unless called for in the Bid Form.

**ARTICLE 9 BIDS FOR ALL OR PART**

Where bids are not qualified by specific limitations, the District reserves the right to Award all or any of the items according to its best interests.

**ARTICLE 10 PRICE SCHEDULE INTERPRETATION**

Quantities appearing in the Price Schedule are approximate only and are prepared for the comparison of bids. Payment will be made only for actual material requirements accepted and for Work performed and accepted. Schedule quantities may be increased, decreased, or omitted and there shall be no adjustment in Contract unit prices except as provided, and except for such materials actually purchased or Work actually performed prior to notification of the change in items affected.

The price of any item, unless otherwise specified shall include full compensation for all materials, tests, samples, manufacturers' guaranties, tools, equipment, labor, and incidental work needed to complete specified items. Prices without exception shall be net, not subject to discount, and shall include all royalties and costs arising from patents, proprietary items, trademarks, and copyrights

**ARTICLE 11 CORRECTIONS**

Erasures and other changes in bids must be explained or noted over the signature of the Bidder.

**ARTICLE 12 BOND REQUIREMENTS**

**A. BID GUARANTY** – On all bids of \$100,000 or more, security is required to insure the execution of the Contract. No bid will be considered unless it is so guaranteed. Each Bidder must furnish with his bid either a Bid Bond (Form No. DC 2640-5), with good and sufficient sureties, a certified check payable to the order of the Treasurer of the District of Columbia (uncertified check will not be accepted), negotiable United States bonds (at par value), or an irrevocable letter of credit in an amount not less than five percent (5) of the amount of his bid as a guaranty that he will not withdraw said bid within the period specified therein after the opening of the same; or, if no period be specified, within ninety (90) days after said opening, and will, within the period specified therefore, or, if no period be specified, within ten (10) days, after the prescribed forms are forwarded to him for execution (or within any extension of time which may be granted by the officer to whom the bid was addressed) execute and deliver a written Contract on the standard District form in accordance with the bid as accepted and give bond with good and sufficient sureties, as specified below for the faithful performance and proper fulfillment of such Contract and payment of laborers and material men as required by law or, in the event of the withdrawal of said bid within the period above stated, of the failure to enter into such Contract and give such bond within the time above stated, that he will pay to the District the difference between the amount specified in said bid and the amount for which the District may procure the required work, if the latter amount be in excess of the former.

Certified checks and United States bonds will be retained from the apparent first, second and third low Bidders. All other Bidders who have tendered monetary guaranties shall have deposits returned by Certified Mail. Certified checks and United States bonds will be returned to the second and third low Bidders after Award of Contract and to successful Bidders after the signing of prescribed forms of Contract and bond. Guaranty bonds will be returned only upon written application.

**B. PERFORMANCE BOND** – For any construction Contract exceeding \$100,000.00 in amount, a Performance Bond (Form No. DC



2640-7) shall be required in a penal amount equal to 100 percent of the Contract price at time of Award.

Additional performance bond protection shall be required in connection with any modification effecting an increase in price under any contract for which a bond is required pursuant to the above if:

1. The modification is for new or additional Work which is beyond the scope of the existing Contract; or,
2. The modification is pursuant to an existing provision of the Contract and is expected to increase the Contract price by \$50,000 or 25 percent of the original total Contract price, whichever is less.

The penal amount of the bond protection shall be increased so that the total performance bond protection is 100 percent of the Contract price as revised by both the modification requiring such additional protection and the aggregate of any previous modification. The increased penal amount may be secured either by increasing the bond protection provided by existing Surety or sureties or by obtaining an additional performance bond from a new Surety.

- C. PAYMENT BOND** – In accordance with the provisions of Section 702(b) of the District of Columbia Procurement Practices Reform Act of 2010, payment bonds shall be required in an amount not less than 50 percent of the total amount payable by the terms of the Contract.

Additional payment protection shall be required in connection with any modification effecting an increase in price under any Contract for which a bond is required pursuant to the above if:

1. The modification is for new or additional Work which is beyond the scope of the existing Contract; or
2. The modification is pursuant to an existing provision of the Contract and is expected to increase the Contract Price by \$50,000 or 25 percent of the original total Contract Price, whichever is less.

The penal amount of the additional bond protection shall generally be such that the total payment bond protection is 50 percent of the Contract Price as revised by both the modification requiring such additional protection, and the aggregate of any previous modification. The additional protection may be secured either by increasing the bond protection provided by the existing Surety or sureties or by obtaining an additional payment bond from a new Surety.

- D. BOND SOURCE** – The bonds may be obtained from any Surety company authorized by the U.S. Treasury Department as acceptable sureties on Federal Bonds and authorized to transact business in the District of Columbia by the Administrator, Insurance Administration, Department of Consumer and Regulatory Affairs.

### ARTICLE 13 SIGNATURE TO BIDS

Each bid must show the full business address of the Bidder and be signed by him with his usual signature. Bids by partnerships must be signed with the partnership name by one of the members of the partnership or by an authorized representative, followed by the signature and designation of the person signing. Bids by corporations must be signed with the name of the corporation, followed by the signature and designation of the President or Vice President and attested by the Secretary of the Corporation and the corporate seal affixed thereto. If bid is signed by other than the President or Vice President, evidence of authority to so sign must be furnished in the form of an extract of minutes of a meeting of the Board of Directors or extract of bylaws certified by the Corporate Secretary and corporate seal affixed thereto. The names of all persons signing shall be typed or printed below the signatures. A bid by a person who affixes to his signature the word "President", "Vice President", "Secretary", "Agent", or other designation, without disclosing his principal, may be held personally to the bid. Bids submitted by a joint venture must be signed by all authorized parties to the joint venture.

### ARTICLE 14 MARKING AND MAILING BIDS

Bids (from Standard Contract Provisions), addenda acknowledgement, and bid guaranty must be securely sealed in suitable envelopes, addressed and marked on the outside with the name of the Bidder, invitation number, and date of opening

### ARTICLE 15 RECEIVING BIDS, MODIFICATIONS, OR WITHDRAWALS

Bids received prior to the time set for opening will be securely kept unopened. The officer whose duty is to open them will decide when the specified time has arrived and no bid received thereafter will be considered unless: (1) they are sent by registered mail or by certified mail for which an official dated post office stamp (post-mark) on the original Receipt for Certified Mail has been obtained and it is

determined by the District that the late receipt was due solely to delay in the mails for which the Bidder was not responsible; or (2) if submitted by mail (or by telegram if authorized by the Contracting Officer), it is determined by the District that the late receipt was due solely to mishandling by the District after receipt at the District agency: Provided, that timely receipt at such agency is established upon examination of an appropriate date or time stamp or other documentary evidence or receipt within the control of such agency.

Bidders using certified mail are cautioned to obtain a receipt for certified mail showing legible, dated postmark and to retain such receipt against the chance that it will be required as evidence that a late bid was timely mailed. The only evidence acceptable in this matter is as follows: (1) where the Receipt of Certified Mail identifies the post office station of mailing, evidence furnished by the Bidder which established that the business day of the station ended at an earlier time, in which case of the time of mailing shall be deemed to be last minute of the business day; or (2) an entry in ink on the Receipt for Certified Mail showing the time of mailing and the initials of postal employee receiving the item and making the entry, with appropriate written verification of such entry from the post office station of mailing, in which case the time of mailing shall be the time shown in the entry. If the postmark on the original Receipt for Certified Mail does not show a date, the bid shall not be considered.

The time of mailing of late bids submitted by registered or certified mail shall be deemed to be the last minute of the date shown in the postmark on the registered mail receipt or registered mail wrapper or on the Receipt for Certified Mail unless the Bidder furnishes evidence from the post office station of mailing which establishes an earlier time.

No responsibility will attach to the District or any of its officers or employees for the premature opening of a bid not properly addressed and identified. Unless specifically authorized, telegraphic bids will not be considered, but modification by telegram, of bids already submitted will be considered if received prior to the hour set for opening, but should not reveal the amount of the original or revised bid.

#### **ARTICLE 16 WITHDRAWAL OF BIDS**

Bids may be withdrawn on written or telegraphic request received from Bidders prior to the time fixed for opening, provided the name of the Bidder appears on the outside of the envelope containing the bid. Negligence on the part of the Bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened.

#### **ARTICLE 17 OPENING OF BIDS**

At the time fixed for the opening of bids, their contents will be made public by the Department of Transportation for the information of Bidders and other properly interested persons.

#### **ARTICLE 18 AWARD OR REJECTION**

The Contract will be awarded to the lowest responsible Bidder complying with conditions of the bid documents, provided his bid is reasonable and it is in the best interest of the District to accept it. The Bidder to whom Award is made will be notified by the Contracting Officer at the earliest possible date. The District, however, reserves the right to reject any and all bids and to waive any informality in bids received whenever such rejection or waiver is in the best interest of the District.

If more than one bid be offered by any one party, by or in the name of his or their clerk, partner, or other person, all such bids may be rejected. This shall not prevent a Bidder from proceeding under Article 8 hereof, nor from quoting different prices on different qualities of materials or different conditions of delivery. A supplier or material man who has quoted prices on materials to a Bidder is not thereby disqualified from quoting to other Bidders or from submitting a bid directly for the materials or Work.

Each Bidder shall bid on all items in the Pay Item Schedule and in accordance with the instructions below. Failure to bid on all items will give the District the option to reject the bid.

The Contracting Officer reserves the right to waive any informalities, to reject any or all bids, or to readvertise for bids. Awards, if made, will be to the lowest responsible and qualified Bidders whose bids are responsive to the invitation and is most advantageous to the District of Columbia, price and other factors considered.

In addition to requirements for qualification of Bidders as set forth in Article 1 hereof, and as determined by the District, Proposals will be considered irregular and may be rejected by the Contracting Officer for any of, but not limited to, the following reasons:

- A.** Incompetency, inadequate Plant, or insufficient capital as revealed by Bidder's statement on AGC or equivalent form.
- B.** Evidence of collusion.

- C. Uncompleted Work which might hinder or prevent proper and prompt execution and completion of Work contemplated.
- D. Evidence that Bidder has not adequately considered all aspects of contemplated Work.
- E. Failure to settle bills, claims and judgments due for labor and material on Bidder's contracts in force on bid opening date.
- F. Default under previous contracts.
- G. Unacceptable rating as listed on published government lists.
- H. Proposal submission on form other than that form furnished by District, or altered or partially detached form.
- I. Unauthorized additions, deletions, omissions, conditional bids, or irregularities which may make Proposal incomplete or ambiguous in meaning.
- J. Failure to acknowledge all addenda issued.
- K. Failure to submit bid in the properly labeled receptacle in the Bid Room (2nd floor) of the Department of Transportation, 2000 14th Street, N.W., Washington, D.C. 20009, and prior to the time set for opening as governed by the Official Clock designated as such in that Branch; or if bid is mailed, it is received at P.O. Box 43182-9182 by the designated time.

#### **ARTICLE 19 CANCELLATION OF AWARDS**

The right is reserved to the District, without any liability upon the District, to cancel the Award of any Contract at any time prior to approval of a formal written Contract signed by the Contractor and the Contracting Officer.

#### **102.02 PROPOSAL FORMS**

The District will furnish each Bidder a Proposal Form which will state the estimated quantity for each and every item upon which a bid is required, a description of the Work to be done, the time in which the Work must be completed, and the date, place, and time Proposals will be opened. It will also state any Special Provision, Supplemental Specifications or requirements which vary from, or are not contained in, the Standard Specifications.

#### **102.03 RESERVED**

#### **102.04 AFFIRMATIVE ACTION PROGRAM**

Submission by the Contractor and all Subcontractors of an Affirmative Action Plan in compliance with Mayor's Order 85-85 is required. This Affirmative Action Plan must be received by the Contracting Officer, within five (5) working days subsequent to the bid opening. Failure to comply in a timely manner may render a bid non-responsive. Contract Award is conditioned on the approval of the Affirmative Action Program. The goals for minority and female participation are as follows:

- A. The goal for minority participation expressed in percentage terms for the Contractor's workforce in each trade on all construction work in the covered area is 28 percent or such other percentage specified in the Specifications and Bid Forms by the Contracting Officer.
- B. The goal of 6.9%, or such other percentage specified in the Specifications and Bid Forms by the Contracting Officer, for female participation is applicable to the Contractor's aggregate on-site construction workforce. This goal is applicable whether or not part of that workforce is performing work on a Federal or federally-assisted construction contract or subcontract.

These goals are applicable to all of the Contractor's work performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, he or she shall apply to goals established for such geographical area where the Work is subject to the goals for both its federally involved and non-federally involved construction.

Each Bidder should submit a certificate with the bids, signed by an official of the company that he or she is aware of the aforementioned orders and that he or she will comply with them in the performance of the Contract.

**102.05 NON COLLUSION**

Every bid submitted shall contain an affidavit signed by an official of the company submitting the bid that said company has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the proposed Contract.

**102.06 ANTI-DISCRIMINATION CLAUSE**

The Contractor: (1) shall not discriminate in any manner based upon the actual or perceived: race, color, religion, national origin, sex, age, marital status, personal appearance, sexual orientation, gender identity or expression, family responsibilities, genetic information, disability, matriculation, or political affiliation of any employee or applicant for employment in violation of under §2-1401.11 of the District of Columbia Human Rights Act (D.C. Law 2-38; D.C. Code §2-1402.11) and (Title VII of the Civil Rights Act of 1964 ); (2) shall include a similar clause in every subcontract, except subcontracts for standard commercial supplies or raw materials, and (3) shall, along with all Subcontractors, post in a conspicuous place, available to employees and applicants for employment, a notice setting forth the provisions of the nondiscrimination clause set forth under 4 DCMR § 4-1103 ( set out in Section 251 of the District of Columbia Human Rights Act (D.C. Code Anno. Section 1-2522); (4) shall not exclude any person from participation in or deny the benefits of any of the Contractor's programs or activities on the basis of race, color, national origin, sex, age, and disability, including the selection and retention of Subcontractors, under Title VI of the Civil Rights Act of 1964, 49 C.F.R. Part 21, 28 C.F.R. section 50.3 and other related statutes.

**102.07 EQUAL EMPLOYMENT OPPORTUNITY CERTIFICATION**

When required in the Special Provisions the Bidder shall submit a certification with his or her bid that he or she has or has not participated in a contract or subcontract subject to in substance either the equal opportunity provisions of 103.02(E) or Section 202 of Executive Order 11246 of 3 CFR; that he or she has or has not filed all required compliance reports under any such contract or subcontract; and that representation indicating submission of required compliance reports signed by proposed Subcontractors will be obtained prior to subcontract Awards.

**102.08 NONSEGREGATED FACILITIES CERTIFICATION**

When required in the Special Provisions the Bidder shall submit a certification with his or her bid that he or she does not and will not maintain or provide for his or her employees any segregated facility at any of his or her establishments; that he or she does not and will not permit his or her employees to perform their services at any location under his or her control where segregated facilities are maintained; and that he or she will obtain and retain identical certifications from proposed Subcontractors prior to Award of subcontracts exceeding \$10,000.00.

“Segregated facilities” shall mean any waiting room, work area, wash and rest room, eating area, time clock, locker room and other storage or dressing area, parking lot, drinking fountain, recreation or entertainment area, transportation and housing facility, provided for employees which is segregated by explicit directive or is segregated on the basis of race, creed, color, or national origin, because of habit, local custom or otherwise.

Penalty for violations or making false statements is prescribed in 18 USC 1001.

**102.09 RESERVED****102.10 EMPLOYMENT OF THE HANDICAPPED**

Pursuant to the Rehabilitation Act of 1973 (for Federal and federally-assisted projects), DC Human Rights Act of 1977 for District of Columbia-funded projects, and the Americans With Disabilities Act, the Contractor and all Subcontractors agree not to discriminate against any handicapped person who is qualified to perform the job. The Contractor also agrees to take Affirmative Action to hire, advance, and treat handicapped people without discrimination.

**103 STANDARD CONTRACT PROVISIONS****103.01 GENERAL PROVISIONS (CONSTRUCTION CONTRACT)****ARTICLE 1 RESERVED****ARTICLE 2 ORDER OF PRECEDENCE**

The Contractor shall keep on the Work Site a copy of Contract Drawings and Specifications and shall at all times give the Contracting Officer access thereto. Anything mentioned in the Specifications and not shown on the Contract Drawings, or shown on the Contract Drawings and not mentioned in the Specifications, shall be of like effect as if shown or mentioned in both.

All Contract requirements are equally binding. Each Contract requirement, whether or not omitted elsewhere in the Contract, is binding as though occurring in any or all parts of the Contract. In case of discrepancy:

- A. The Contracting Officer shall be promptly notified in writing of any error, discrepancy, or omission, apparent or non-apparent.
- B. Applicable Federal and D.C. Code requirements have priority over: the Contract form, General Provisions, Change Orders, Addenda, Contract Drawings, Special Provisions and Specifications.
- C. The Contract form, General Provisions and Labor Provisions have priority over: Change Orders, Addenda, Contract Drawings, Special Provisions and Specifications.
- D. Change Orders have priority over: Addenda, Contract Drawings and Specifications.
- E. Addenda have priority over: Contract Drawings, Special Provisions and Specifications. A later dated Addendum has priority over earlier dated Addenda.
- F. Special Provisions have priority over: Contract Drawings and Specifications.
- G. Shown and indicated dimensions have priority over scaled dimensions.
- H. Original scale drawings and details have priority over any other different scale drawings and details.
- I. Large scale drawings and details have priority over small scale drawings and details.

**ARTICLE 3 CHANGES**

A. **DESIGNATED CHANGE ORDERS** – The Contracting Officer may, at any time, without notice to the sureties, by written order designated or indicated to be a Change Order, make any change in the Work within the general scope of the Contract, including but not limited to changes:

- 1. In the Contract Drawings and Specifications;
- 2. In the method or manner of performance of the Work;
- 3. In the District furnished facilities, equipment, materials, or services; or;
- 4. Directing acceleration in the performance of the Work.

Nothing provided in this Article shall excuse the Contractor from proceeding with the prosecution of the Work so changed.

B. **OTHER CHANGE ORDERS** – Any other written order or an oral order (which term as used in this Section (B) shall include direction, instruction, interpretation, or determination) from the Contracting Officer, which causes any such change, shall be treated as a Change Order under this Article, provided that the Contractor gives the Contracting Officer written notice stating the date, circumstances and sources of the order and that the Contractor regards the order as a Change Order.

- C. GENERAL REQUIREMENTS** – Except as herein provided, no order, statement or conduct of the Contracting Officer shall be treated as a change under this Article or entitle the Contractor to an equitable adjustment hereunder.

If any change under this Article causes an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of this Work under the Contract, whether or not changed by any order, an equitable adjustment shall be made and the Contract modified in writing accordingly. Provided, however, that except for claims based on defective Specifications, no claim for any change under (B) above shall be allowed for any cost incurred more than twenty (20) days before the Contractor gives written notice as therein required unless this twenty (20) days is extended by the Contracting Officer. In case of defective drawings and Specifications, the equitable adjustment shall include any increased cost reasonably incurred by the Contractor in attempting to comply with such defective drawings and Specifications.

If the Contractor intends to assert a claim for an equitable adjustment under this Article, he must within thirty (30) days after receipt of a written Change Order under (A) above or the furnishing of a written notice under (B) above, submit to the Contracting Officer a written statement setting forth the general nature and monetary extent of such claim, unless this period is extended by the Contracting Officer. The statement of claim hereunder may be included in the notice under (B) above.

No claim by the Contractor for an equitable adjustment hereunder shall be allowed if asserted after final payment under the Contract.

- D. CHANGE ORDER BREAKDOWN** – Contract Prices shall be used for Change Order work where work is of similar nature; no other costs, overhead, or profit will be allowed.

Where Contract Prices are not appropriate and the nature of the change is known in advance of construction, the parties shall attempt to agree on a fully justifiable price adjustment and/or adjustment of completion time.

When Contract Prices are not appropriate, or the parties fail to agree on an equitable adjustment, or in processing claims, equitable adjustments for Change Order work shall be per this Article and Article 4 and shall be based upon the breakdown shown in following subsections 1 through 7. The Contractor shall assemble a complete cost breakdown that lists and substantiates each item of work and each item of cost.

- 1. Labor** – Payment will be made for direct labor cost plus indirect labor cost such as insurance, taxes, fringe benefits and welfare provided such costs are considered reasonable. Indirect costs shall be itemized and verified by receipted invoices. If verification is not possible, up to 18 percent of direct labor costs may be allowed. In addition, up to 20 percent of direct plus indirect labor costs may be allowed for overhead and profit.
- 2. Bond** – Payment for additional bond cost will be made per bond rate schedule submitted to the Department of Transportation with the executed Contract.
- 3. Materials** – Payment for cost of required materials will be F.O.B. (Free On Board) destination (job site) with an allowance up to 15% for overhead and profit.
- 4. Rented Equipment** – Payment for required equipment rented from an outside company that is neither an affiliate of, nor a subsidiary of, the Contractor will be based on receipted invoices which shall not exceed rates given in the current edition of the Rental Rate Blue Book for Construction Equipment published by Data Quest. If actual rental rates exceed manual rates, written justification shall be furnished to the Contracting Officer for consideration. No additional allowance will be made for overhead and profit. The Contractor shall submit written certification to the Contracting Officer that any required rented equipment is neither owned by nor rented from the Contractor or an affiliate of or subsidiary of the Contractor.
- 5. Contractor's Equipment** – Payment for required equipment owned by the Contractor or an affiliate of the Contractor will be based solely on an hourly rate derived by dividing the current appropriate monthly rate by 176 hours. No payment will be made under any circumstances for repair costs, freight and transportation charges, fuel, lubricants, insurance, any other costs and expenses or overhead and profit. Payment for such equipment made idle by delays attributable to the District will be based on one-half the derived hourly rate under this subsection.
- 6. Miscellaneous** – No additional allowance will be made for general superintendence, use of small tools, and other costs for which no specific allowance is herein provided.

7. **Subcontract Work** – Payment for additional necessary subcontract work will be based on applicable procedures in 1 through 6, to which total additional subcontract work up to an additional 10 percent may be allowed for the Contractor’s overhead and profit

#### **ARTICLE 4 EQUITABLE ADJUSTMENT OF CONTRACT TERMS**

Pursuant to 23 CFR 635.109, the Contractor or District may be entitled to an equitable adjustment of the Contract whenever the following situations develop:

##### **A. DIFFERING SITE CONDITIONS**

1. During the progress of the Work, if subsurface or latent physical conditions are encountered at the Site differing materially from those indicated in the Contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the Work provided for in the Contract, are encountered at the Site, the Contractor, upon discovering such conditions, shall promptly notify the Contracting Officer and Engineer in writing of the specific differing conditions before they are disturbed and before the affected Work is performed.
2. Upon written notification, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any Work under the Contract, an adjustment, excluding loss of anticipated profits, will be made and the Contract modified in writing accordingly. The Contracting Officer will notify the Contractor of the determination whether or not an adjustment of the Contract is warranted.
3. No Contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.
4. No Contract adjustment will be allowed under this clause for any effects caused on unchanged Work.

##### **B. SUSPENSIONS OF WORK ORDERED BY THE CONTRACTING OFFICER**

1. If the performance of all or any portion of the Work is suspended or delayed by the Contracting Officer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or Contract Time is due as a result of such suspension or delay, the Contractor shall submit to the Contracting Officer in writing a request for adjustment within seven (7) Calendar Days of receipt of the notice to resume Work. The request shall set forth the reasons and support for such adjustment.
2. Upon receipt, the Contracting Officer will evaluate the Contractor’s request. If the Contracting Officer agrees that the cost and/or time required for the performance of the Contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or Subcontractors at any approved tier, and not caused by weather, the Contracting Officer will make an adjustment (excluding profit) and modify the Contract in writing accordingly. The Contracting Officer will notify the Contractor of the determination of whether or not an adjustment of the Contract is warranted.
3. No Contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.
4. No Contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other terms or condition of this Contract.

##### **C. SIGNIFICANT CHANGES IN THE CHARACTER OF WORK**

1. The Contracting Officer reserves the right to make, in writing, at any time during the Work such changes in quantities and such alterations in the Work as are necessary to satisfactorily complete the Project. Such changes in quantities and alterations shall not invalidate the Contract nor release the Surety, and the Contractor agrees to perform the Work as altered.

2. If the alterations or changes in quantities significantly change the character of the Work under the Contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the Contract. The basis for the adjustment shall be agreed upon prior to the performance of the Work. If a basis cannot be agreed upon, then an adjustment will be made whether for or against the Contractor in such amount as the Contracting Officer may determine to be fair and equitable.
3. If the alteration or changes in quantities significantly change the character of the Work to be performed under the Contract, the altered Work will be paid for as provided elsewhere in the Contract.
4. The term "significant change" shall only apply to the following circumstances:
  - a. When the character of the Work as altered differs materially in kind of nature from that involved or included in the Contract or
  - b. When an item of Work is increased or decreased by more than 25 percent of the original Contract quantity. Any adjustment for an increase or decrease in price shall apply only to that portion in excess of 125 percent of the original Contract item quantity, or in case of a decrease below 75 percent, to the actual amount of Work performed.

#### ARTICLE 5 TERMINATION-DELAYS

If the Contractor refuses or fails to prosecute the Work, or any separable part thereof, with such diligence as will insure its completion within the time specified in the Contract, or any extension thereof, or fails to complete said Work within specified time, the District may, by written notice to the Contractor, terminate his right to proceed with the Work or such part of the Work involving the delay. In such event the District may take over the Work and prosecute the same to completion, by contract or otherwise, and may take possession of and utilize in completing the Work such materials, appliances, and Plant as may have been paid for by the District or may be on the Site of the Work and necessary thereof. Whether or not the Contractor's right to proceed with the Work is terminated, he and his sureties shall be liable for any liability to the District resulting from his refusal or failure to complete the Work within the specified time.

If fixed and agreed Liquidated Damages are provided in the Contract and if the District does not so terminate the Contractor's right to proceed, the resulting damage will consist of such Liquidated Damages until the Work is completed or accepted.

The Contractor's right to proceed shall not be so terminated nor the Contractor charged with resulting damage if:

- A. The delay in the completion of the Work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not restricted to acts of God, acts of the public enemy, acts of the District in either its sovereign or contractual capacity, acts of another Contractor in the performance of a contract with the District, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, climatic conditions beyond the normal which could be anticipated, or delays of Subcontractors or suppliers arising from unforeseeable causes beyond the control and without the fault or negligence of both the Contractor and such Subcontractors or suppliers (the term Subcontractors or suppliers shall mean Subcontractors or suppliers at any tier); and
- B. The Contractor, within ten (10) days from the beginning of any such delay, (unless the Contracting Officer grants a further period of time before the date of final payment under the Contract) notifies the Contracting Officer in writing of the causes of the unforeseeable delay.

The Contracting Officer shall ascertain the facts and the extent of the delay and extend the time for completing the Work when, in his judgment, the findings of fact justify such an extension, and his findings of fact shall be final and conclusive on the parties, subject only to appeal as provided in Article 7 herein.

If after notice of termination of the Contractor's right to proceed under the provisions of this article, it is determined for any reason that the Contractor was not in fault under the provisions of this Article, or that the delay was excusable under the provisions of this Article, the rights and obligations of the parties shall be in accordance with Article 6 herein. Failure to agree to any such adjustment shall be a dispute concerning a question of fact within the meaning of Article 7 herein.

The rights and remedies of the District provided in this Article are in addition to any other rights and remedies provided by law or under the Contract.



The District may, by written notice, terminate the Contract or a portion thereof as a result of an Executive Order of the President of the United States with respect to the prosecution of war or in the interest of national defense. When the Contract is so terminated, no claim for loss of anticipated profits will be permitted.

#### **ARTICLE 6 TERMINATION FOR CONVENIENCE OF THE DISTRICT**

- A.** The performance of Work under the Contract may be terminated by the District in accordance with this Article in whole, or in part, whenever the Contracting Officer shall determine that such termination is in the best interest of the District. Any such termination shall be effected by delivery to the Contractor of a Notice of Termination specifying the extent to which performance of Work under the Contract is terminated, and the date upon which such termination becomes effective
- B.** After receipt of a Notice of Termination, and except as otherwise directed by the Contracting Officer, the Contractor shall:
1. Stop Work under the Contract on the date and to the extent specified in the Notice of Termination.
  2. Place no further orders or subcontracts for materials, services, or facilities except as may be necessary for completion of such portion of the Work under the Contract as is not terminated.
  3. Terminate all orders and subcontracts to the extent that they relate to the performance of Work terminated by the Notice of Termination.
  4. Assign to the District, in the manner, at the times, and to the extent directed by the Contracting Officer, all of the right, title, and interest of the Contractor under the order and subcontracts so terminated, in which case the District shall have the right, in its discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts.
  5. Settle all outstanding liabilities and all claims arising out of such termination of orders or subcontracts, with the approval or ratification of the Contracting Officer to the extent he may require, which approval or ratification shall be final for all purposes of this Article.
  6. Transfer title to the District and deliver in the manner, at the times, and to the extent, if any, directed by the Contracting Officer:
    - a. The fabricated or unfabricated parts, work in progress, completed work, supplies, and other materials procured as a part of, or acquired in connection with, the performance of the Work terminated by the Notice of Termination; and
    - b. The completed or partially completed Plans, drawings, information, and other property which, if the Contract had been completed, would have been required to be furnished to the District.
  7. Use his best efforts to sell, in the manner, at the times, to the extent, and at the price or prices directed or authorized by the Contracting Officer, any property of the types referred to in 6 above provided, however, that the Contractor:
    - a. Shall not be required to extend credit to any purchase, and
    - b. May acquire any property under the conditions prescribed and at a price or prices approved by the Contracting Officer, and
    - c. Provided further, that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the District to the Contractor under the Contract or shall otherwise be credited to the price or cost of the Work covered by the Contract or paid in such other manner as the Contracting Officer may direct.
  8. Complete performance of such part of the Work as shall not have been terminated by the Notice of Termination.
  9. Take such action as may be necessary, or as the Contracting Officer may direct, for the protection and preservation of the property related to the Contract which is in the possession of the Contractor and in which the District has or may acquire an interest.

- 10.** The Contractor shall proceed immediately with the performance of the above obligations notwithstanding any delay in determining or adjusting the cost, or any item of reimbursable cost, under this Article.
- 11.** "Plant clearance period" means, for each particular property classification (such as raw materials, purchased parts, and work in progress) at any one Plant or location, a period beginning with the effective date of the termination for convenience and ending ninety (90) days after receipt by the Contracting Officer of acceptable inventory schedules covering all items at that particular property classification in the termination inventory at that Plant or location, or ending on such later date as may be agreed to by the Contracting Officer and the Contractor. Final phase of Plant clearance period means that part of a Plant clearance period which occurs after the receipt of acceptable inventory schedules covering all items of the particular property classification at the Plant or location.

At any time after expiration of the Plant clearance period, as defined above, the Contractor may submit to the Contracting Officer a list, certified as to quantity and quality, of any or all items of termination inventory not previously disposed of, exclusive of items the disposition of which has been directed or authorized by the Contracting Officer, and may request the District to remove such items or enter into a storage agreement covering them. Not later than fifteen (15) days thereafter, the District will accept title to such items, and remove them or enter into a storage agreement covering the same; provided, that the list submitted shall be subject to verification by the Contracting Officer upon removal of the items or, if the items are stored, within forty-five (45) days from the date of submission of the list, and any necessary adjustments to correct the list as submitted, shall be made prior to final settlement.

- C.** After receipt of a Notice of Termination, the Contractor may submit to the Contracting Officer his termination claim, in the form with the certification prescribed by the Contracting Officer. Such claim shall be submitted promptly but in no event later than one (1) year from the effective date of termination, unless one or more extensions in writing are granted by the Contracting Officer upon request of the Contractor made in writing within such one (1) year period or authorized extension thereof. However, if the Contracting Officer determines that the facts justify such action, he may receive and act upon any such termination claim at any time after such one (1) year period or extension thereof. Upon failure of the Contractor to submit his termination claim within the time allowed, the Contracting Officer may, subject to any review required by the District's procedures in effect as of the date of execution of the Contract, determine on the basis of information available to him, the amount, if any, due to the Contractor by reason of termination and shall thereupon pay to the Contractor the amount so determined.
- D.** Subject to the provisions of C. above, the subject to any review required by the District's procedures in effect as of the date of execution of the Contract, the Contractor and Contracting Officer may agree upon the whole or any part of the amount or amounts to be paid to the Contractor by reason of the total or partial termination of Work pursuant to this Article, which amount or amounts may include a reasonable allowance for profit only on completed Work; provided, that such agreed amount or amounts, exclusive of settlement costs, shall not exceed that total Contract Price as reduced by the amount of payments otherwise made and as further reduced by the Contract price of Work not terminated. The Contract shall be amended accordingly, and the Contractor shall be paid the agreed amount. Nothing in E. below prescribing the amount to be paid to the Contractor in the event of failure of the Contractor and the Contracting Officer to agree upon the whole amount to be paid to the Contractor by reason of the termination of Work pursuant to this Article, shall be deemed to limit, restrict, or otherwise determine or effect the amount or amounts which may be agreed upon to be paid to the Contractor pursuant to this paragraph.
- E.** In the event of the failure of the Contractor and the Contracting Officer to agree as provided in D. above upon the whole amount to be paid to the Contractor by reason of the termination of Work pursuant to this Article, the Contracting Officer shall, subject to any review required by the District's procedures in effect as of the date of execution of the Contract, determine, on the basis of information available to him, the amount, if any, due the Contractor by reason of the termination and shall pay to the Contractor the amounts determined by the Contracting Officer, as follows, but without duplication of any amounts agreed upon in accordance with D. above:
- 1.** With respect to all Contract Work performed prior to the effective date of the Notice of Termination, the total (without duplication of any items) of:
    - a.** The cost of such Work;
    - b.** The cost of settling and paying claims arising out of the termination of Work under subcontracts or orders as provided in B. 5. above, exclusive of the amounts paid or payable on account of supplies or materials delivered or services furnished

by the Subcontractor prior to the effective date of the Notice of Termination of Work under the Contract, which amounts shall be included in the cost on account of which payment is made under E. 1. a. above; and

- c. A sum, as profit on E. 1. a. above, determined by the Contracting Officer to be fair and reasonable; provided however, that if it appears that the Contractor would have sustained a loss on the entire Contract had it been completed, no profit shall be included or allowed under this subparagraph and an appropriate adjustment shall be made reducing the amount of the settlement to reflect the indicated rate of loss; and provided further that profit shall be allowed only on preparation made and Work done by the Contractor for the terminated portion of the Contract but may not be allowed on the Contractor's settlement expenses. Anticipatory profits and consequential damages will not be allowed.
2. The reasonable cost of the preservation as protection of property incurred pursuant to B. 9; and any other reasonable cost incidental to the termination of Work under the Contract including expense incidental to the determination of the amount due to the Contractor as the result of the termination of Work under the Contract.
- F.** The total sum to be paid to the Contractor under E. 1. above shall not exceed the total Contract price as reduced by the amount of payments otherwise made and as further reduced by the Contract price of Work not terminated. Except for normal spoilage, and except to the extent that the District shall have otherwise expressly assumed the risk of loss, there shall be excluded from the amounts payable to the Contractor under E. 1 above, the fair value, as determined by the Contracting Officer, of property which is destroyed, lost, stolen, or damaged so as to become undeliverable to the District, or to a buyer pursuant to B.7. above.
- G.** The Contractor shall have the right of appeal under Article 7. herein, from any determination made by the Contracting Officer under C. or E. above, except that, if the Contractor has failed to submit his claim within the time provided in C. above and has failed to request extension of such time, he shall have no such right of appeal. In any case where the Contracting Officer has made a determination of the amount due under C. and E above, the District shall pay to the Contractor the following:
1. If there is no right of appeal hereunder or if no timely appeal has been taken, the amount so determined by the Contracting Officer, or
  2. If an appeal has been taken, the amount finally determined on such appeal.
- H.** In arriving at the amount due the Contractor under this Article, there shall be deducted:
1. All unliquidated advance or other payments on account theretofore made to the Contractor, applicable to the terminated portion of the Contract;
  2. Any claim which the District may have against the Contractor in connection with the Contract; and
  3. The agreed price for, or the proceeds of sale of, any materials, supplies, or other things kept by the Contractor or sold, pursuant to the provisions of this Article and not otherwise recovered by or credited to the District.
- I.** If the termination hereunder be partial, prior to the settlement of the terminated portion of the Contract, the Contractor may file with the Contracting Officer a request in writing for an equitable adjustment of the price or prices specified in the Contract relating to the continued portion of the Contract (the portion not terminated by the Notice of Termination), and such equitable adjustment as may be agreed upon shall be made at such price or prices; however, nothing contained herein shall limit the right of the District and the Contractor to agree upon the amount or amounts to be paid to the Contractor for the completion of the continued portion of the Contract when said Contract does not contain an established Contract price for such continued portion.
- J.** The District may from time to time, under such terms and conditions as it may prescribe, make partial payments against costs incurred by the Contractor in connection with the terminated portion of the Contract whenever in the opinion of the Contracting Officer the aggregate of such payments shall be within the amount to which the Contractor will be entitled hereunder. If the total of such payments is in excess of the amount finally agreed or determined to be due under this Article, such excess shall be payable by the Contractor to the District upon demand, together with interest computed at the rate of 6 percent per annum for the period from the date such excess is received by the Contractor to the date on which such excess is repaid to the District; provided however, that no interest shall be charged with respect to any such excess payment attributable to a reduction in the Contractor's claim by reason

of retention or other disposition of termination inventory until ten (10) days after the date of such retention or disposition, or such later date as determined by the Contracting Officer by reason of the circumstances.

- K.** Unless otherwise provided in the Contract or by applicable statute, the Contractor, from the effective date of termination and for a period of three (3) years after final settlement under the Contract, shall preserve and make available to the District at all reasonable times at the office of the Contractor, but without direct charge to the District, all his books, records, documents, and other evidence bearing on the costs and expenses of the Contractor under the Contract and relating to the Work terminated hereunder, or, to the extent approved by the Contracting Officer, photographs and other authentic reproductions thereof.

## ARTICLE 7 DISPUTES

All disputes arising under or relating to a Contract shall be resolved as provided herein.

- A. CLAIMS BY A CONTRACTOR AGAINST THE DISTRICT** - Claim, as used in this clause, means a written assertion by the Contractor seeking as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of Contract terms, or other relief arising under or relating to a Contract. A claim arising under a Contract, unlike a claim relating to that Contract, is a claim that can be resolved under a Contract clause that provides for the relief sought by the claimant.
1. All claims by a Contractor against the District arising under or relating to a Contract shall be in writing and shall be submitted to the Contracting Officer for a decision. The Contractor's claim shall include at least the following:
    - a. A description of the claim and the amount in dispute.
    - b. Any data or other information to support the claim.
    - c. A description of the Contractor's efforts to resolve the dispute prior to filing the claim, and
    - d. The Contractor's request for relief or other action by the Contracting Officer.
    - e. Certification that, to the best of the Contractor's knowledge, the cost and pricing data included with the claim is accurate, complete and current as of the date of claim submission. The Contractor shall agree that there is a continuing requirement to update cost and pricing data through the completion date of negotiations with the District. The Contractor shall also agree that prices, including profit or fee, will be adjusted to exclude any significant price increases occurring as a result of cost or pricing data that was inaccurate, incomplete or not current.
  2. The Contracting Officer may meet with the Contractor in a further attempt to resolve the claim by agreement.
  3. For any claim of \$50,000.00 or less, the Contracting Officer shall issue a decision within sixty (60) Calendar Days from receipt of a written request from a Contractor that a decision be rendered within that period.
  4. For any claim over \$50,000.00, the Contracting Officer shall issue a decision within ninety (90) Calendar Days of receipt of the claim. Whenever possible, the Contracting Officer shall take into account such factors as the size and complexity of the claim and the adequacy of the information in support of the claim provided by the Contractor.
  5. The Contracting Officer's written decision shall include the following:
    - a. Provide a description of the claim or dispute.
    - b. Refer to pertinent Contract terms.
    - c. State the factual areas of agreement and disagreement.
    - d. State the reasons for the decision, including any specific findings of fact, although specific findings of fact are not required and, shall not be binding in any subsequent proceeding.

- e. If all or any part of the claim is determined to be valid, determine the amount of monetary settlement, the Contract adjustment to be made, or other relief to be granted.
  - f. Indicate that the written document is the Contracting Officer's final decision, and,
  - g. Inform the Contractor of the right to seek further redress by appealing the decision to the Contract Appeals Board.
6. Any failure by the Contracting Officer to issue a decision on a Contract claim within the required time period will be deemed to be a denial of the claim, and will authorize the commencement of an appeal to the Contract Appeals Board, as authorized by D.C. Official Code§ 2-309.04.
7. If the Contractor is unable to support any part of his or her claim and it is determined that the inability is attributable to a material misrepresentation of fact or fraud on the part of the Contractor, the Contractor shall be liable to the District for an amount equal to the unsupported part of the claim in addition to all costs to the District attributable to the cost of reviewing that part of the Contractor's claim.
- Liability under paragraph 7 above shall be determined within six (6) years of the commission of the misrepresentation of fact or fraud.
8. The decision of the Contracting Officer shall be final and not subject to review unless an administrative appeal or action for judicial review is timely commenced by the Contractor as authorized by D.C. Official Code§ 2-309.04.
9. Pending final decision of an appeal, action, or final settlement, a Contractor shall proceed diligently with performance of the Contract in accordance with the decision of the Contracting Officer.

#### **B. CLAIMS BY THE DISTRICT AGAINST A CONTRACTOR**

1. Claim as used in this clause means a written demand or written assertion by the District seeking, as a matter of right, the payment of money in a sum certain, the adjustment of Contract terms, or other relief arising under or relating to a contract. A claim arising under a contract, unlike a claim relating to that contract, is a claim that can be resolved under a contract clause that provides relief sought by the claimant.
2. All claims by the District against a Contractor arising under or relating to a Contract shall be decided by the Contracting Officer.
- a. The Contracting Officer shall send written notice of the claim to the Contractor. The Contracting Officer's written decision shall do the following:
    - i. Provide a description of the claim or dispute;
    - ii. Refer to pertinent Contract terms;
    - iii. State the factual areas of agreement and disagreement;
    - iv. State the reasons for the decision, including any specific findings of fact, although specific findings of fact are not required and, if made, shall not be binding in any subsequent proceeding;
    - v. If all or any part of the claim is determined to be valid, determine the amount of monetary settlement, the Contract adjustment to be made, or other relief to be granted.
    - vi. Indicate that the written document is the Contracting Officer's final decision, and
    - vii. Inform the Contractor of the right to seek further redress by appealing the decision to the Contract Appeals Board.

- b. The decision shall be supported by reasons and shall inform the Contractor of his or her rights as provided herein.
  - c. The authority contained in this clause shall not apply to a claim or dispute for penalties or forfeitures prescribed by statute or regulation which another District agency is specifically authorized to administer, settle, or determine.
  - d. This clause shall not authorize the Contracting Officer to settle, compromise, pay, or otherwise adjust any claim involving fraud.
3. The decision of the Contracting Officer shall be final and not subject to review unless an administrative appeal or action of judicial review is timely commenced by the District as authorized by D.C. Official Code§ 2-309.04.
  4. Pending final decision of an appeal, action or final settlement, the Contractor shall proceed diligently with performance of the Contract in accordance with the decision of the Contracting Officer.

#### **ARTICLE 8 PROTESTS**

Any actual or prospective Bidder, offerer or Contractor who is aggrieved in connection with the solicitation or Award of a Contract, must file with the D.C. Contract Appeals Board (Board) a protest no later than ten (10) business days after the basis of the protest is known or should have been known, whichever is earlier. A protest based on alleged improprieties in a solicitation which are apparent prior to bid opening or the time set for receipt of initial Proposals shall be filed with the Board prior to bid opening or the time set for receipt of initial Proposals. In procurement in which Proposals are requested, alleged improprieties which do not exist in the initial solicitation, but which are subsequently incorporated into this solicitation, must be protested no later than the next closing time for receipt of Proposals following the incorporation. The protest shall be filed in writing, with the Contract Appeals Board, 717 14th Street, N.W., Suite 430, Washington, D.C. 20004. The aggrieved persons shall also mail a copy of the protest to the Contracting Officer for the solicitation.

#### **ARTICLE 9 PAYMENTS TO CONTRACTOR**

The District will pay the Contract Price or prices as hereinafter provided in accordance with District and Federal regulations.

The District will make progress payments monthly as the Work proceeds, or at more frequent intervals as determined by the Contracting Officer, on estimates approved by the Contracting Officer. The Contractor shall furnish a breakdown of the total Contract Price showing the amount included therein for each principal category of the Work, in such detail as requested, to provide a basis for determining progress payments. In the preparation of estimates the Contracting Officer, at his discretion, may authorize material delivered on the Site and preparatory Work done to be taken into consideration. Material delivered to the Contractor at locations other than the Site may also be taken into consideration:

- A. If such consideration is specifically authorized by the Contract;
- B. If the Contractor furnishes satisfactory evidence that he has acquired title to such material, that it meets Contract requirements and that it will be utilized on the Work covered by the Contract; and
- C. If the Contractor furnishes to the Contracting Officer an itemized list.

The Contracting Officer at his/her discretion shall cause to be withheld retention in an amount sufficient to protect the interest of the District of Columbia. The amount shall not exceed ten percent of the partial payment. However, if the Contracting Officer, at any time finds that satisfactory progress is being made, he/she may authorize any of the remaining progress payments to be made in full or may retain from such remaining partial payments less than 10 percent thereof. Also, whenever Work is substantially complete, the Contracting Officer, if he considers the amount retained to be in excess of the amount adequate for the protection of the District, at his/her discretion, may release to the Contractor all or a portion of such excess amount. Furthermore, on completion and acceptance of each separate building, public work, or other division of the Contract, on which the price is stated separately in the Contract, payment may be made thereof without the retention of percentage, less authorized deductions.

All material and Work covered by progress payments made shall thereupon become the sole property of the District, but this provision shall not be construed as relieving the Contractor from the sole responsibility for all material and Work upon which payments have been made or the restoration of any damaged work, or as waiving the right of the District to require the fulfillment of all of the terms of the Contract.

Upon completion and acceptance of all Work, the amount due the Contractor under the Contract shall be paid upon presentation of a properly executed voucher and after a release, if required, of all claims against the District arising by virtue of the Contract, other than claims instated amounts as may be specifically excepted by the Contractor from the operation of the release.

All payments by the District to the Contractor are subject to the provisions of D.C. Law 9-81 (District of Columbia Government Quick Payment Act of 1984 Amendment Act of 1992).

#### **ARTICLE 10 TRANSFER OR ASSIGNMENT**

Unless otherwise provided by law, neither the Contract nor any interest therein may be transferred or assigned by the Contractor to any other party without the written consent of the Contracting Officer nor without the written acceptance by the Surety on the Performance and Payment Bond securing the Contract of the assignee as the Contractor and the principal on such bond; and any attempted transfer or assignment not authorized by this Article shall constitute a breach of the Contract and the District may for such cause terminate the right of the Contractor to proceed in the same manner as provided in Article 5 herein, and the Contractor and his sureties shall be liable to the District for any excess cost occasioned the District thereby.

#### **ARTICLE 11 MATERIAL AND WORKMANSHIP**

- A. GENERAL** – Unless otherwise specifically provided in the Contract, all equipment, material, and articles incorporated in the Work covered by the Contract shall be new and of the most suitable grade for the purpose intended. Unless otherwise specifically provided in the Contract, reference to any equipment, material, article, or patented process, by trade name, make, or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition, and the Contractor may use any equipment, material, article, or process which, in the judgment of the Chief Engineer, is equivalent to that named unless otherwise specified. The Contractor shall furnish to the Chief Engineer for his approval the name of the manufacturer, the model number, and other identifying data and information respecting the performance, capacity, nature, and rating of the mechanical and other equipment which the Contractor contemplates incorporating in the Work. Machinery and equipment shall be in proper condition. When required by the Contract or when called for by the Chief Engineer, the Contractor shall furnish the Chief Engineer for approval full information concerning the material or articles which he contemplates incorporating in the Work. When so directed, samples shall be submitted for approval at the Contractor's expense, with all shipping charges prepaid. Machinery, equipment, material, and articles installed or used without required approval shall be at the risk of subsequent rejection and subject to satisfactory replacement at Contractor's expense.
- B. SURPLUS MATERIALS USE** – Whenever specified in the Contract or authorized by the Chief Engineer that materials become the property of the Contractor, which by reference or otherwise shall include disposal of materials, it is understood that the Contractor accepts such materials "as is" with no further expense or liability to the District. If such material specified in the Contract will have a potential or real interest of value, the Contractor shall make allowance in the Contract to show such value.
- C. DISTRICT MATERIAL** – No material or equipment shall be furnished by the District unless specific provisions have been made by and authorized by the Contracting Officer. Any material and equipment that is authorized to be supplied to the Contractor by the District shall not be applied to any other use, public or private, than that for which they are issued to the Contractor. The full amount of the cost to the District of all materials and equipment furnished by the District to the Contractor, and for which no charge is made, which are not accounted for by the Contractor to the satisfaction of the Contracting Officer or Chief Engineer, will be charged against the Contractor and his sureties. These costs may be deducted from any monies due the Contractor, and this charge shall be in addition to and not in lieu of any other liabilities of the Contractor whether civil or criminal. Materials and equipment furnished by the District for which a charge is made at a rate mentioned in the Contract will be delivered to the Contractor upon proper requisitions thereof and will be charged to his account.
- D. PLANT** – The Contractor shall at all times employ sufficient tools and equipment for prosecuting the various classes of work to full completion in the manner and time required. The Contractor shall at all times perform work in sufficient light and shall provide proper illumination, including lighting required for night work as directed, as a Contract requirement.

All equipment, tools, formwork, and staging used on the Project shall be of sufficient size and in proper mechanical and safe condition to meet work requirements, to produce satisfactory work quality and to prevent injury to persons, the Project, or adjacent property.

When methods and equipment are not prescribed in the Contract, the Contractor is free to use tools, methods, and equipment that he satisfactorily demonstrates will accomplish the Work in conformity with Contract requirements.

If the Contractor desires to use a method or type of tool or equipment other than specified in the Contract, he shall request approval to do so; the request shall be in writing and shall include a full description of proposed methods, tools, and equipment and reasons for the change or substitution. Approval of substitutions and changed methods will be on condition that the Contractor will be fully responsible for producing Work meeting Contract requirements. If, after trial use of the substituted methods, tools, and equipment, the Chief Engineer determines that Work produced does not meet Contract requirements, the Contractor shall complete remaining Work with specified methods, tools, and equipment.

**E. CAPABILITY OF WORKERS** – All Work under the Contract shall be performed in a skillful and workmanlike manner. The Chief Engineer may require the Contractor to remove from the Work any such employees as the Chief Engineer deems incompetent, careless, insubordinate, or otherwise objectionable, or whose continued employment on the Work is deemed by the Chief Engineer to be contrary to the public interest. Such request will be in writing.

**F. CONFORMITY OF WORK AND MATERIALS** – All Work performed and materials and products furnished shall be in conformity, within indicated tolerances, with lines, grades, cross sections, details, dimensions, materials, and construction requirements shown or intended by the drawings and Specifications.

When materials, products, or work cannot be corrected, written notice of rejection will be issued. Rejected materials, products, and work shall be eliminated from the Project and acceptably replaced at Contractor's expense. The Chief Engineer's failure to reject any portion of the Project shall not constitute implied acceptance nor in any way release the Contractor from Contract requirements.

**G. UNAUTHORIZED WORK AND MATERIALS** – Work performed or materials ordered or furnished for the Project deviating from requirements without written authority will be considered unauthorized and at Contractor's expense. The District is not obligated to pay for unauthorized work. Unauthorized work and materials may be ordered removed and replaced at Contractor's expense.

## ARTICLE 12 INSPECTION AND ACCEPTANCE

Except as otherwise provided in the Contract, inspection and test by the District of material and workmanship required by the District shall be made at reasonable times and at the Site of the Work, unless the Chief Engineer determines that such inspection or test of material which is to be incorporated in the Work shall be made at the place of production, manufacture, or shipment of such material. To the extent specified by the Chief Engineer at the time of determining to make off-site inspection or test, such inspection or test shall be conclusive as to whether the material involved conforms to Contract requirements. Such off-site inspection or test shall not relieve the Contractor of responsibility for damage to or loss of the material prior to acceptance, nor in any way affect the continuing rights of the District after acceptance of the completed Work under the terms of the last paragraph of this Article, except as herein above provided.

The Contractor shall, without charge, replace any material and correct any workmanship found by the District not to conform to the Contract requirements, unless in the public interest the District consents to accept such material or workmanship with an appropriate adjustment in the Contract price. The Contractor shall promptly segregate and remove rejected material from the premises at Contractor's expense.

If the Contractor does not promptly replace rejected material or correct rejected workmanship, the District:

- A.** May, by Contract or otherwise, replace such material and correct such workmanship and charge the cost thereof to the Contractor, or
- B.** May terminate the Contractor's Right to Proceed in accordance with Article 5 herein.

The Contractor shall furnish promptly, without additional cost to the District, all facilities, labor and material needed for performing such safe and convenient inspection and test as may be required by the Chief Engineer. All inspections and tests by the District shall be performed in such manner as not unnecessarily to delay the Work. Special, full size, and performance tests shall be performed as described in the Contract. The Contractor shall be charged with any additional cost of inspection when material and workmanship are not ready for inspection at the time specified by the Contractor.

Should it be considered necessary or advisable by the Chief Engineer at any time before acceptance of the Work, either in part or in its entirety, to make an examination of Work completed, by removing or tearing out same, the Contractor shall, on request promptly furnish all necessary facilities, labor and material to do same. If such Work is found to be defective or nonconforming in any material respect,



due to the fault of the Contractor or his Subcontractors, he shall defray all the expenses of such examination and of satisfactory reconstruction. If, however, such Work is found to meet the requirements of the Contract, an equitable adjustment shall be made in the Contract price to compensate the Contractor for the additional services involved in such examination and reconstruction and, if completion of the Work has been delayed thereby, he shall, in addition, be granted an equitable extension of time.

Unless otherwise provided in the Contract, acceptance by the District will be made as promptly as practicable after completion and inspection of all Work required by the Contract. Acceptance shall be final and conclusive except as regards to latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the District's rights under any warranty or guaranty.

The warranty of all Work shall commence at Substantial Completion and continue for a period of 2 years. If the Department declares partial Substantial Completion on any portion of the Work in advance of the final project Substantial Completion, the warranty period shall commence on the date of partial Substantial Completion and continue for a period of 2 years.

The Department at any time during the warranty period may conduct an inspection of the Work in order to determine conformance to the Contract. If a determination is made by the Department that defective work of any nature is present and is the responsibility of the Contractor, the Contractor shall immediately make corrective action to bring the defective Work into compliance with the Contract, or to the satisfaction of the Department, and at no expense of the Department.

### **ARTICLE 13 SUPERINTENDENCE BY CONTRACTOR**

The Contractor shall give his personal superintendence to the performance of the Work or have a competent foreman or Superintendent, satisfactory to the Chief Engineer, on the Work Site at all times during progress, with authority to act for him.

### **ARTICLE 14 PERMITS AND RESPONSIBILITIES**

The Contractor shall, without expense to the District, be responsible for obtaining any necessary licenses, certificates, and permits, and for complying with any applicable Federal, State, and Municipal laws, codes, and regulations, in connection with the prosecution of the Work. He shall be similarly responsible for all damages to persons or property that occur as a result of his fault or negligence. He shall take proper safety, health and environmental precautions to protect the Work, the workers, the public, and the property of others. He shall also be responsible for all materials delivered and Work performed until completion and acceptance of the entire construction work, except for any completed unit of construction thereof which theretofore may have been accepted.

### **ARTICLE 15 INDEMNIFICATION**

The Contractor shall indemnify and save harmless the District and all of its officers, agents, and servants against any and all claims or liability arising from or based on, or as a consequence or result of, any act, omission or default of the Contractor, his employees, or his Subcontractors, in the performance of, or in connection with, any work required, contemplated, or performed under the Contract.

### **ARTICLE 16 PROTECTION AGAINST TRESPASS**

Except as otherwise expressly provided in the Contract, the Contractor is authorized to refuse admission either to the premises or to the working space covered by the Contract to any person whose admission is not specifically authorized in writing by the Contracting Officer.

### **ARTICLE 17 CONDITIONS AFFECTING THE WORK**

**A. GENERAL** – The Contractor shall be responsible for having taken steps reasonably necessary to ascertain the nature and location of the Work, and the general and local conditions which can affect the Work and the cost thereof. Any failure by the Contractor to do so will not relieve him from responsibility for successfully performing the Work specified without additional expense to the District. The District assumes no responsibility for any understanding or representation concerning conditions made by any of its officers or agents prior to the execution of the Contract, unless such understanding or representation by the District is expressly stated in the Contract.

**B. WORK AND STORAGE SPACE** – Available work and storage space designated by the

District shall be developed as required by the Contract or restored at completion of the Project by the Contractor to a condition equivalent to that existing prior to construction. No payment will be made for furnishing or restoration of any work and storage space.

If no area is designated or the area designated is not sufficient for the Contractor's operations, he shall obtain necessary space elsewhere at no expense or liability to the District.

- C. WORK ON WEEKENDS, LEGAL HOLIDAYS, AND AT NIGHT** – No work shall be done at any time on Sundays or legal holidays, or Saturdays before 9 a.m. or after 5:00 p.m., or on any other day before 7 a.m. or after 7 p.m., except with the written permission of the Contracting Officer or his designee, or as otherwise specified in the Contract Documents, and pursuant to the requirements of the Police Regulations of the District.
- D. EXISTING FEATURES** – Subsurface and topographic information including borings data, utilities data, and other physical data contained in the Contract or otherwise available, are not intended as representations or warranties but are furnished as available information. The District assumes no expense or liability for the accuracy of, or interpretations made from, existing features. The Contractor shall be responsible for reasonable consideration of existing features above and below ground which may affect the Project.
- E. UTILITIES AND VAULTS** – The Contractor shall take all necessary measures to prevent interruption of service or damage to existing utilities within or adjacent to the Project. It shall be the Contractor's responsibility to determine, by visual means, if applicable, exact locations of all utilities in the field that impact the Work, including but not limited to the use of test pits or other similar visual conformation techniques.

For any underground utility or vault encountered, the Contractor shall immediately notify the Chief Engineer and take necessary measures to protect the utility or vault and maintain its service until relocation by owner is accomplished. No additional payment will be made for the encountering of these obstructions.

In case of damage to utilities by the Contractor, either above or below ground, the Contractor shall restore such utilities to a condition equivalent to that which existed prior to the damage by repairing, rebuilding, or otherwise restoring as may be directed, at the Contractor's sole expense. Damaged utilities shall be repaired by the Contractor or, when directed by the Contracting Officer, the utility owner will make needed repairs at the Contractor's expense.

No compensation, other than authorized time extensions, will be allowed the Contractor for protective measures, work interruptions, changes in construction sequence, changes in methods of handling excavation and drainage, or changes in types of equipment used, made necessary by existing utilities, imprecise utility or vault information, or by others performing work within or adjacent to the Project.

- F. SITE MAINTENANCE** – The Contractor shall maintain the Project Site in a neat and presentable manner throughout the course of all operations, and shall be responsible for such maintenance until final acceptance by the District. Trash containers shall be furnished, maintained, and emptied by the Contractor to the satisfaction of the Chief Engineer. Excavated earthwork, stripped forms, and all other materials and debris not scheduled for reuse on the Project shall be promptly removed from the Site.

The Chief Engineer may order the Contractor to clean up the Project Site at any stage of work at no added expense to the District within 24 hours of the request. If the Contractor fails to comply with this order, the Contracting Officer may require the work to be done by others and the costs will be charged to the Contractor.

Upon completion of all Work and prior to final inspection, the Contractor shall clean up and remove from the Project area and adjacent areas all excess materials, equipment, temporary Structures, and refuse, and restore said areas to an acceptable condition.

- G. PRIVATE WORK** – Except as specifically authorized by the Contracting Officer, the Contractor shall not perform any private work abutting District projects with any labor, materials, tools, equipment, supplies, or supervision scheduled for the Contract until all Work under the Contract has been completed. Contract materials used for any unauthorized purpose shall be subtracted from Contract amount.
- H. DISTRICT OF COLUMBIA NOISE CONTROL ACT OF 1977** – The Contractor shall be in strict compliance with D.C. Law 2-53, District of Columbia Noise Control Act of 1977 and all provisions thereof effective March 16, 1978 (24 D.C. Register 5293).

## ARTICLE 18 OTHER CONTRACTS

The District may undertake or Award other contracts for additional Work and the Contractor shall fully cooperate with such other contractors and District employees and carefully coordinate his own work with such additional work as may be directed by the

Contracting Officer. The Contractor shall not commit or permit any act which will interfere with the performance of work by any other contractor or by District employees. The District assumes no liability, other than authorized time extension, for Contract delays and damages resulting from delays and lack of progress by others.

#### **ARTICLE 19 PATENT INDEMNITY**

Except as otherwise provided, the Contractor agrees to indemnify the District and its officers, agents, and employees against liability, including costs and expenses, for infringement upon any Letters Patent of the United States (except Letters Patent issued upon an application which is now or may hereafter be, for reasons of national security, ordered by the Federal Government to be kept classified or otherwise withheld from issue) arising out of the performance of the Contract or out of the use or disposal by or for the account of the District, of supplies furnished or construction work performed hereunder.

#### **ARTICLE 20 COVENANT AGAINST CONTINGENT FEES**

The Contractor warrants that no persons or selling agency has been employed or retained to solicit or secure the Contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty the District shall have the right to terminate the Contract without liability or in its discretion to deduct from, the Contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.

#### **ARTICLE 21 APPOINTMENT OF ATTORNEY**

The Contractor does hereby irrevocably designate and appoint the Clerk of the Superior Court of the District of Columbia and his successors in office as the true and lawful attorney of the Contractor for the purpose of receiving service of all notices and processes issued by any court in the District, as well as service of all pleadings and other papers, in relation to any action or legal proceeding arising out of or pertaining to the Contract or the Work required or performed hereunder.

The Contractor expressly agrees that the validity of any service upon the said Clerk as herein authorized shall not be affected either by the fact that the Contractor was personally within the District and otherwise subject to personal service at the time of such service upon the said Clerk or by the fact that the Contractor failed to receive a copy of such process, notice, pleading or other paper so served upon the said Clerk, provided that said Clerk shall have deposited in the United States mail, certified and postage prepaid, a copy of such process, notice, pleading, or other papers addressed to the Contractor at the address stated in the Contract.

#### **ARTICLE 22 OFFICIALS NOT TO BENEFIT**

No Member of or Delegate to Congress or Mayor or Member of the City Council or officer or employee of the District shall be admitted to any share or part of the Contract or to any benefit that may arise therefrom and any Contract entered into by any Contracting Officer in which he or any officer or employee of the District shall be personally interested shall be void, and no payment shall be made thereon by the Director or any officer thereof; but this provision shall not be construed to extend to the Contract if made with a corporation for its general benefit.

#### **ARTICLE 23 WAIVER**

No waiver of any breach of any provision of the Contract shall operate as a waiver of such provision or of the Contract or as a waiver of subsequent or other breaches of the same or any other provision of the Contract; nor shall any action or non-action by the Contracting Officer or by the Mayor be construed as a waiver of any provision of the Contract or of any breach thereof unless the same has been expressly declared or recognized as a waiver by the Contracting Officer or the Mayor in writing.

#### **ARTICLE 24 BUY AMERICAN**

**A. AGREEMENT** – In accordance with the Buy American Act (41 USC 10a-10d), and Executive Order 10582, December 17, 1954 (3 CFR, 1954-58 Comp., p. 230), as amended by Executive Order 11051, September 27, 1962 (3 CFR, 1059-63 Comp., p 635), the Contractor agrees that only domestic construction material will be used by the Contractor, Subcontractors, material men, and suppliers in the performance of the Contract, except for non-domestic material listed in the Contract.

**B. DOMESTIC CONSTRUCTION MATERIAL** – “Construction material” means any article, material, or supply brought to the construction Site for incorporation in the building or work. An unmanufactured construction material is a “domestic construction material” if it has been mined or produced in the United States. A manufactured construction material is a “domestic construction

material” if it has been manufactured in the United States and if the cost of its components which have been mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. “Component” means any article, material, or supply directly incorporated in a construction material.

- C. **DOMESTIC COMPONENT** – A component shall be considered to have been “mined, produced, or manufactured in the United States” regardless of its source, in fact, if the article, material, or supply in which it is incorporated was manufactured in the United States and the component is of a class or kind determined by the District to be not mined, produced, or manufactured in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality.
- D. **FOREIGN MATERIAL** – When steel materials are used in a project a minimal use of foreign steel is permitted. The cost of such materials cannot exceed one-tenth of one percent of the total project cost, or \$2,500.00, whichever is greater.

## ARTICLE 25 TAXES

- A. **FEDERAL EXCISE** – Materials, supplies, and equipment are not subject to the Federal Manufacturer’s Excise Tax, if they are furnished or used in connection with the Contract provided that title to such materials, supplies, and equipment passes to the District under the Contract. The Contractor shall in such cases furnish his Subcontractors and suppliers with a purchaser’s certificate in the form prescribed by the U.S. Internal Revenue Service.
- B. **SALES AND USE TAXES** – Materials which are physically incorporated as a permanent part of real property are not subject to District of Columbia Sales and Use Tax. The Contractor shall, when purchasing such materials, furnish his suppliers with a Contractor’s Exempt Purchase Certificate in the form prescribed in the Sales and Use Tax Regulations of the District of Columbia. Where the Contractor, Subcontractor, or material supplier has already paid the Sales and Use Tax on materials, as prescribed above, the Sales and Use Tax Regulations of the District of Columbia permit the Contractor, Subcontractor, or material man to deduct the sales or use tax on the purchase price of the same on his next monthly return as an adjustment. However, the Contractor, Subcontractor, or material supplier must satisfy the Finance Officer, D.C., that no sum in reimbursement of such tax was included in the Contract or else that the District has received a credit under the Contract in an amount equal to such tax.

District of Columbia Sales and Use Tax shall be paid on any material and supplies, including equipment rentals, which do not become a physical part of the finished Project. (See District of Columbia Sales and Use Tax Administration Ruling No. 6).

The Contractor, Subcontractor or material supplier shall provide proof of compliance with the provisions of D.C. Law 9-260, as amended, codified in D.C. Code Title 46-103- Employer Contributions, prior to Contract Award.

The Contractor, Subcontractor or material supplier shall provide proof of compliance with the applicable tax filing and licensing requirements set forth in D.C. Code, Title 47- Taxation and Fiscal Affairs, prior to Contract Award.

## ARTICLE 26 SUSPENSION OF WORK

The Contracting Office may order the Contractor in writing to suspend, delay, or interrupt all or any part of the Work for such period of time as he may determine to be appropriate for the convenience of the District.

If the performance of all or any part of the Work is, for an unreasonable period of time, suspended, delayed or interrupted by an act of the Contracting Officer in the administration of the Contract, or by his failure to act within the time specified in the Contract (or, if no time is specified, within a reasonable time), an adjustment may be made for an increase in the cost of performance of the Contract (excluding profit) necessarily caused by such unreasonable suspension, delay or interruption and the Contract modified in writing accordingly. However, no adjustment will be made under this Article for any suspension, delay or interruption to the extent:

- A. That performance would have been so suspended, delayed or interrupted by any other cause, including the fault or negligence of the Contractor, or
- B. For which an equitable adjustment is provided or excluded under any other provision of the Contract.
- C. No claim under this Article shall be allowed:
  - 1. For any costs incurred more than twenty (20) days before the Contractor shall have notified the Contracting Officer in writing of the act or failure to act involved (but this requirement shall not apply as to a claim resulting from a suspension order), and

2. Unless the claim, in an amount stated, is asserted in writing as soon as practicable after the termination of such suspension, delay or interruption, but not later than the date of final payment under the Contract.

#### **ARTICLE 27 SAFETY PROGRAM**

- A. GENERAL** – In order to provide safety controls for the protection of the life and health of District and Contract employees and the general public; prevention of damage to property, materials, supplies, and equipment; and for avoidance of work interruptions in the performance of the Contract, the Contractor shall comply with all applicable Federal and local laws governing safety, health, and sanitation including the Safety Standards, Rules and Regulations issued by the American National Standards, U.S. Department of Labor, U.S. Department of Health and Human Services, D.C. Minimum Wage and Industrial Safety Board and the latest edition of “Manual of Uniform Traffic Control Devices” issued by the Federal Highway Administration.

The Contractor shall also take or cause to be taken such additional safety measures as the Chief Engineer may determine to be reasonably necessary.

The Contractor shall designate one person to be responsible for carrying out the Contractor’s obligation under this Article.

The Contractor shall maintain an accurate record of all accidents resulting in death, injury, occupational disease and/or damage to property, materials, supplies and equipment incidental to Work performed under the Contract. Copies of these reports shall be furnished to the Chief Engineer within two (2) working days after occurrence.

The Chief Engineer will notify the Contractor of any noncompliance with the foregoing provisions and the action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or his representative at the Site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Chief Engineer may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

This Article is applicable to all Subcontractors used under the Contract and compliance with these provisions by the Subcontractors will be responsibility of the Contractor.

(In Contracts involving work of short duration or of nonhazardous character, the following Section B. will be deleted by Special Provision.)

- B. CONTRACTOR’S PROGRAM SUBMISSION** – Prior to commencement of the Work, the Contractor shall:
1. Submit in writing to the Contracting Officer for his approval his program for complying with this Article for accident prevention.
  2. Meet with the Contracting Officer’s Safety Representative after submission of the above program to develop a mutual understanding relative to the administration of the overall safety program.

#### **ARTICLE 28 RETENTION OF RECORDS**

Unless otherwise provided in the Contract, or by applicable statute, the Contractor, from the effective date of Contract and for a period of three (3) years after final settlement under the Contract, shall preserve and make available to the District at all reasonable times at the office of the Contractor but without direct charge to the District, all his books, records, documents and other evidence, bearing on the costs and expenses of the Contractor under the Contract.

#### **103.02 CONTRACT LABOR PROVISIONS**

The provisions of the Federal Labor Standards (construction contracts) of the Standard Contract Provisions, as amended or modified, that are applicable to the Project are made a part of the construction Contract. The Contractor shall keep fully informed of these articles which in any manner affect those engaged or employed on the Work. He shall at all times observe and comply with these provisions. Penalty formulations of the Federal Labor Standards are prescribed in Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

- A. STANDARD CONTRACT CLAUSES** - Each Contract and subcontract at any tier “in excess of \$2,000 which is entered into for

the actual construction, alteration and/or repair, including painting and decoration of a public building or public work, or building” shall be subject to these labor provisions.

## 1. Minimum Wages

- a. All laborers and mechanics employed or working upon the Site of the Work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the Project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor, United States Department of Labor, hereinafter referred to as the Secretary of Labor, under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at the time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under (1)(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics, are considered wages paid to such laborers or mechanics subject to the provisions of 103.02A.1.(iv); also regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 103.02A.(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer’s payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under 103.02A (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its Subcontractors at the Site of the Work in a prominent and accessible place where it can be easily seen by the workers.

- b. The Contracting Officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the Contract shall be classified in conformance with the wage determination. The Contracting Officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
- i. Except with respect to helpers as defined in 29 CFR 5.2(n)(4), the Work to be performed by the classification requested is not performed by a classification in the wage determination; and
  - ii. The classification is utilized in the area by the construction industry; and
  - iii. The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination: and.
  - iv. With respect to helpers as defined in 29 CFR 5.2 (n)(4), such a classification prevails in the area in which the Work is performed.
- c. If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, agree with the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the Contracting Officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, D.C. 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within thirty (30) days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the thirty (30) day period that additional time is necessary.
- d. In the event the Contractor, or the laborers or mechanics to be employed in the classification or their representatives, and the Contracting Officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the Contracting Officer shall refer the questions, including the views of all interested

parties and the recommendation of the Contracting Officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within thirty (30) days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the thirty (30) day period that additional time is necessary.

- e. The wage rate (including fringe benefits where appropriate) determined pursuant to (B) and (C) above shall be paid to all workers performing work in the classification under this Contract from the first day on which work is performed in the classification.
  - f. Whenever the minimum wage rate prescribed in the Contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
  - g. If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any cost reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.
2. **Withholding** - The Contracting Officer shall upon his or her own action or upon written request of an authorized representative of the United States Department of Labor withhold or cause to be withheld from the Contractor under this Contract or any other Federal contract with the same prime Contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime Contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any Subcontractor the full amount of wages required by the Contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the Site of the Work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the Project), all or part of the wages required by the Contract, the Contracting Officer may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.
3. **Payrolls And Basic Records**
- a. Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the Work and preserved for a period of three (3) years thereafter for all laborers and mechanics working at the Site of the Work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the Project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly numbers of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approval programs shall maintain written evidence of the registration of apprenticeship programs, the certification of trainee programs, the registration of the apprenticeship programs, the certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.
  - b. The Contractor shall submit weekly for each week in which any Contract Work is performed a copy of all payrolls to the District of Columbia Government if the agency is a party to the Contract, but if the agency is not such a party, the Contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the District of Columbia Government. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 5.5(a)(3)(i) of Regulations, 29 CFR Part 5. This information may be submitted in any form desired. Optional Form WH-347 may be purchased for this purpose from the Superintendent of Documents (FSN 029-005-0014-

1), U.S. Government Printing Office, Washington, D.C. 20402. The prime Contractor is responsible for the submission of copies of payrolls by all Subcontractors.

Each payroll submitted shall be accompanied by a "Statement of Compliance" signed by the Contractor or Subcontractor or his or her agent who pays or supervises the payment of the persons employed under the Contract and shall certify the following:

- i. That the payroll for the payroll period contains the information required to be maintained under 5.5(a)(3)(i) of Regulations, 29 CFR Part 5 and that such information is correct and complete;
- ii. That each laborer or mechanic (including each helper, apprentice and trainee) employed on the Contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR Part 3;
- iii. That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the Contract.

The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by (B) immediately above.

The Contractor shall notify the Contracting Officer in writing of all periods in which no work is performed. This notification applies to the prime Contractor and to all Subcontractors.

The falsification of any of the above certifications may subject the Contractor or Subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

- c. The Contractor or Subcontractor shall make the records required under 103.02A.3.(i) available for inspection, copying, or transcription by authorized representatives of the Contracting Officer or the United States Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the Contractor or Subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

#### 4. Apprentices And Trainees

- a. *Apprentices* - Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first ninety (90) days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeypersons on the job Site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job Site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a Contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyperson hourly rate) specified in the Contractor's or Subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyperson's hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship



program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- b. *Trainees* - Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeypersons on the job Site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeypersons hourly rate specified in the applicable wage determination.

Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job Site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- c. *Equal Employment Opportunity* - The utilization of apprentices, trainees, and journeypersons under this part shall be in conformity with the equal employment opportunity requirements and Executive Order 11246, as amended and 29 CFR Part 30.

5. **Compliance With Copeland Act Requirements** - The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this Contract.
6. **Subcontracts** - The Contractor or Subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the Contracting Officer may by appropriate instructions require, and also a clause requiring the Subcontractors to include these clauses in any lower tier subcontracts. The prime Contractor shall be responsible for the compliance by any Subcontractor or lower tier Subcontractor with all the Contract clauses in 29 CFR 5.5
7. **Contract Termination: Debarment** - A breach of the Contract clauses in 29 CFR 5.5 may be grounds for termination of the Contract, and for debarment as a Contractor and a Subcontractor as provided in 29 CFR 5.12.
8. **Compliance With Davis-Bacon And Related Act Requirements** - All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3 and 5 are herein incorporated by reference in this Contract.
9. **Disputes Concerning Labor Standards** - Disputes arising out of the labor standards provisions of this Contract shall not be subject to the general disputes clause of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6 and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its Subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

#### 10. Certification Of Eligibility

- a. By entering into this Contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an

interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

- b. No part of this Contract shall be subcontracted to any person or firm ineligible for Award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

**B. CONTRACT WORK HOURS AND SAFETY STANDARDS** - The Agency Head shall cause or require the Contracting Officer to insert the following clauses set forth in B.1., 2., 3. and 4. in full in any contract subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 5.5(a) or 4.6 of Part 4 of 29 CFR. As used in this paragraph, the terms "laborers" and "mechanics" include watchpersons and guards.

1. **Overtime Requirements** - No Contractor or Subcontractor contracting for any part of the Contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any work week in which he or she is employed on such work to work in excess of forty (40) hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than 1 ½ times the basic rate of pay for all hours worked in excess of forty (40) hours in such workweek.
2. **Violation; Liability For Unpaid Wages; Liquidated Damages** - In the event of a violation of the clause set forth in 103.02B.1., the Contractor and any Subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such Contractor and Subcontractor shall be liable to the United States (in the case of work done under Contract for the District of Columbia or a territory, to such District or to such territory) for Liquidated Damages. Such Liquidated Damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in B.1. above, in the sum of \$10 for each Calendar Day on which such individual was required or permitted to work in excess of eight (8) hours or in excess of the standard workweek of forty (40) hours without payment of the overtime wages required by the clauses set forth in B.1. above.
3. **Withholding For Unpaid Wages And Liquidated Damages** - The Contracting Officer shall upon his own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Contractor or Subcontractor under any such contract or any other Federal contract with the same prime Contractor, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime Contractor, such sums as may be determined to be necessary to satisfy any liabilities of such Contractor or Subcontractor for unpaid wages and Liquidated Damages as provided in the clause set forth in B.2 above.
4. **Subcontracts** - The Contractor or Subcontractor shall insert in any subcontracts the clauses set forth in B.1 through B.4, and also a clause requiring the Subcontractors to include these clauses in any lower tier subcontracts. The prime Contractor shall be responsible for compliance by any Subcontractor or lower tier Subcontractor with the clauses set forth in B.1 through B.4.

**C. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT** - In addition to the clauses contained in 103.02B., in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 5.1, the Agency Head shall cause or require the Contracting Officer to insert a clause requiring that the Contractor or Subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three (3) years from the completion of the Contract for all laborers and mechanics, including guards and watch men, working on the Contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency head shall cause or require the Contracting Officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the Contractor or Subcontractor for inspection, copying, or transcription by authorized representatives of the Contracting Officer and the Department of Labor, and the Contractor or Subcontractor will permit such representatives to interview employees during working hours on the job.

**D. CONVICT LABOR (18 USC 436)** - Convict labor shall not be used on Contract work unless otherwise provided by law.

- E. EQUAL OPPORTUNITY** - On contracts exceeding \$25,000.00, the Contractor shall not discriminate against any employee or applicant for employment because of race, color, age, sex, religion or national origin. The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, age, sex, religion or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this Article. The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, age, sex, religion or national origin.

The Contractor shall send to each labor union or representative of workers with which he has a collective bargaining agreement or other Contract or understanding, a notice, to be provided by the Contracting Officer, advising the said labor union or worker's representative of the Contractor's commitments under this Article, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

The Contractor shall permit access to his books, records and accounts by the Contracting Officer and the Office of Local Business Development or their agents, for purposes of investigation to ascertain compliance with this Article.

In the event of the Contractor's non-compliance with this Article, the Contract may be canceled in whole or in part and the Contractor may be declared ineligible for further District contracts.

The Contractor shall include the provisions of this Article in every subcontract unless exempted by rules, regulations or orders of the District, so that such provisions will be binding upon each Subcontractor or vendor. The Contractor shall take such action with respect to any subcontract as the Contracting Officer may direct as a means of enforcing such provisions, including sanctions for non-compliance; provided, however, that in the event the Contractor becomes involved in, or is threatened with litigation with a Subcontractor or vendor as a result of such directions by the Contracting Officer, the Contractor may request the District to enter into such litigation to protect the interest of the District.

- F. NONSEGREGATED FACILITIES** - The Contractor certifies that he does not and will not maintain or provide for his employment any segregated facility at any of his establishments; that he does not and will not permit his employees to perform their services at any location under his control where segregated facilities are maintained; and that he will obtain and retain identical certifications from proposed Subcontractors prior to Award of subcontracts.

"Segregated facilities" shall mean any waiting room, work area, wash and rest rooms, restaurant and other eating area, time clock, locker room and other storage or dressing area, parking lot, drinking fountain, recreation or entertainment area, transportation and housing facility provided for employees which is segregated by explicit directive or is segregated on the basis of race, color, age, sex, religion or national origin, because of habit, local custom, or otherwise.

Penalty for violation or making false statements is prescribed in 18 USC 1001.

**G. BUSINESS EQUAL EMPLOYMENT OPPORTUNITY**

- 1. General** - An Award cannot be made to any Bidder who has not satisfied the equal opportunity requirements as set forth by the Office of Local Business Development.

**2. Open Market Solicitations**

- a. Preference for Local Businesses, Disadvantaged Businesses, Resident Business Ownerships or Business Operation in an Enterprise Zone**

- i. General Preferences** - Under the provisions of D.C. Law 13-169, "Equal Opportunity for Local, Small or Disadvantaged Business Enterprises Amendment Act of 2000", (the "Act"), the District shall apply preferences in evaluating offers from businesses that are local, disadvantaged, resident business ownership or located in an enterprise zone of the District of Columbia.

For evaluation purposes, the allowable preferences under the Act for open market procurements are as follows:

4 percent reduction in the bid price or the addition of 4 points on a 100- point scale for a local business

enterprise (LBE) certified by the Local Business Opportunity Commission (LBOC);

3 percent reduction in the bid price or the addition of 3 points on a 100- point scale for a disadvantaged business enterprise (DBE) certified by the Local Business Opportunity Commission.

3 point reduction in the bid price or the addition of 3 points on a 100- point scale for a resident ownership (RBO), as defined in Section 2 (a) (8A) of the Act, and certified by the Local Business Opportunity Commission; and,

2 percent reduction in the bid price or the addition of 2 points on a 100-point scale for a business located in an enterprise zone, as defined in Section 2 (5) of D.C. Law 12-268 and in 27 DCMR 899, 39 DCR 9087-9088 (December 4, 1992).

Any Prime Contractor that is an LBE certified by the LBOC will receive a 4 percent reduction in bid price for a bid submitted by the LBE in response to an Invitation for Bids (IFB) or the addition of 4 points on a 100-point scale added to the overall score for bids submitted by the LBE in response to a Request for Proposal.

Any Prime Contractor that is a DBE certified by the LBOC will receive a 3 percent reduction in the bid price submitted by the DBE in response to an IFB or the addition of 3 points on a 100- point scale added to the overall score of Proposals submitted by the DBE in response to a RFP.

Any Contractor that is a RBO certified by the LBOC will receive a 3 percent reduction in the bid price for a bid submitted by the RBO in response to an IFB or the addition of 3 points on a 100 point scale added to the overall score for Proposals submitted by the RBO in response to a RFP.

Any Prime Contractor that is a business enterprise located in an enterprise zone will receive a 2 percent reduction in bid price for a bid submitted by such business enterprise in response to an IFB or the addition of 2 points on a 100 point scale added to the overall score for Proposals submitted by such business in response to a RFP.

- ii. Preferences for Subcontracting in Open Market solicitations with No LBE, DBE, or RBO Subcontracting Set Aside. The preferences for subcontracting in open market solicitations where there is no LBE, DBE, or RBO subcontracting set aside are as follows:

If the Prime Contractor is not a certified LBE, certified DBE, certified RBO or a business enterprise in an enterprise zone, the District will Award the above stated preferences by reducing the bid price or increasing the points proportionally based on the total dollar value of the bid or Proposal that is designated by the Prime Contractor for subcontracting with a certified LBE, DBE, RBO or business located in an enterprise zone.

If the Prime Contractor is a joint venture that is not a certified LBE, certified DBE or certified RBO joint venture, or if the Prime Contractor is a joint venture that includes a business in an enterprise zone but such business located in an enterprise zone does not own and control at least 51 percent (51%) of the joint venture, the District will Award the above-stated preferences by reducing the bid price or by increasing the points proportionally in the Proposal based on the total dollar value of the bid or Proposal that is designated by the Prime Contractor for a certified LBE, DBE, RBO or business located in an enterprise zone, for participation in the joint venture.

EXAMPLE: If a non-certified Prime Contractor subcontracts with a certified local business enterprise for a percentage of the work to be performed on an RFP, the calculation of the percentage points to be added during evaluation would be according to the following:

$(\text{Amount of Subcontract} / \text{Amount of Contract}) \times 4 = \text{Points awarded for Evaluating LSDBE Subcontracting, where 4 is equivalent to 4 points on a 100 point scale.}$

The maximum total preference under the Act of this type of procurement is 12 percent for bids submitted in response to an IFB or the equivalent of 12 points on a 100 point scale for Proposals submitted in response to an RFP. Any Prime Contractor receiving the full bid price reduction or point addition to its overall score for a particular preference will not receive any additional bid price reduction or points for further participation on a subcontracting level for that particular preference.

However, the Prime Contractor shall receive a further proportional bid price reduction or point addition on a different preference for participation on a subcontracting level for that different preference. For example, if an LBE Prime Contractor receives the 4 percent bid price reduction or the equivalent of 4 points on a 100 point scale, the LBE

Prime Contractor does not receive a further price reduction or additional points if such Contractor proposes subcontracting with an LBE. However, if this same LBE Prime Contractor proposes subcontracting with a DBE, the LBE Prime Contractor receives a further proportional bid price reduction or point addition for the DBE participation at the subcontracting level.

- iii. Preferences for Open Market Solicitations with LBE, DBE or RBO Subcontracting Set Aside. If the solicitation is an open market solicitation with LBE, DBE or RBO subcontracting set-aside, the Prime Contractor will receive the LBE, DBE or RBO preferences only if it is a certified LBE, DBE or RBO. There shall be no preference awarded for subcontracting by the Prime Contractor with a LBE, DBE or RBO, even if the Prime Contractor proposes LBE, DBE or RBO subcontracting above the subcontracting levels required by the solicitation. However, the Prime Contractor shall be entitled to the full preference for business located in an enterprise zone if it is a business located in an enterprise zone or a proportional preference if the Prime Contractor subcontracts with a business located in an enterprise zone.

The maximum total preference under the Act for this type of procurement is 12 percent for bids submitted in response to an IFB or the equivalent of 12 points on a 100 point scale for Proposals submitted in response to an RFP.

- b. *Preferences for Certified Joint Ventures Including Local or Disadvantaged Business or Resident Business Ownership* – When the LBOC-certified joint venture includes a local business enterprise (LBE), disadvantaged business (DBE) or a resident business ownership (RBO), and the LBE, DBE or RBO owns and controls at least 51 percent of the venture, the joint venture will receive the preferences as if it were a certified LBE, DBE or RBO.
  - c. *Preference for Joint Ventures Including Businesses Located in an Enterprise Zone* - When a joint venture includes a business located in an enterprise zone, and such business located in an enterprise zone owns and controls at least 51 percent of the venture, the joint venture will receive the preferences as if it were a business located in an enterprise zone.
  - d. *Penalties and Misrepresentations* - Any material misrepresentation on the sworn notarized self-certification form could result in termination of the Contract, the Contractor's liability for civil and criminal action in accordance with the Act, D.C. Law 12-268, and other District laws, including debarment.
  - e. *Local, Small and Disadvantaged Business Enterprise Subcontracting*
    - i. When a Prime Contractor is certified by the Office of Local Business Development as a local, small or disadvantaged business or a resident business ownership, the Prime Contractor shall perform at least 50 percent of the contracting effort, excluding the cost of materials, goods, and supplies with its own organization resources, and if it subcontracts, 50 percent of the subcontracting effort, excluding the cost of materials, goods and supplies shall be with certified local, small or disadvantaged business enterprises and resident business ownerships, unless a waiver is granted by the Contracting Officer, with prior approval and consent of the Director of LBOC under the provisions of 27 DCMR 805, 39 DCR 5578-5580 (July 24, 1992).
    - ii. By submitting a signed bid or Proposal, the Prime Contractor certifies that it will comply with the requirements of this clause.
3. **Open Market Solicitations With LBE, DBE Or RBO Subcontracting Set-Aside** - Under the provisions of 27DCMR 801.2(b), 39 DCR 5571 (July 24, 1992), a percentage, defined in the Contract Documents, of the total dollar value of a contract may be set aside for performance through subcontracting with local business enterprises, disadvantaged business enterprises, or resident business ownerships. Any Prime Contractor responding to a solicitation of this type shall submit with its bid or Proposal a notarized statement detailing its subcontracting Plans (see 103.02 H (B) (1) and 103.02 H (B) (2)). Once the plan is approved by the Contracting Officer, changes will occur only with the prior written approval of the Contracting Officer.
4. **Open Market Solicitations With LBE, DBE Or RBO Subcontracting Or Subcontracting With Business Located In An Enterprise Zone**
- a. *Subcontracting Plan* - A notarized statement detailing a subcontracting plan shall be submitted, as part of the bid or

Proposal, by any Prime Contractor seeking a preference on the basis of proposed subcontracting with LBE, DBE, RBO or business located in an enterprise zone; and by any Prime Contractor responding to a solicitation in which there is a LBE, DBE, RBO subcontracting set aside. Each subcontracting plan shall include the following:

- i. A description of the goods and services to be provided by the LBE, DBE, or RBO of business located in the enterprise zone;
  - ii. If the Prime Contractor is seeking a preference on the basis of proposed subcontracting with a LBE, DBE, RBO or a business located in an enterprise zone, a statement of the dollar amount, by type of business enterprise, of the bid or Proposal that is designated by the Prime Contractor for a LBE, DBE, RBO or business located in an enterprise zone;
  - iii. If the solicitation contains a LBE, DBE, or RBO subcontracting set-aside, a statement of the dollar value, by type of business enterprise, of the bid or Proposal that pertains to the subcontracts to be performed by the LBEs, DBEs, RBOs or businesses located in the enterprise zone;
  - iv. The names and addresses of all proposed Subcontractors who are LBEs, DBEs, RBOs or businesses located in an enterprise zone;
  - v. The name of the individual employed by the Prime Contractor who will administer the subcontracting plan, and a description of the duties of the individual;
  - vi. A description of the efforts the Prime Contractor shall make to ensure that LBEs, DBEs, RBOs and businesses located in an enterprise zone will have an equitable opportunity to compete for subcontracts;
  - vii. In all subcontracts that offer further subcontracting opportunities, assurances that the Prime Contractor shall include a statement, approved by the Contracting Officer, that the Subcontractor shall adopt a subcontracting plan similar to the subcontracting plan required by the Contract;
  - viii. Assurances that the Prime Contractor shall cooperate in any studies or surveys that may be required by the Contracting Officer, and submit periodic reports, as requested by the Contracting Officer, to allow the District to determine the extent of compliance by the Prime Contractor with the subcontracting plan;
  - ix. List the type of records the Prime Contractor shall maintain to demonstrate procedures adopted to comply with the requirements set forth in the subcontracting plan, and include assurances that the Prime Contractor shall make such records available for review upon the District's request; and
  - x. A description of the Prime Contractor's recent effort to locate LBEs, DBEs, RBOs and businesses located in an enterprise zone and to Award subcontracts to them.
- b. *Liquidated Damages***
- i. If during the period of performance on a contract, the Contractor fails to comply with the subcontracting plan submitted in accordance with the requirements of the Contract and 27 DCMR 804.9, 39 DCR 5578 (July 24, 1992), and as approved by the Contracting Officer, the Contractor shall pay the District Liquidated Damages in the amount as defined in the Contract Documents for each day the Contractor fails to comply with the subcontracting plan, unless the Contracting Officer determines that the Contractor made a good faith effort to comply with the subcontracting plan in accordance with subparagraph (b) below:
  - ii. Prior to assessing any Liquidated Damages under this provision, the Contracting Officer shall issue a written notice informing the Contractor that it is not in compliance with the subcontracting plan and set forth the areas of non-compliance. The written notice from the Contracting Officer shall provide the Contractor with ten (10) Calendar Days from receipt of the written notice to correct any areas of non-compliance or to demonstrate that the Contractor has used good faith efforts to comply with the subcontracting plan. If the Contractor fails to correct any areas of non-compliance or demonstrate good faith efforts within the ten (10) day period, the Contracting Officer shall assess

Liquidated Damages beginning on the first day after the end of the ten (10) day period.

- iii. If failure to comply with the subcontracting plan is such that the Contracting Officer determines it to be a material breach of the Contract and terminates the Contract under the Default Clause of the Standard Contract Provisions, the Contractor shall be liable for aforementioned Liquidated Damages accruing until the time the District may reasonably obtain similar goods and services.

#### 5. Procurements Restricted To The Small Business Enterprise (SBE) Set-Aside Market

- a. *Designation of Solicitation for the Small Business Set Aside Market Only* - Invitations for Bids or Requests for Proposals under this type of procurement are designated for certified small business enterprise (SBE) offerors only under the provisions of “The Equal Opportunity for Local, Small and Disadvantaged Business Enterprises of 1998, D.C. Law 12-268 (the “Act”) and “The Equal Opportunity for Local, Small and Disadvantaged Business Opportunity Amendment Act of 2000” D.C. Law 13-169 (the “Amendment”).

A SBE must be certified as small in the procurement category as defined in the advertisement for a given solicitation in order to be eligible to submit a bid or Proposal in response to that solicitation.

- b. *Subcontracting by Certified Small Business Enterprise*

- i. When a Prime Contractor is certified by the Local Business Opportunity Commission (LBOC) as a small business, the Prime Contractor shall perform at least 50 percent of the contracting effort, excluding the cost of materials, goods and supplies, with its own organization and resources, and if it subcontracts, 50 percent of the subcontracting effort, excluding the cost of materials, goods and supplies shall be with certified local, small, and disadvantaged business enterprises and resident business ownerships unless a waiver is granted by the Contracting Officer, with the prior approval and consent of the Director of the LBOC, under the provisions of 27 DCMR 805, 39 DCR 9050-9060 (December 4, 1992).
- ii. By submitting a signed bid or Proposal, the Prime Contractor certifies that it will comply with the requirements of paragraph (a) of this clause.

- c. *Vendor Submission of Certification* - Any vendor seeking to submit a bid or Proposal as a small business enterprise (SBE) in response to a solicitation must submit one of the following at the time of, and as part of its bid or Proposal:

- i. A copy of the SBE letter of certification from the Local Business Opportunity Commission;, or
- ii. A copy of a sworn notarized Self-Certification Form prescribed by the LBOC along with an acknowledgement letter issued by the Director of LBOC.

Bids or Proposals from vendors that are not certified as small business enterprises through one of the means described in this section will not be considered. Bidders or offerors must submit the required evidence of certification or self-certification at the time of submission of bids or Proposals.

The Self-Certification Package will be included as an attachment in procurement documents. In order to be eligible to submit a bid or Proposal, or to receive any preferences under this type of solicitation, any vendor seeking self-certification must complete and submit Self-Certification forms to:

Department of Human Rights and Local Business Development

ATTN: LSDBE Certification Program

441 Fourth Street, N.W. Suite 970 N Washington, D.C. 20001

All vendors are encouraged to contact the Local, Small and Disadvantaged Business Enterprises Certification Program at (202) 727-3900 if additional information is required on certification procedures and requirements.

- d. *Penalties for Misrepresentation* - Any material misrepresentation on the sworn notarized self-certification form could

result in termination of the Contract, the Contractor's liability for civil and criminal action in accordance with the Act and other District laws, including debarment.

- e. *Preferences in the SBE Set-Aside Market* - For evaluation purposes, a certified small business enterprise (SBE) that is also certified by the LBOC as a local business enterprise (LBE) will receive a 4 percent reduction in the bid price for a bid submitted in response to an Invitation for Bids (IFB) or the addition of 4 points on a 100-point scale added to the overall score for Proposals submitted in response to a Request for Proposals (RFP).

A certified small business that is also certified by the LBOC as a disadvantaged business enterprise (DBE) will receive a 3 percent reduction in the bid price submitted in response to an IFB or the addition of 3 points on a 100-point scale added to the overall score for Proposals submitted in response to an RFP.

A certified small business that is also certified by the LBOC as a resident business ownership (RBO), as defined in Section 2(a)(8A) of the Amendment, will receive 3 percent reduction in the bid price for a bid submitted in response to an IFB or the addition of 3 points on a 100-point scale added to the overall score for Proposals submitted in response to a RFP.

A certified small business that is also certified by the LBOC as a business in an enterprise zone, as defined in Section 2(5) of the Act and in 27DCMR 899, 39 DCR 9087-9088 (December 4, 1992), will receive 2 percent reduction in the bid price for a bid submitted in response to an IFB or the addition of 2 points on a 100-point scale added to the overall score for Proposals submitted by such business enterprise in response to an RFP.

The maximum total preference under the SBE Set-Aside Program is 12 percent reduction in the bid price for bids submitted in response to an IFB or the addition of 12 points on a 100-point scale added to the overall score for Proposals submitted in response to an RFP. The District shall Award the preference points based only on whether the SBE Prime Contractor is also a LBE, DBE, RBO or business located in an enterprise zone. There shall be no points awarded for subcontracting by the SBE Prime Contractor to a LBE, DBE, RBO or business located in an enterprise zone.

If the Prime Contractor is a certified SBE joint venture that is also certified as a LBE, DBE, or RBO joint venture, or if the Prime Contractor is a certified SBE joint venture that includes a business located in an enterprise zone and such business owns and controls at least 51 percent of the joint venture, the Prime Contractor will receive the preference as if it were a LBE, DBE, RBO or business located in an enterprise zone. There shall be no more points awarded for any other joint venture participation by LBEs, DBEs, RBOs or businesses located in an enterprise zone.

- f. *SBE Joint Ventures* - A joint venture between a small business enterprise (as defined under Section 2(6) of the Act and implementing regulations) and another entity shall be eligible to submit a bid or Proposal in response to a SBE set-aside solicitation if the joint venture is certified by LBOC under the provisions of 27 DCMR 817, 39 DCR 9072-9075 (December 4, 1992) or is self-certified under DCMR 818, 39 DCR 9075-9076 (December 4, 1992).
- g. The LBOC shall certify a joint venture when the SBE affiliates itself with another entity to form a joint venture for a SBE set-aside solicitation if:
  - i. The non-SBE partner demonstrates to the LBOC that its size does not exceed the size limitations set forth in the Act; or
  - ii. The LBOC determines that the certification of the joint venture with an entity exceeding the size limitation of the Act would not be detrimental to the SBE set-aside program.

- H. **WEEKLY COMPLIANCE STATEMENT** - The Contractor and each Subcontractor engaged in the construction, prosecution, completion or repair of any public building or public work shall furnish each week a statement with respect to the wages paid each of his employees engaged on work covered by these Labor Provisions during the preceding weekly payroll period. The statement shall be executed by the Contractor or Subcontractor, or by an authorized officer or employee or the Contractor or Subcontractor, who supervised the payment of wages, and shall be on the form entitled "Weekly Statement of Compliance" (Form No. DC 2640-11).

### 103.03 EQUAL EMPLOYMENT OPPORTUNITY RESPONSIBILITIES

- A. **GENERAL** - Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal



employment opportunity as required by Executive Order 11246 and Executive Order 11375 are set forth in Required Contract Provisions (Form FHWA-1273 or 1316, as appropriate) and these Special Provisions which are imposed pursuant to Section 140 of Title 23, U.S.C., as established by Section 22 of the Federal-Aid Highway Act of 1968. The requirements set forth in these Special Provisions shall constitute the specific affirmative action requirements for project activities under this Contract and supplement the equal employment opportunity requirements set forth in the Required Contract Provisions.

The Contractor will work with the State highway agencies and the Federal Government in carrying out equal employment opportunity obligations and in the review of his/her activities under the Contract.

The Contractor and all his/her Subcontractors holding subcontracts not including material suppliers, of \$10,000 or more, will comply with the following minimum specific requirement activities of equal employment opportunity: (The equal employment opportunity requirements of Executive Order 11246, as set forth in Volume 6, Chapter 4, Section 1, Subsection 1 of the Federal-Aid Highway Program Manual, are applicable to material suppliers as well as contractors and Subcontractors.) The Contractor will include these requirements in every subcontract of \$10,000 or more with such modification of language as is necessary to make them binding on the Subcontractor.

- B. EQUAL EMPLOYMENT OPPORTUNITY POLICY** - The Contractor will accept as his/her operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex or national origin, and to promote the full realization of equal employment opportunity through a positive continuing program:

“It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, or national origin. Such action shall include: employment, upgrading, demotion or transfer, recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre- apprenticeship, and/or on-the-job training.”

- C. EQUAL EMPLOYMENT OPPORTUNITY OFFICER** - The Contractor will designate and make known to the Contracting Officer an equal employment opportunity officer (hereinafter referred to as the EEO Officer) who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of equal employment opportunity and who must be assigned adequate authority and responsibility to do so.

- D. DISSEMINATION OF POLICY** - All members of the Contractor’s staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the Contractor’s equal employment opportunity policy and contractual responsibilities to provide equal employment in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

1. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six (6) months, at which time the Contractor’s equal employment opportunity policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.
2. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer or other knowledgeable company official, covering all major aspects of the Contractor’s equal employment opportunity obligations within thirty (30) days following their reporting for duty with the Contractor.
3. All personnel who are engaged in direct recruitment for the Project will be instructed by the EEO Officer or appropriate company official in the Contractor’s procedures for locating and hiring minority group employees.

In order to make the Contractor’s equal employment opportunity policy known to all employees, prospective employees and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., the Contractor will take the following actions:

- a. Notices and posters setting forth the Contractor’s equal employment opportunity policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

- b. The Contractor's equal employment opportunity policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, other appropriate means.

**E. RECRUITMENT** - When advertising for employees, the Contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be published in newspapers or other publications having a large circulation among minority groups in the area from which the Project work force would normally be derived.

The Contractor shall, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants, including, but not limited to, State employment agencies, schools, colleges and minority group organizations. To meet this requirement, the Contractor will, through his EEO Officer, identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to the Contractor for employment consideration.

In the event the Contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, he is expected to observe the provisions of that agreement to the extent that the system permits the Contractor's compliance with equal employment opportunity Contract provisions. (The U.S. Department of Labor has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the Contractors to do the same, such implementation violates Executive Order 11246, as amended.)

The Contractor shall encourage his present employees to refer minority group applicants for employment by posting appropriate notices or bulletins in areas accessible to all such employees. In addition, information and procedures with regard to referring minority group applicants will be discussed with employees.

**F. PERSONNEL ACTIONS** - Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, or national origin. The following procedures shall be followed:

1. The Contractor will conduct periodic inspections of Project Sites to ensure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.
2. The Contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.
3. The Contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the Contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.
4. The Contractor will promptly investigate all complaints of alleged discrimination made to the Contractor in connection with his obligations under this Contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the Contractor will inform every complainant of all of his avenues of appeal.

**G. TRAINING AND PROMOTION**

1. The Contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.
2. Consistent with the Contractor's work force requirements and as permissible under Federal and State regulations, the Contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of Contract performance. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event the Training Special Provision is provided under this Contract, this subparagraph will be superseded as indicated in Attachment 2 of the Special Provisions.
3. The Contractor will advise employees and applicants for employment of available training programs and entrance requirements

for each.

4. The Contractor will periodically review the training and promotion potential of minority group and women employees and will encourage eligible employees to apply for such training and promotion.

**H. UNIONS** - If the Contractor relies in whole or in part upon unions as a source of employees, the Contractor will use his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions by the Contractor either directly or through a contractor's association acting as agent will include the procedures set forth below:

1. The Contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.
2. The Contractor will use best efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, or national origin.
3. The Contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the Contractor, the Contractor shall so certify to the State highway department and shall set forth what efforts have been made to obtain such information.
4. In the event the union is unable to provide the Contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, the Contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, or national origin; making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents the Contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these Special Provisions, such Contractor shall immediately notify the State highway agency.

**I. SUBCONTRACTING**

1. The Contractor will use his best efforts to solicit bids from and to utilize minority group Subcontractors or Subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of minority-owned construction firms from State highway agency personnel.
2. The Contractor will use his best efforts to ensure Subcontractor compliance with their equal employment opportunity obligations.

**J. RECORDS AND RECEIPTS**

1. The Contractor will keep such records as are necessary to determine compliance with the Contractor's equal employment opportunity obligations. The records kept by the Contractor will be designed to indicate:
  - a. The number of minority and non-minority group members and women employed in each work classification on the Project.
  - b. The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).
  - c. The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees, and

- d. The progress and efforts being made in securing the services of minority group Subcontractors or Subcontractors with meaningful minority and female representation among their employees.
2. All such records must be retained for a period of three (3) years following completion of the Contract work and shall be available at reasonable times and places for inspection by authorized representatives of the State highway agency and the Federal Highway Administration.
3. The Contractors will submit an annual report to the State highway agency each July for the duration of the Project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the Contract work. This information is to be reported on Form PR 1391. If on-the-job training is being required by "Training Special Provision", the Contractor will be required to furnish Form FHWA 1409.

#### 103.04 EMPLOYEE TRAINING REQUIREMENTS

When referenced in the Contract Special Provisions, this article shall be utilized in the implementation of 23 U.S.C. Pt. 230, Subpt. A, App. B.

The Contractor shall provide on-the-job training aimed at developing full journeyworkers in the type of trade or job classification involved.

In the event that a Contractor subcontracts a portion of the Contract work, he/she shall determine how many, if any, of the trainees are to be trained by the Subcontractor, provided, however, that the Contractor shall retain the primary responsibility for meeting the training requirements imposed by this Special Provision. The Contractor shall also ensure that this training Special Provision is made applicable to such subcontract. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

The number of trainees shall be distributed among the work classifications on the basis of the Contractor's needs and the availability of journeyworkers in the various classifications with a reasonable area of recruitment. Prior to commencing construction, the Contractor shall submit to the Department for approval the names, addresses and social security numbers of the trainees to be trained in each selected classification. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed by him/her on the Contract work who is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided hereinafter.

Training and upgrading of minorities and women toward journey worker status is a primary objective of this Training Special Provision. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g., by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent that such persons are available within a reasonable area of recruitment. The Contractor will be responsible for demonstrating the steps that he/she has taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with this Training Special Provision. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

No employee shall be employed as a trainee in any classification in which he/she has successfully completed a training course leading to journeyworker status or in which he/she has been employed as a journeyworker. The Contractors should satisfy this requirement by including appropriate questions in the employee application or by other suitable means. Regardless of the method used, the Contractors records should document the findings in each case.

The minimum length and type of training for each classification will be as established in the training program approved by the District of Columbia, Department of Transportation and the Federal Highway Administration. The Department and the Federal Highway Administration shall approve a program if it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyworker status in the classification concerned by the end of the training period. Furthermore, apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau and Training programs approved but not necessarily sponsored by the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training shall also be considered acceptable provided they are being administered in a manner consistent with the equal employment obligations of Federal-aid highway construction contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program. It is the intention of these provisions that training is to be provided in the construction crafts rather than clerk-typists or secretarial-type positions. Training is permissible in lower level management positions such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that

significant and meaningful training is provided and approved by the division office. Some off-site training is permissible as long as the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

The Contractor will be reimbursed in the amount indicated in the unit price column of the Pay Item Schedule in the Bid Form and Proposals for each hour of training. As verified by the Chief Engineer, reimbursement will be made for training persons in excess of the number specified herein. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other does not specifically prohibit the Contractor from receiving other reimbursement. Reimbursement for off-site training indicated above may only be made to the Contractor where he/she does one or more of the following and the trainees are concurrently employed on a Federal-aid project; contributes to the cost of the training, provides the instruction to the trainee or pays the trainees wages during the off-site training period.

No payment shall be made to the Contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyworker, is caused by the Contractor and evidences a lack of good faith on the part of the Contractor in meeting the requirements of Training Provision. It is normally expected that a trainee will begin his/her training on the Project as soon as feasible after start of work utilizing the skill involved and remain on the Project as long as training opportunities exist in his/her work classification or until he/she has completed his training program. It is not required that all trainees be on board for the entire length of the Contract. A Contractor will have fulfilled his/her responsibilities under the Training Provision if he/she has provided acceptable training to the number of trainees specified. The number trained shall be determined on the basis of the total number enrolled on the Contract for a significant period.

Trainees will be paid at least 60 percent of the appropriate minimum journeyworkers rate specified in the Contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on this Project. In that case, the appropriate rates approved by the Departments of Labor or Transportation in connection with the existing program shall apply to all trainees being trained for the same classification who are covered by the Training Provision.

The Contractor shall furnish the trainee a copy of the program he/she will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

The Contractor will provide for the maintenance of records and furnish periodic reports documenting his/her performance under this article.

## 104 SCOPE OF WORK

### 104.01 INTENT OF CONTRACT

The intent of the Contract is to provide for the construction and completion in every detail of the Work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the Work in accordance with the Plans, Specifications and terms of the Contract.

### 104.02 MAINTENANCE OF TRAFFIC

Unless otherwise specified in the Contract Documents, the Roadway, while undergoing improvements shall be kept open to traffic by the Contractor. The Contractor shall keep the portion of the Project being used by the public in such condition that the traffic will be adequately protected and accommodated and the Roadway smooth and free of potholes. Snow removal from the Roadway will not be required of the Contractor. The Contractor shall provide, erect, maintain and remove all barricades, warning signs, delineators, and flaggers in accordance with the MUTCD and 612 Traffic Control of these Specifications. Failure by the Contractor to open traffic lanes when required and to maintain designated lanes open to traffic shall be subject to \$1,000.00 fine per hour/per occurrence, as determined by the Chief Engineer. All fines levied for such violations shall be deducted from the next partial payment and shall not be refundable.

- A. TRAFFIC FLOW RESTRICTIONS** - On arterial streets the full Roadway width shall be opened to traffic between the hours of 5:30 AM and 9:30 AM and between 3:30 PM and 7:00 PM, Monday through Friday, exclusive of legal holidays, and at all times when work is not actually in progress. Unless otherwise provided, during these restricted hours, work may be performed provided that the full Roadway width remains opened to traffic. During other times traffic shall be maintained. Traffic on streets other than arterials shall be maintained at all times unless specifically directed otherwise. No materials or equipment shall be placed or stored on city travelways when Work is not actually in progress, unless specifically authorized.

If it becomes necessary to remove illegally parked or abandoned vehicles, the Contractor, with the assistance of a Metropolitan Police Department Officer, shall be responsible for moving any such vehicle at no expense to the District.

Pedestrian access to abutting properties, and vehicular access for ambulances, police, fire and other emergency equipment shall be maintained. When access is to be temporarily curtailed, the Contractor shall be responsible for giving adequate notice to the affected parties prior to blocking the access.

Whenever any street, highway, sidewalk, trail, or portion thereof is in acceptable condition for travel, it shall be opened to traffic subject to the approval by and at the direction of the Engineer. Such opening shall not be held to be in any way an acceptance of the Roadway or any part of it or a waiver of any of the provisions of these Specifications and Contract.

Unless otherwise provided the Contractor shall bear all expenses of maintaining traffic over the section of road undergoing improvement without direct compensation. The Contractor shall give fourteen (14) days prior notice to the District when major (phase) changes in traffic flow patterns are planned to be made.

- B. TRAFFIC CONTROL PLAN (TCP)** - The TCP for the Project shall meet applicable requirements of the MUTCD and of these Specifications, and shall be prepared so that the requirements of Traffic Control Restrictions as specified in the Contract Documents are met. The TCP shall indicate the scheduling of construction where appropriate and shall show lane closures, means of channelizing traffic through the work areas, roadway closures and detours when specified in the Contract Documents, and all traffic control devices, such as warning signs, barricades, drums, cones, beacons, safety barriers with impact attenuators, including their sizes, locations and arrangements, all as required to perform the traffic control as specified.

When required to submit a TCP for approval, it will be submitted as a shop drawing in accordance with 105.02(B). In the event there is no TCP included in the Contract Documents, the Contractor shall prepare and submit for approval a TCP meeting requirements herein, if required by the Contract. Payment for preparation, submittal, revising and re-submittal if necessary, of the TCP will be made as specified in 612(C).

When a TCP is included with the Contract Documents, the Contractor will not be required to prepare and submit a TCP. If the Contractor wishes to accept the TCP for use on the Project, he shall so certify by letter to the Chief Engineer. If the Contractor does not wish to use the TCP in the Contract Documents, he may submit for approval, prior to start of construction, his own TCP. All costs for preparation, submission, revising and re-submittal, if necessary, of this TCP will be borne by the Contractor. This Traffic Control Plan (TCP) shall:

1. Show in detail the placement of all signs, channelizing devices and crash attenuating devices for each phase of construction. The TCP shall be to the same scale as the Contract drawing.
2. Contain an itemized summary for each phase of the type and quantity of all traffic control devices which will be needed for that phase.
3. Maintain equal or greater traffic flow capacity and lane widths as the suggested TCP.

Prior to Notice to Proceed, the Contractor may submit a conceptual TCP in lieu of a detailed TCP for preliminary approval. However, the detailed TCP shall be submitted and approved by the District prior to beginning the affected work.

### C. TRAFFIC CONTROLS

1. **General** - All work dealing with traffic control shall be accomplished in accordance with these Specifications, the approved TCP, and with the requirements of Part VI of the MUTCD.

All work shall be performed within times as specified in 104.02(A). The Contractor shall not work at nights, on weekends or holidays unless otherwise specified in the Contract Documents or approved by the Engineer. Normal traffic flow shall be maintained during these times unless otherwise specified. The time required to implement and remove closures and install and remove traffic control devices shall be included within stated work times.

The Contractor shall coordinate his maintenance of traffic work with other contractors and utility companies working in the same general area to maintain continuity of traffic flow and minimize congestion.

Where directed, vehicular access to abutting properties shall be maintained. The Contractor shall furnish, place, maintain and remove when no longer required all materials, such as AC and/or soil materials, for temporary driveway and Alley entrances, where shown in the Contract Documents or where directed.

2. **Traffic Safety Officer** - For the duration of the Project, the Contractor shall provide a traffic safety officer assigned full-time to the Project, who shall be responsible for the maintenance of traffic operations. The traffic safety officer shall meet the qualifications as specified in 612.02(B) (1).
3. **Pedestrian Control** - The Contractor shall maintain ADA compliant, safe flow of pedestrian traffic within and adjacent to the Project area at all times. Access to abutting properties for pedestrians shall be maintained. The Contractor shall furnish, install, maintain and remove when no longer required the proper traffic control devices, including warning signs, to detour pedestrians when closing Sidewalk to pedestrian traffic, where shown in the Contract Documents or where directed. The Contractor shall furnish, place, maintain and remove when no longer required all materials for temporary pedestrian walkways, where shown in the Contract Documents or where directed.
4. **Lane Closures** - When closing a lane to traffic, the Contractor shall furnish, install, maintain and remove when no longer required the necessary signs, channelizing devices such as traffic drums, Type II barricades or cones, and arrow boards, to effect lane closures and to separate lanes of traffic moving in opposite directions through the Work area, as outlined in the TCP, Part VI of the MUTCD and these Specifications.

Where shown in the Contract Documents or where directed, the Contractor shall remove existing lane markings and shall install temporary lane markings, meeting requirements of 612.13 or 612.14, to delineate the temporary lanes as required. Temporary lane markings shall be removed when no longer required.

The Contractor shall furnish, place and relocate as required portable PCC safety barriers, meeting requirements of 610.02, to prevent the intrusion of errant vehicles into any excavated area deeper than 6 inches. Except when necessary to provide vehicular ingress and egress for the Work area, open spaces between adjacent barrier sections shall not be permitted. The Contractor shall furnish and place at all approach ends of the PCC barriers, or at any other roadway obstruction caused by construction, suitable impact attenuators as approved by the Engineer. After the PCC or AC base has been placed in the excavated area or if the area is plated over, the Contractor shall remove the PCC barriers and impact attenuators.

During surfacing or resurfacing operations, PCC barriers shall not be used to protect the Work area. Traffic shall be directed past the Work area with traffic drums, cones or Type II barricades.

When specified in the Contract Documents or when directed, the Contractor shall furnish, install, maintain and remove when no longer required lights, meeting requirements of 612.08, for placement with advance warning signs and upon barriers, drums and/or barricades.

When specified in the Contract Documents or when directed, the Contractor shall provide flaggers, meeting requirements of 612.02(B)(2), to safely and expeditiously guide traffic through the Work area.

The Contractor shall be required to replace all damaged traffic control devices. Traffic control devices damaged for any reason whatever shall be removed and repaired or replaced by the Contractor at no additional cost to the District.

5. **Roadway Closures** - When specified in the Contract Documents, the Contractor shall furnish, place and remove when no longer required Type III PVC barricades for placement at each end of the length of roadway to be closed and the necessary signs to effect the proper detours around the closed length of roadway.
6. **Pavement Markings** - On those roadways where temporary pavement markings are to be replaced with permanent markings, the Contractor shall not remove the temporary markings unless permanent markings can be placed immediately. At no time shall a roadway be without pavement markings, either temporary or permanent.

### 104.03 VALUE ENGINEERING PROPOSALS BY CONTRACTOR

- A. **GENERAL** - This subsection describes the requirements for Value Engineering Change Proposals (VECPs) which are initiated and developed by the Contractor to change the Contract Drawings and Specifications, or other requirements of a contract for the purpose of reducing the total cost of construction without reducing design capacity or quality of the finished product.

A VECP identical to one submitted under one contract, by the same or any other contractor, may also be submitted under a subsequent contract.

- B. **VECP REQUIREMENTS** - In order to be considered as a VECP, the Contractor at the time of submission to the Engineer, must identify the submission as a Value Engineering Proposal. The VECP must require a change to the Contract, must demonstrate increased value to the Contract, and must maintain the finished product's required function such as service life, reliability, economy of operation, ease of maintenance, necessary standardized features and appearance, and justify any extension of Contract Time.

1. A VECP submission shall be of sufficient detail to clearly define the proposed change, including:
  - a. A description of the difference between the existing and the proposed Contract requirements, and the comparative advantages and disadvantages of each;
  - b. Contract requirements recommended to be changed if the Proposal is accepted;
  - c. A detailed estimate of the amount of the net savings, as defined in (E) herein, that will result from acceptance of the Proposal;
  - d. A prediction of any effects the proposed change would have on the cost of maintenance and operation; and
  - e. A statement of the time by which the Proposal must be accepted so as to obtain the maximum price reduction, noting any effect upon the Contract Time.
2. The following shall not be considered to be a VECP, but rather a change requested by the Contractor which will result in a reduction in the Contract Price by the full amount of the gross savings, including the Contractor's labor, material, equipment, overhead, profit and bond:
  - a. Changes resulting from a waiver of specification requirements.
  - b. Changes resulting from unavailability of specified materials.
  - c. Changes requested by the Contracting Officer.
  - d. Changes based solely on a change in deliverable end item quantities.



- C. VECP SUBMISSION WITHDRAWAL** - The Contractor has the right to withdraw part or all of any VECP at any time prior to acceptance by the Contracting Officer. Such withdrawal shall be made in writing to the Engineer. Each VECP submitted by the Contractor shall remain valid for a period of sixty (60) days from date submitted. If the Contractor desires to withdraw the Proposal prior to the expiration of this period, he may be liable for the cost incurred by the Engineer in reviewing the Proposal.
- D. VECP ACCEPTANCE OR REJECTION** - The Contracting Officer may accept or reject part or all of any VECP by giving the Contractor written notice thereof. Until such notice is issued, the Contractor shall remain obligated to perform in accordance with the terms of the Contract. VECP'S will be processed expeditiously. However, the Contracting Officer shall not be liable for any delay in acting upon any proposal submitted pursuant to this section. The decision of the Contracting Officer as to acceptance of any such Proposal shall be final and shall not be subject to GENERAL PROVISIONS, ARTICLE 7, DISPUTES.
- E. CONTRACT ADJUSTMENTS AND PAYMENTS** - When a VECP submission is accepted:
1. An adequate adjustment of the Contract Price and in any other affected provisions of the Contract shall be made and the Contract modified in accordance with this section and GENERAL PROVISIONS, ARTICLE 3, CHANGES, or other applicable provision of the Contract.
  2. The net savings resulting from the change shall be shared equally between the Contractor and the District. The Contractor's share will be paid as part of the next Partial Payment Estimate following the signed approval of a Change Order by the Contracting Officer in proportion to the amount of Work completed under the VECP.
  3. Net savings shall be determined by deducting from the estimated gross savings, the Contractor's cost of developing and implementing the Proposal and the estimated amount of increased costs to the District resulting from the change, such as implementation, inspection, increases in related items and District furnished equipment or property. Estimated gross saving shall include Contractor's labor, material, equipment, overhead and profit. Anticipated price adjustments for increases in the cost of fuel or material shall not be included as part of the estimated gross savings. The Contract Price shall be reduced by the sum of the District's costs and share of the net savings.
  4. The Contractor is entitled to share in instant Contract savings only to the full extent provided for in this section. For purposes of sharing under (E)(1) above, the item "Instant Contract" shall not include any Change Orders or other modifications to this Contract executed subsequent to acceptance of the particular VECP, by which the Contracting Officer increases the quantity of any item or adds any item.
- F. RESTRICTIONS ON USE** - The Contractor may restrict the District's right to use any VECP data by marking it with the following statement:
- "The data, furnished pursuant to the Value Engineering section of the Contract, shall not be duplicated, used nor disclosed, in whole or in part, for any purpose except to evaluate the VECP, unless the Proposal is accepted by the Contracting Officer. This restriction does not limit the District's right to use information contained in this data if it is or has been obtained, or is otherwise available from the Contractor, or from another source, without limitations. When this Proposal is accepted by the Contracting Officer, the District shall have the right to duplicate, use, and disclose any data in any matter and for any purpose whatsoever, and have others do so whether under this or any other District Contract."

## 105 CONTROL OF WORK

### 105.01 CHIEF ENGINEER'S AUTHORITY

The Chief Engineer will have the authority, in consultation with the Contracting Officer, for administration and engineering supervision of the Contract.

The Chief Engineer will decide any question as to interpretation of the Contract including quality and acceptability of furnished materials, Work performed, rate of progress and acceptable Contract fulfillment. The Chief Engineer has authority to suspend Work wholly or in part due to the Contractor's failure to correct conditions unsafe for workmen or the general public; for failure to carry out Contract provisions; for such periods needed due to unsuitable weather; for conditions deemed unsuitable for prosecution of the Work; or for any condition in the public interest. The Chief Engineer has authority to reject any piece of equipment, staging, formwork or other appliance considered unsafe, improper, or inadequate; whether or not the Chief Engineer exercises this authority, the Contractor is not relieved of his responsibility for safe and proper execution of the Contract.

The Chief Engineer will determine the quantity of each item of Work performed and materials furnished, and such decision and estimate for partial payment shall be final and conclusive; such estimate shall be a condition precedent to the Contractor's right to receive any money due under the Contract. In the event of disagreement with the Chief Engineer's decision, the Contractor will have the right to present the matter in dispute to the Contracting Officer for decision pursuant to Contract provisions.

The Chief Engineer has the authority to require the Contractor to replace any Contractor's representative, including staff, who is not performing to the satisfaction of the Chief Engineer.

### 105.02 PLANS AND WORKING DRAWINGS

**A. REPRODUCIBLE PLANS** - Upon request from the Contractor, the District will furnish free of cost for the Contractor's use, one set of full size reproducible Project Plans printed from official Plans, or an electronic version (CADD file or PDF file).

**B. SHOP AND WORKING DRAWINGS** - Shop and Working Drawings, when required, shall be prepared by the Contractor and submitted to the Chief Engineer sufficiently ahead of proposed Work so that review, correction and approval actions as described will not delay construction operations.

Shop and Working Drawings, materials certifications, laboratory test reports, and other required submittals will be subject to review by the Engineer. Every effort will be made to respond to these submittals within twenty-one (21) working days of the receipt of submittal by the Engineer. The Contractor shall transmit 6 copies and one electronic, reproducible copy of submittals to the Engineer. The electronic, reproducible copy shall be in .pdf file format, shall be virus free and uncorrupted, and shall be submitted on CD or DVD.

**1. General - Shop drawings** and working drawings shall be drawn or printed on a material from which clean reproducible copies may be obtained; vellums will not be required.

Working drawings, catalog cuts, performance data and other needed information, for those features that require selection by the Contractor, shall show in detail or by written description the proposed methods and data in sufficient detail so that strengths and sufficiencies can be checked.

The Contractor shall not use any shop or working drawing which does not bear the authorized Review Completed or Accepted stamp. No Work for which shop and Working Drawings are required shall be started until drawings have authorized approval.

Acceptance of Shop and Working Drawings by the District shall not relieve the Contractor of his responsibility to furnish all materials and perform all Work required by the Contract.

The District is not responsible for discrepancies, errors and omissions on drawings furnished by the Contractor, even though drawings containing discrepancies, errors and omissions were approved.

No change shall be made to approved Shop and Working Drawings without resubmission. Any change so made shall be clearly marked and dated.

**2. Submission Procedure** - The Contractor shall submit to the Engineer Shop Drawings for reinforcing steel, structural steel, Class A stone masonry, railing, electrical work, guardrail, permanent sheeting, temporary Structures and other design details as determined by the Department; and Working Drawings for formwork and false work, bracing, bridging, scaffolding and other construction details as determined by the Engineer. Shop and Working Drawings which provide engineering details not

included in the Plans furnished by the Department shall be prepared under the direction of and sealed by a Registered Professional Engineer.

The Contractor shall submit Shop and Working Drawings for sewer and water main work showing details for pipe layouts, joints and harnessing, fittings, valves, pile thrust block layouts, pipe reinforcement, and other manufactured equipment and materials. Design data and computations shall be included when requested. For pressure conduits and rubber gasket jointed pipe, a check list shall be submitted showing sequence of submission of anticipated drawings, geometry sheets, bills of material, and laying schedules. Each item shall be tabulated by number, title, sheet or other means of positive identification.

Every effort will be made to return a copy to the Contractor for any correction required within twenty-one (21) consecutive Calendar Days after receipt.

The Contractor shall resubmit 6 corrected and dated copies plus 1 corrected and dated electronic, reproducible copy of drawings, until approved.

Following approval, the approved copy will be sent to the Contractor.

3. **Steel Structures** – Shop and Working Drawings for steel Structures, including metal handrails, shall consist of shop detail, erection, and other drawings showing details, dimensions, sizes of units, and other information necessary for the fabrication and erection of metal work. Such drawings and calculations shall be signed and sealed by a Registered Professional Engineer when details are not included in the Plans furnished by the Department.
4. **Falsework, Sheeting, Shoring, Staging, Cofferdams, and Underpinning** - Working drawings shall be signed and sealed by a Registered Professional Engineer.
5. **Concrete Structures and Prestressed Concrete Members** – Shop and Working Drawings for concrete Structures and prestressed concrete members shall provide such details as required for the successful prosecution of the work and which are not included in the Plans furnished by the Department. Drawings shall include Plans for items such as prestressing strand details and elongation calculations, location of lift points, falsework, bracing, centering, form work, masonry, layout diagrams and bending diagrams for reinforcing steel when necessary or when requested. Such drawings shall be signed and sealed by a Registered Professional Engineer.

No measure or payment will be made for Shop and Working Drawings. Cost shall be reflected and distributed in applicable Pay Items.

### 105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

All Work performed and all materials furnished shall be in conformity with the lines, grades, cross sections, dimensions, material and construction requirements, including tolerances, shown on the Plans or indicated in the Specifications.

In the event the Chief Engineer finds the materials furnished, Work performed, or the finished product not in conformity with the Contract Documents, but that reasonably acceptable Work has been produced, the Chief Engineer shall then make a determination as to whether the Work shall be accepted and remain in place. In this event, the Chief Engineer will document the basis of acceptance by Contract modification which will provide for an appropriate adjustment in the Contract Price for such Work or materials necessary to conform to his determination. Any action taken pursuant to this paragraph may not result in an increase of the Contract Price.

In the event the Chief Engineer finds the materials furnished, Work performed, or the finished product are not in reasonably close conformity with the Contract Documents and have resulted in an inferior or unsatisfactory product, the Work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

### 105.04 COORDINATION OF PLANS AND SPECIFICATIONS

The Contractor shall take no advantage of any error or omission in the Plans or of any discrepancy between the Plans and Specifications, supplemental Specifications or Special Provisions, and the Chief Engineer shall make such corrections and interpretations as may be deemed necessary for the satisfactory completion of the Work.

On all Plans, the calculated dimensions will govern in case of discrepancy over the scaled dimensions.

### 105.05 COOPERATION WITH UTILITY RELOCATION

The Department will notify all utility companies, all pipe line owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

Before commencing excavation or demolition work the Contractor shall notify affected parties in conformance with 107.16.

The Department of Transportation's records on locations of utility lines are on file in the Public Space Permits and Records Division. These files are available for the Contractor's use. However, such use shall not be the basis of any claim against the District.

Utility work will be performed by utility owners at no cost to the Contractor except for utility work included as part of the Contract. Vault adjustments will be made by vault owners. It is anticipated that utility or vault work to be performed by others will not interfere with work under the Contract; however, should work by others become necessary during the life of the Contract, the Contractor shall cooperate accordingly.

For any underground utility or vault encountered, the Contractor shall immediately notify the Engineer and take necessary measures to protect the utility or vault and to maintain its service until relocation by the utility owner is accomplished.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions and that no additional compensation will be allowed for delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them. Should the Contractor be granted a time extension for third party utility delays beyond his control, the time granted shall be the sole remedy and no form of compensation will accompany the time extension.

The Contractor shall have responsibility for notifying all affected utility companies prior to the necessity of performing any work on their utilities and shall cooperate with them in achieving the desired result. All damage to utility facilities caused by the Contractor's operations shall be the responsibility of the Contractor.

#### **105.06 FIELD LAYOUT**

- A. GENERAL** - The Chief Engineer will furnish all lines, grades and measurements necessary for grading and paving projects. The Chief Engineer will furnish only the baseline and bench marks for Bridge and other Structure projects including associated paving work. The Contractor shall perform all remaining engineering layout in an approved manner. Layout for Bridge and other Structure projects shall be performed by competent surveyors under the direction of a Registered Professional Engineer.

The Contractor shall perform all layout for landscape work except for street line trees which will be located by the Urban Forestry Administration.

Work shall be performed only within authorized lines and grades; operations outside authorized areas will not be included for measure and payment.

Stakes or marks the Chief Engineer sets for guidance shall be preserved by the Contractor. If, in the opinion of the Chief Engineer, stakes are displaced, removed or lost due to Contractor's negligence, they will be replaced by the Chief Engineer and charged the Contractor at \$100.00 per stake.

- B. MATCH OLD WORK** - The Contractor assumes full responsibility for successfully carrying out the complete construction and the fitting of all members. Dimensions shown on the drawings taken from original design and Shop Drawings are not guaranteed. Where new work is to be fitted to old work, the Contractor shall be responsible for checking all dimensions and conditions in the field. If the parts do not fit properly, the Contractor shall make alterations to the new parts necessary to assure proper fit and connection in accordance with instructions of the Chief Engineer, at no additional expense to the District.

Prior to preparing his bid, the Contractor shall visit the worksite and carefully examine the condition of the various parts of the Structure and then include in his bid, costs for making measurements necessary or convenient for the proper completion of the Work.

#### **105.07 INSPECTOR'S AUTHORITY**

Inspectors designated as representatives of the Department, including private consultants, shall have authority to inspect all Work and furnished materials. Such inspection may extend to all or any part of the Work and to the preparation, fabrication or manufacture of the material to be used. In case of dispute between the Contractor and Inspector, the Inspector has authority to reject Work and materials and to suspend Work until the Chief Engineer is able to resolve the case. Inspectors have no authority to alter, waive or add to Contract requirements.

**105.08 LOAD RESTRICTIONS**

The Contractor shall comply with all legal load restrictions in the hauling of materials on the streets and bridges beyond the limits of the Project. A special permit will not relieve the Contractor of liability for damage which may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures, or appurtenances will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed by the Chief Engineer to prevent damage to any portion of the pavement structure or underlying utilities. No loads will be permitted on a concrete pavement, base or structure before the expiration of the curing period. In no case shall legal load limits be exceeded unless permitted in writing. The Contractor shall be responsible for all damage done by equipment.

**105.09 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE**

If the Contractor, at any time, fails to maintain the Site properly in conformance with the terms of the Contract Documents, the Chief Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to commence repair, beyond mobilization, of the unsatisfactory maintenance within four (4) hours of receipt of such notice, the Chief Engineer may immediately proceed to maintain the Project, and the entire cost of the maintenance will be deducted from the Contract Price.

**105.10 WEEKEND WORK**

No work shall be permitted on Sundays without prior written approval of the Chief Engineer, his designee or as otherwise specified in the Contract Documents.

**105.11 NIGHT WORK AND NOISE LEVEL RESTRICTIONS**

**A. GENERAL** -The Contractor shall work at night when it is specified or when, in the judgment of the Chief Engineer, such action is necessary and shall maintain illumination levels for safe operations in all active work areas during evening and night work. Temporary lighting for the Contractor’s operations shall comply with OSHA regulations, Section 1926, task requirements and as specified in Contract Documents.

The Contractor shall be subjected to area noise ordinances for night work from 7 P.M. to 7 A.M. and to the restrictions on equipment as indicated below except as permitted by a variance. The Department will support the Contractor’s efforts in applying for a variance from the Department of Consumer and Regulatory Affairs that will permit reasonable day and nighttime noise limits. However, the Department gives no guarantee concerning the noise levels granted in any waiver, nor whether or not the variance is granted.

**TABLE 105.11 D.C. MAXIMUM PERMITTED NOISE LEVEL**

(as defined in D.C. Law2-53, District of Columbia Noise Control Act of 1977)

Zone	MAXIMUM NOISE LEVEL (DBA)	
	DAYTIME	NIGHTTIME
Residential, Special Purpose or Waterfront Zone	60	55
Commercial or Light Manufacturing Zone	65	60
Industrial Zone	70	65

**B. RESTRICTIONS** – The use of all mechanical impact demolition equipment will be absolutely prohibited between the hours of 7:00 P.M. and 7:00 A.M.

**C. MEASURE AND PAYMENT** – No separate measure or additional payment will be made for Night Work or Night Lighting.

**105.12 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK AND MATERIALS**

No work shall be performed for the Project without supervision or inspection by a representative of the Department.

Work done prior to Notice to Proceed, work beyond Project limits intended by plans or as directed, work done during a work suspension, work deviating from requirements without written authority, extra work done without authority or work done contrary to the Chief Engineer's instructions will be considered unauthorized. The District is not obligated to pay for unauthorized work. Unauthorized work and materials may be ordered removed and replaced as directed at Contractor expense.

**105.13 INSPECTION – ACCEPTANCE**

- A. GENERAL** - Any work or materials determined to be unacceptable or unauthorized under 105.12 may be ordered removed and replaced at Contractor expense. Failure to inspect or reject work or material shall not in any way imply acceptance, nor prevent the District from later rejecting the work.

The Contractor shall be responsible for providing all access, traffic control devices, equipment, and labor to complete inspections by the Engineer.

Costs associated with inspection services will not be permitted in claims nor as a basis of claims.

When a unit of government other than the District, a utility company, or a railroad has an interest in or is affected by the Contract, its respective representatives shall have the right to inspect the portion of the Work affecting its interests. Such inspection shall not make any government unit, utility company, or railroad a party to the Contract nor interfere with the rights of the District or the Contractor.

- B. PARTIAL ACCEPTANCE/** - When the Contractor completes a suitable unit or portion of the Project, the Engineer may make, or the Contractor may request, final inspection of that unit. If the Chief Engineer finds the unit complete and meets Contract requirements, he may accept in writing that unit as complete which written acceptance shall include a description of specific work accepted, and the Contractor may be relieved of further responsibility for the accepted unit. Such partial acceptance shall not void nor alter any Contract provision.
- C. FINAL INSPECTION AND ACCEPTANCE** - Within thirty (30) consecutive Calendar Days after receipt of written notice from the Contractor that Contract work is complete and the Project area cleaned up, the Chief Engineer will make final inspection of the Project. The Contractor shall promptly correct any deficiency as determined, and upon acceptable completion of all Work and cleanup the Chief Engineer will certify in writing as to completion and the amount and value of each class of completed Work for purposes of final payment. All prior certificates or estimates upon which partial payments may have been made will be subject to correction in the final payment.

The Project will not be accepted until the Contractor has met all Contract requirements. The Contractor remains responsible for the correction of any deficient or non-compliant aspects of the Work until final acceptance, even if discovered after final inspection.

## 106 CONTROL OF MATERIALS

### 106.01 SOURCE OF SUPPLY AND QUALITY

Only materials meeting the requirements of these Specifications and approved by the Chief Engineer shall be used. Materials may be subjected to inspection or test at any time during their preparation for use.

The materials used on the Work shall meet all quality requirements of the Contract. In order to expedite the inspection and testing of materials, the Contractor shall notify the Chief Engineer of his proposed sources of materials prior to delivery. At the option of the Chief Engineer, materials may be approved at the source of supply before delivery is started. If it is found that sources of supply for previously approved materials do not produce specified products, the material and/or source of supply may be rejected.

The entire output of any source of supply may be rejected when a continuous supply of satisfactory material cannot be obtained.

Unless specifically approved by the Chief Engineer, material sources shall not be changed in the course of a project.

Approval of a material for a particular purpose, use, or project in a specified manner does not constitute approval for its use for any other purpose, project or manner.

Materials which appear defective upon arrival shall not be used until approved. All rejected materials shall be promptly removed from the Site.

### 106.02 SAMPLES, TESTS AND CITED SPECIFICATIONS

All materials shall be inspected, tested and accepted by the Chief Engineer before incorporation in the Work. Any Work in which untested or unaccepted materials are used will be performed at the Contractor's risk and may be considered as unacceptable and unauthorized Work.

The Contractor shall furnish material samples for inspection or testing. These samples may be required prior to or during the use of the material or at any time prior to acceptance of the Work. Unless otherwise designated, materials shall be sampled and tested in accordance with the requirements of the standards which are Current on the date of Advertisement for bids.

Samples shall be taken in accordance with the following:

- A. Samples of untreated aggregates or soils shall be taken from the road at the lay down machine prior to compaction.
- B. Samples of bituminous mixtures shall be taken from the road at the lay down machine and from the Plant out of the truck; for the determination of gradation, bituminous content, and other properties as specified. In addition, the Contractor shall furnish test samples cut from the compacted mixtures (3 per city block) at locations designated by the Chief Engineer. The Contractor shall repair the areas from which the samples were cut at no additional cost to the District.
- C. Samples of Portland Cement Concrete shall be taken from the hauling unit at the Project Site for the determination of slump and air content, unit weight and for the fabrication of test beams and cylinders.
- D. Samples of cement-treated and lime-treated materials shall be taken from the road at the laydown machine prior to compaction for the determination of gradation, moisture content, unit weight and the fabrication of test cylinders.
- E. Tests for density shall be made after the compaction process has been completed.
- F. Thickness determinations of pavement layers shall be made on the road, by coring or test pitting, after all compacting and processing has been completed.
- G. Manufactured materials such as Portland cement, steel, hydrated lime, bituminous materials, paint, materials used in signs, lighting and traffic signals may be sampled at the producer's Plant. Before final acceptance, such materials shall be subject to inspection and further testing after delivery to the Project as determined by the Chief Engineer. Project samples shall be taken before the material is incorporated into any other product.

Where sampling and testing of a material prior to use is required by Contract or directed by the Chief Engineer, the Contractor shall provide the necessary samples sufficiently in advance of contemplated use for testing and approval. Samples shall be delivered to

the location as determined by the Chief Engineer. Material samples shall be submitted with the appropriate project name, source of material, and intended use of material.

When samples are taken at the job Site by the Department's personnel or by any personnel of a materials testing firm employed by the Department to obtain such samples for testing, the Contractor shall provide sufficient personnel of his employment to convey the samples from the sampling location to the vehicle waiting to transport them for testing, and load the samples upon the vehicle for shipment to the testing laboratory. All costs to the Contractor for assisting in this effort shall be absorbed as part of the payment made for the item for which the material is being furnished.

Table 106.02 gives the minimum sampling requirements for materials for test.

Longer times required to test materials does not waive any specification requirements for the material or work.

New materials sources or non standard materials are job dependent.

**TABLE 106.02 MINIMUM SAMPLING REQUIREMENTS FOR MATERIALS**

<b>MATERIAL</b>	<b>MINIMUM SAMPLE REQUIRED</b>	<b>WORKING DAYS TO OBTAIN VERBAL TEST RESULTS</b>
Admixtures (Portland Cement Concrete)	See 814	
Aggregate, Coarse (PVV & Asphalt)	70 Pounds	5
Aggregate, Fine Bituminous	20 Pounds	5
Blanket	10 Pounds	
Concrete	20 Pounds	
Filter	10 Pounds	
Mortar	10 pounds	
Vertical	10 pounds	
Aggregate, Source (new)	200 pounds	60
Anchor Bolts	1 specimen per lot	6
Asphalt Cement (complete)	Standard 16 oz. can	5
Asphalt Cores	Job Dependent	1
Asphalt, Cut-Back	1 quart	5
Asphalt, Emulsified	4 quarts	5
Asphalt Primer for Waterproofing	1 quart	5
Asphalt Seal Coat for Waterproofing	1 quart	5
Bituminous Mixtures	12 pounds	12
Job Mix Formulas	75 pounds	21
Brick		
Building	10 specimens	12
Sewer	10 specimens	12
Burlap	3 foot length x width of roll	4
Caulking Compound	1 pint	20
Canvas Ceramic Tile	2 square yards	4
Concrete Mix Design	25 specimens	40
Concrete, Wet (Dunagan)	6 cubic feet	50
Dowel Bars	30 pounds	
Electrical Items	3 specimens	6
Expansion Joint Filler	Job Dependent	16
Gravel	3 foot length x width (4- ½ inch min)	
High Tensile Strand (or wire)	70 pounds	
Load Transfer Devices	5 foot length	11
Masonry Cement	1 specimen	6
Membrane (liquid) Curing Compound	10 pounds	16
	1 quarts	6



MATERIAL	MINIMUM SAMPLE REQUIRED	WORKING DAYS TO OBTAIN VERBAL TEST RESULTS
Mineral Fiber Paint and Coatings (2)	5 pounds	5
Pipe		
Clay	4-1 quart cans	30
Concrete	2 specimens	6
Polyethylene Sheeting	2 yards x 10 inches	11
Portland Cement	10 pounds	
Preformed Bearing Pads	4 inch x 4 inch	
Prestressed Reinforcement	Per Section 815.02	
Reinforcing Steel		
Bars Nos. 2 through 9	1 specimen 5 feet in length	6
Bars larger than No. 9	1 specimen 7 feet in length	6
Saturated Cotton Fabric	4 foot length x width of roll	6
Sealing Compounds		
Cold Poured, Emulsion	1 quart	16
Cold Poured, Mastic	1 quart	16
Cold Poured, Two-component	1 quart	20
Hot Poured	5 pounds	16
Shear Connector Studs	1 specimen	
Soils		
Gradation LL and PI	20 pounds	5
Gradation and Proctor	100 pounds	6
Top Soil	20 pounds	11
Subgrade Paper	3 foot length x width of roll	6
Tar (Creosote) Primer for Waterproofing	1 quart	6
Tar, Road	1 quart	6
Tar Seal, Coat for Waterproofing	1 quart	6
Tie rod assemblies	3 specimens	6
Waterproof Paper	2 square yards	11
Waterstop, Rubber	2 square feet	11
Waterstop, PVC	2 square feet	30
Weld Wire Fabric	3 feet x 3 feet	6
Miscellaneous Materials and Tests		
Determining Thickness of Metals	Representative sample	6
Determining Unit Weight of Metals	Representative sample	6
Determining Thickness of Galvanizing	Representative sample	6
Identification of Wrought Iron Infa Red Spectrum	Representative sample	2

### 106.03 MATERIALS COMPLIANCE CERTIFICATION

The Contractor shall furnish material compliance certifications for all manufactured materials obtained from vendors or producers, prior to their incorporation into the Work .

The Contractor shall submit certificates to demonstrate proof of compliance with requirements for products and materials, qualifications of personnel, and results of testing. Each certificate shall be signed by an official authorized to certify on behalf of the issuing organization. Certificates shall show the name and address of the Contractor, the Project identification (Invitation Number, Project Description and Federal-Aid Number(s), if applicable, as shown on the title pages of the Specifications and Bid Proposals) and, if for a material, the quantity and date(s) of shipment to which the certification applies. Certificates shall not be construed as relieving the Contractor from furnishing satisfactory material if in subsequent testing of samples the material does not meet specified requirements. The original and two copies of all certificates shall be submitted unless otherwise specified.

The Contractor shall certify monthly that the portland cement, portland blast furnace slag cement, coarse and fine aggregates, admixtures and water conform to the source, quality and grading as stated on the current approved job mix formulae and the Contract Documents.

The Chief Engineer may permit use prior to sampling and testing of certain materials or assemblies accompanied by certifications stating that such materials or assemblies fully comply with the requirements of the Contract. The certificate shall be signed by the manufacturer. Each lot or assembly delivered to the Work must be accompanied by a certification in which the lot is clearly identified.

Materials used on the basis of certifications may be sampled and tested at any time and if found not to be in conformity with Contract requirements will be subject to rejection whether in place or not.

#### **106.04 PLANT INSPECTION**

The Department shall have full access at all times to those parts of materials sources, asphalt and PCC Plants, steel fabrication shops and pre-cast facilities as may concern the production and manufacture of materials and products needed for the Contract.

The Quality Assurance/Quality Control Engineer should visit the Pre-Cast facilities shortly after start-up of production in order to inspect the actual product pieces and the contractor process control. The contractor will be responsible for all cost incurred by the Department to inspect the precast Plant

The Contractor shall notify the office of the chief plant Inspector twenty-four (24) hours before concrete or asphalt is to be delivered to the Project Site. In the event that delivery is suspended for an indefinite period, a twenty-four (24) hour notice is also required in advance of a resumption of delivery.

#### **106.05 QUALITY CONTROL OF PLANTS**

The Contractor shall assume the responsibility for the quality control and condition of all material during the handling, blending and mixing operations. The Contractor shall assume responsibility for the initial determination and all necessary subsequent adjustments in proportioning of materials used to produce the specified job-mix. The Contractor shall have available the testing equipment necessary to perform stockpile and hot bin analysis (asphalt) or bin samples (PCC) required below.

The Department's Inspector will not assume by act or word the responsibility for mix control adjustments, calculations or the setting of dials, gages, scales and meters. Such duties are to be assumed only by the Contractor. Tests for conformance with the Specifications may be made on samples of the materials entering into the composition of the mix, samples of the mixture, and samples cut from the completed pavement. The Contractor shall cooperate with the Chief Engineer in obtaining these samples. When samples are cut from the pavement, the voids caused by the cuts shall be replaced and refinished without additional compensation. The preparation of all bituminous mixtures and Portland cement concrete mixes shall be subject to inspection at the Plant. For this purpose, the Contractor shall provide an acceptably furnished and equipped Laboratory in accordance with the requirements of 106.06(A).

Generally, the testing of bituminous and Portland cement concrete mixes at the Plant is provided by the Department as a routine check upon the adequacy of the Contractor's quality control procedures.

In lieu of an acceptance program involving continuous sampling, testing, and weight verifications at the source, small quantities of material may be accepted by the Chief Engineer based upon continuous or occasional sampling and testing at the source, supplemented by visual examination at point of delivery; and, based upon weights furnished by the Contractor (or supplier) on the weight tickets. The frequency of sampling, testing and weight verification by an Inspector at the source will be established by the Chief Engineer based upon the Department's current acceptance program and local conditions encountered.

#### **106.06 FIELD FACILITIES**

**A. ASPHALT AND PCC PLANTS** - The Contractor shall furnish and maintain a laboratory wherein approval testing for mixture composition will be performed by the Department at the location(s) approved for Plant processing of material at the Contractor's expense. The Contractor may utilize the laboratory and equipment for the purpose of performing quality control testing; however, in the event the dual testing programs overlap in such a manner as to interfere with the check and acceptance tests to be performed by the Department, the Department shall have priority in the use of the facilities and equipment. Only one laboratory will be required by the Department per plant regardless of the number of contracts from which the material is being processed.

The plant laboratory and equipment furnished by the Contractor shall remain the property of the Contractor. Equipment furnished by the Contractor shall be subject to inspection and calibration by the District at anytime during the Contract performance period. Test equipment found not to be in calibration and proper working condition shall be adjusted, repaired or replaced immediately to the

satisfaction of the Chief Engineer. The space provided for the plant laboratory shall be used for laboratory purposes only. The laboratory shall be erected before the processing of material begins and shall be available throughout the duration of the plant operation. It shall be removed upon completion of the Project, if located on the Project.

The laboratory shall be of weatherproof construction, tightly floored and roofed, and constructed with an air space above the ceiling for ventilation.

The width of the laboratory shall not be less than 8 feet and the floor-to-ceiling height shall not be less than 6 feet 6 inches. The floor space shall be not less than 160 square feet, with a minimum working area of not less than 140 square feet. The inside walls and ceiling shall be constructed of plywood, masonite, gypsum board, or other suitable materials. Walls and ceiling shall be insulated.

The laboratory shall contain at least 2 windows, each having an area of not less than 540 square inches, can be easily opened and secured from the inside only. The laboratory shall contain at least 1 door. Both window and door screens shall be provided. The door(s) shall be equipped with lock(s) and at least 2 keys for each lock shall be furnished to the Chief Engineer.

The laboratory shall have satisfactory lighting, telephone, heating equipment, water supply, exhaust fan, air-conditioner and electrical outlets (120 V and 220 V) and shall be connected to an operational power source.

Heating and air conditioning equipment shall maintain a temperature of not less than 68°F and not more than 78°F.

The capacity of the exhaust fan shall be such that it will exhaust, each hour, a volume of air equal to at least 10 times the cubical volume of the laboratory. Fuel for the heating equipment and electrical current shall be furnished by the Contractor. The Contractor shall also furnish and maintain one chemical type and one 2-1/2 gallon pressurized water fire extinguisher of standard commercial quality.

A suitable indoor toilet connected to a sanitary sewer shall be provided. If a sanitary sewer is not available a suitable outdoor toilet conforming to the requirements of the Board of Health, or other bodies having jurisdiction in the area, shall be provided.

In addition to the general requirements stated herein, the laboratory shall be equipped with the following:

1	Work bench (96 x 30 inches)
1	Desk (60 x 34 inches)
1	Sink connected to operational water source with approximate dimensions: length 24 inches; front to back 18 inches; depth 8 inches
1	Printing electronic calculator
1	Metal, 4 drawer file cabinet (15 inch drawer width)
2	Chairs
1	Waste basket
1	Pencil sharpener
1	First aid kit
1	Potable water supply
1	Eye wash station connected to a potable water supply (asphalt laboratory)

The Contractor will furnish the following minimum testing equipment:

1	Centrifuge extractor (3,000 grams capacity) or equal
2	Electric hot plates thermostatically controlled with 3-way plug and cord
1	Triple beam balance with scoop, capacity 2600 grams
1	Triple beam balance with scoop, capacity 20 kilograms
1	Set of sampling equipment, steel buckets, square nose shovel, sampling thief and sampling bags
1	Mechanical sieve shaker for 8 inch diameter sieves, 2 inch through No. 200 mesh
1	Set of brass frames, 8 inch diameter sieves, 2 inch through No. 200 mesh
1	No. 200 Wet Washing Sieve, brass frame 4" height above mesh
1	Sample Splitter with opening to 1 1/2 inches
1	Mechanical Shaker, with the following screen tray sizes: 2", 1-1/2", 1", 3/4", 1/2", 3/8", No. 4, No. 8, No. 10, No. 16 and pan; and also, for asphalt Plants, the following specified equipment which shall conform to the requirements of AASHTO T 245. Concrete thermometers Specimen

3	Mold Assembly Specimen
1	Extractor
1	Compaction Hammer Mechanical Compactor with counter and pedestal
1	Safety can, 2-1/2 gallon capacity
1	Lab Type Oven
2	Dial Type Asphalt Thermometers Extraction fluid Conforming to AASHTO T 164. Used extraction fluid shall be disposed of by the Contractor in conformance with Federal and City laws.

Miscellaneous supplies; pans, brushes, scoops or large spoons, trowels, graduated beakers and an adequate supply of running water shall be provided. The equipment specified shall be installed ready for operation in a field laboratory conforming to the above requirements.

Adjacent to the platform scales at asphalt Plants, the Contractor shall furnish a platform of sufficient height for checking mix temperatures and operations.

- B. STEEL FABRICATION SHOP** - The Contractor shall make provisions, at his expense, to furnish and maintain at the steel fabrication shop acceptable office space with adequate light and a telephone for the exclusive use of personnel performing shop inspection for the District.

This office space shall be furnished with the following:

1	Drawing table
1	Metal, 4 drawer file cabinet (15" drawer width)
1	Desk
2	Chairs

- C. PRECAST FACILITIES** - The Inspector shall have full access at all times to all parts of the yard where units to be inspected are being constructed. The Contractor shall furnish the necessary equipment and facilities for inspection of workmanship and physical tests. The Contractor shall provide for the Inspector a suitable office with all utilities including telephone service.

**106.07 STORAGE OF MATERIALS**

Materials shall be stored so as to insure the preservation of their quality and fitness for the Work and shall be located so as to facilitate prompt inspection. When considered necessary by the Engineer, material shall be placed on concrete platforms or other hard, clean surfaces and not on the ground, and shall be placed under cover when necessary for proper protection. The Contractor is responsible for the replacement of all material stored improperly as required by the Engineer.

Materials from different sources of supply shall not be stored in the same stockpile unless approved by the Engineer.

Stockpiles of aggregate shall be built in horizontal layers not to exceed 3 feet in height. Each layer shall be completely in place before the next is started and shall not be of such height as to cause coning or segregation. Aggregates which become mixed or contaminated with soil or other foreign material when in stockpiles shall be rejected. Care must be used in removing the material near the base of the pile.

**106.08 HANDLING OF MATERIALS**

Vehicles used in transporting aggregates, Portland cement, asphalt, or similar construction materials must be kept clean and free from all foreign matter, be in proper working condition and have strong, substantial bodies which will prevent the escape of materials during transportation. Any material shipped in a conveyance containing foreign material shall be rejected regardless of the quality of said materials as determined otherwise.

Aggregates shall be handled in such a manner as to prevent coning or segregation.

**106.09 UNACCEPTABLE MATERIALS**

All materials not conforming to the requirements and Specifications shall be considered as unacceptable and will be rejected and be removed immediately from the Site of the Work. Rejected material shall not be used until the defects have been corrected and approved by the Engineer.

- A. REFERENCE TESTS** - In the event the Contractor demonstrates that the test results obtained from a sample taken to evaluate a particular lot appear questionable, the Contractor may request in writing that additional tests be taken of that lot. Upon receipt of the written request, additional samples will be randomly selected and an appropriate number of retests made.

If the results of the new tests indicate the material does not conform to the Specifications and is not acceptable, the full cost of the test shall be borne by the Contractor.

#### **106.10 MATERIAL SHORTAGES**

The Contractor is advised to anticipate shortages of certain products particularly those containing steel, copper, aluminum, Portland cement, and asphalt, and is urged to place orders as early as practicable to provide producers and suppliers with maximum lead time. If timely deliveries still cannot be assured from usual sources, alternative suppliers should be fully considered.

Reasonable time extensions, exclusive of further compensation, for delays due to such products being in short supply, may be granted only if delays are beyond the control of the Contractor, fabricator, or supplier and written evidence of such delays, satisfactory to the Chief Engineer, is submitted concurrently with the delays and not after the fact.

#### **106.11 MATERIALS ORDER**

A completed materials order shall accompany each quantity and shipment of materials from issue point to the job Site, and shall be delivered to the Inspector. Each materials order shall consist of an approved form serially numbered; additional information and certification shall be promptly furnished if requested.

A copy of each order shall be retained by the Inspector at material issue point. Payment may not be made for materials not accompanied by a proper materials order.

#### **106.12 PROCESSING OF MATERIALS**

All Work shall conform to the appropriate provisions of the current Occupational Safety and Health Standards (OSHA). The attention of those contractors furnishing and processing materials in the District is specifically directed to OSHA 29 CFR 1926.58 issued June 1986.

#### **106.13 CONTRACTOR PROCESS QUALITY CONTROL AT ASPHALT AND CONCRETE PLANTS**

- A. SCOPE** – This section establishes minimum requirements and activities for Contractor-based process quality control systems (Process Control). Process control is a series of samples and tests for controlling the delivery, handling, measuring, batching and mixing of construction materials at Asphalt and Concrete Plants. The results of process control tests may be used as a basis to accept or reject a material.

- B. FUNCTIONS AND RESPONSIBILITIES** – The Department will approve mix designs and job mix formulas. The Department will also provide random plant inspections to monitor and verify control of the operations to assure conformity of materials with the Contractual Specifications.

At no time will the Department representative issue instructions to the Contractor or their producer as to setting of dials, gauges, scales and meters. However, the Department representatives may question and warn the Contractor against the continuance of any operation(s) or sequence of operations which may result in unsatisfactory compliance with specification requirements.

The Contractor shall submit in writing their proposed quality control plan to the Department prior to the pre-construction conference for review and approval. The plan should contain the sampling, testing, inspection, and frequencies to maintain process quality control. Minimum testing, and inspection activities are shown in Table 106.13A and 106.13B.

The activities shown in Tables 106.13A and 106.13B are minimum activities necessary to control production at an acceptable quality level. It is recognized, however, that depending on the type of process or materials, some of the activities listed may not be necessary and in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. The frequency of these activities, when there are deficiencies in the quality of the materials processed, will be increased until the proper conditions have been restored.

The Contractor shall provide and keep up-to-date control charts/computer data bases (as approved by the Contractor's QA/QC Plan) for all quality control sampling and testing.

The Contractor shall be responsible for the formulation of all mix designs. In accordance with Standard Specifications 817 and 818, the Contractor's proposed mix designs must be submitted to the Department for approval, thirty-five (35) Calendar Days prior to their use and for each calendar year. The Contractor shall be responsible for the process control of all materials during handling, blending, mixing, and the placing operations.

### C. MINIMUM CONTRACTOR PROCESS QUALITY CONTROL REQUIREMENTS FOR BITUMINOUS MATERIALS

#### 1. All Types Of Plants

##### a. *Stockpiles*

- i. Determine gradation of all incoming aggregates as per AASHTO T-27 (Weekly or as directed by the Chief Engineer)
- ii. Inspect stockpiles for separation, contamination, segregation, etc. (Daily)

##### b. *Cold Bins* - Observe operation of cold feed for uniformity (Daily)

##### c. *Bituminous Mixture*

- i. Determine percent bitumen as per AASHTO T-308 (per 500 tons)
  - ii. Determine mix gradient per AASHTO T-30 (per 500 tons)
  - iii. Determine mix percent air voids as per AASHTO T-269 (per 500 tons)
  - iv. Produce and test Gyratory samples as per AASHTO TP4 (per 500 tons)
  - v. Check mix temperatures (Hourly)
  - vi. Maintain file of incoming asphalt binders (asphalt cement) certifications.
  - vii. Determine asphalt dust ratio as per the Department Specifications
  - viii. Maintain log of various asphalt binders in storage tanks.
- d. Completion of Shipping Tickets shall include the following information:
- i. Name of Asphalt supplier.
  - ii. Ticket serial number.
  - iii. Quality control person's certification of performance for each mix type and each Contract number (with first load).
  - iv. Date, truck and load number.
  - v. Name of Contractor.
  - vi. D.C. Contract number and location of placement.
  - vii. Department approved job mix formula and asphalt class.
  - viii. Temperature of mix loaded on truck.
  - ix. Certified truck weight and total volume weight of asphalt shipped.
  - x. Release agent for truck beds.

#### 2. Batch Plants

- a. Check mixing times.
- b. Check operations of weight bucket and scales.

#### 3. Drum Mixer Plants

- a. Determine gate calibration chart for each bin.
- b. Determine gate settings for each bin to assure compliance with the Department approved job mix formula.

- c. Determine gallons per revolution or gallons per minute to assure compliance with the Department approved job mix formula.
- d. Determine moisture content of stockpiles.

**D. MINIMUM CONTRACTOR PROCESS QUALITY CONTROL REQUIEMENTS FOR PORTLAND CEMENT CONCRETE (PCC)**

**1. Incoming Materials**

- a. Maintain file of incoming Portland cement and admixture shipment certifications.
- b. Check proper Portland cement storage.
- c. Determine gradation of incoming aggregates and fineness modulus of fine aggregate as per ASTM C-136 (Daily).
- d. Certify that all incorporated materials are from approved sources.
- e. Maintain stockpiles to prevent separation, contamination, segregation, frozen aggregates, etc. (Daily).

**2. Measuring Devices**

- a. Check that scales are calibrated/checked for accuracy and precision (Daily).
- b. Check that flow meters are calibrated/checked (Daily).
- c. Moisture meter checked/verified by ASTM C-566 method moisture testing (Daily).
- d. Check admixture dispensers calibrated and functioning (Daily).
- e. Check Plant clock for accuracy (Daily).

**3. Mixers**

- a. Manufacturer's design details on-hand.
- b. Check that the central mixer-timing device is certified and properly functioning (Daily)
- c. Check that truck mixer-timing device is certified and is properly operating.
- d. Check water gauges, etc. (Daily).
- e. Check that mixes are free of hardened concrete (Twice annually).
- f. Inspect mixers for proper functioning, wear, hardened concrete, etc. (Twice annually).

**4. Mixing Concrete**

- a. Check for proper batching sequence (Daily)
- b. Check for proper mixing speed and time (Daily)
- c. Check concrete for uniformity, tested for specification compliance (Twice daily) (Slump as per ASTM C-143; Air Content as per ASTM C-172,C-173 and C-231; unit weight as per ASTM C-138)
- d. Mixture Adjustment- adjustment for moisture correction every four (4) hours.

**5. Completion Of Batch Tickets - Include the following information:**

- a. Name of Concrete supplier
- b. Ticket serial number, date, D.C. Contract number, and truck number.
- c. Name of Contractor
- d. Quality control person's certification of performance for each mix type and Contract number (for first load).
- e. Location of placement.
- f. The Department mix design approval number and concrete class.

- g. Component quantities and concrete total volume.
- h. Moisture correction for aggregate moisture, and total water in mix.
- i. Time of batching.
- j. Maximum amount of water that may be added to the mix at the Project Site.

#### E. QUALITY CONTROL SYSTEM

1. **General Requirements** - The Contractor shall furnish and maintain a quality control system that will provide reasonable assurance that all materials and products submitted to the Department for acceptance conform to the Contract requirements, whether manufactured or processed by the Contractor or procured by the Contractor from suppliers or Subcontractors. The Contractor shall have performed the inspection and tests required to substantiate product conformance to Contract requirements by the Department certified materials testing laboratory. The Contractor shall have a qualified quality control technician, who has been certified by the Department at an asphalt or concrete Plant where materials are being produced for the Department. Department certification is dependent upon a Mid-Atlantic State's certification and on-the-job performance evaluated through the Department Independent Assurance Test Program and random inspections conducted by Department staff. The Contractor's quality control procedures, inspection, and test results shall be documented and available for review by the Department throughout the life of the Contract. Upon completion of the Project, the Contractor shall submit these items to the Department.
2. **Documentation** - The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of tests made, the number of deficiencies found, the quantities approved and rejected, and the nature of corrective action taken. The Contractor's documentation procedures will be subject to the review and approval of the Department prior to start of the Work and to compliance checks during the progress of the Work. All charts and records documenting the Contractor's quality control tests and inspections shall become the property of the Department upon completion of the Work.
3. **Charts And Forms** - All conforming and nonconforming inspections and test results shall be recorded on approved forms and charts, which shall be kept up-to-date and complete, and shall be available at all times to the Department assuring the performance of the Work. Test properties for various materials and mixtures shall be charted on forms that are in accordance with applicable requirements of the Department. A copy of each chart and form to be used by the Contractor shall be furnished to the Department. The Department will design and provide standardized test report forms and material control charts in an electronic format. The Plant Laboratory shall utilize the forms and charts as designed for their reporting purposes.
4. **Corrective Actions** - The Contractor shall take prompt action to correct any errors, equipment malfunctions, process changes, or other assignable causes, which have resulted in or could result in the submission of non-compliant materials or products. When it becomes evident to the Department that a Contractor is not controlling its process and is making no effort to take corrective actions, the Department will require that operations be ceased until such time as the Contractor can demonstrate that it can and will control the process. Should it become evident that a fraudulent claim has been made as to the quality of the material(s) utilized or produced, or a similarly fraudulent claim is made to the calibration of equipment, the Chief Engineer may de-certify the Plant operation for a period of thirty (30) Calendar Days, or as otherwise determined by the Chief Engineer. Additional fines, penalties or damages may be assessed as determined by the Chief Engineer and authorized by law, regulation or contract terms.
5. **Asphalt And Concrete Laboratories With Measuring And Testing Equipment** - The Contractor shall ensure that the Plant's testing laboratory is equipped with all the necessary equipment and supplies for proper process control sampling, testing, record keeping and test reporting purposes. To assure accuracy, the testing equipment shall be checked prior to startup and periodically as directed by the Department in accordance with applicable standards.
6. **Sampling And Testing** - Sampling testing methods and procedures used by the Contractor to determine quality conformance of the materials and products will be the same as those used by the Department (See Tables 106.13 A and 106.13B). The Contractor's quality control plan will include the taking of samples on a random basis as approved in Quality Assurance Control Plan and the plotting of test results on control charts and/or computer data files.



7. **Alternative Procedures** - The Contractor may use alternative sampling methods, procedures, and inspection equipment when such procedures provide, at a minimum, the quality assurance required by the Contract Documents. Prior to applying such alternative procedures, the Contractor shall describe them in written proposal and shall demonstrate for the approval of the Department that their effectiveness is equal to, or better than, the Contract requirements. In case of dispute as to whether certain procedures proposed by the Contractor may be used, the Contract Documents shall apply. Where Contract Documents are silent on the matters in question, it is left to the final determination of the Chief Engineer.
8. **Department Inspection At Subcontractor Or Suppliers Facilities** - The Department reserves the right to inspect materials not manufactured within the Contractor's facility. This inspection shall not constitute acceptance nor shall it in any way replace the Contractor's inspection or otherwise relieve the Contractor of their responsibility to furnish an acceptance material or product. When inspection of the Subcontractor's product is performed by the Department, such inspection shall not be used by the Contractor as evidence of effective inspection of such Subcontractor's or supplier product. The Contractor, as necessary to assure conformance with Contract requirements, shall inspect subcontracted or purchased materials when received. The Contractor shall report to the Department any nonconformance found on the Department source inspection material and shall require the supplier to take necessary corrective action.

#### **106.14 MINIMUM REQUIREMENTS FOR TESTING LABORATORIES AT ASPHALT AND CONCRETE PLANTS**

- A. **SCOPE** – To have assurance that testing laboratories are capable of achieving an acceptable level of results, it is necessary that certain minimum standards be established. The minimum requirements include criteria for personnel, equipment and quality control procedures. The requirements apply to all construction acceptance testing and inspection including asphalt concrete job mix formulas and Portland cement concrete mix designs.
- B. **REQUIREMENTS** – To achieve approval, the testing laboratory shall meet the current Department Specifications requirements applicable to the Work for which it is to be engaged.

The testing laboratory shall have its laboratory equipment and procedures inspected and approved annually by the Department. In addition, testing machines and weighing devices must be calibrated as per AASHTO Designation R18 by impartial means using devices of accuracy traceable to the National Institute of Standards and Technology (NIST).

In fields other than those covered by the referenced AASHTO/ASTM Standards, the Contractor's own testing laboratory shall accept only those assignments that it is capable to perform competently by use of its own personnel and equipment. Any Work to be subcontracted must be subcontracted to laboratories meeting the appropriate criteria.

The inspection and testing services of the testing laboratory shall be under the direction of a full-time employee certified by one of the States in the Mid-Atlantic States Region. They shall have experience in inspection and testing of the specific materials and construction they direct.

The supervisor of the laboratory and field technicians shall have documented experience of inspection and/or testing of materials involved in a related area of construction. Technicians must have a current Mid-Atlantic Region Technician Certification in their area of testing available for inspection.

It is the responsibility of the testing laboratory to provide the documents necessary to show continuing compliance with requirements outlined in this section.

## **107 LEGAL RELATIONS & RESPONSIBILITY TO PUBLIC**

### **107.01 RESTORATION OF SURFACES OPENED BY PERMIT**

The right to construct or reconstruct any utility service in a highway, street, or within Department Right-of-Way or to grant permits for same is expressly reserved by the Department and the Contractor shall not be entitled to any damages as a result of any action or for any delay occasioned thereby.

When an individual, firm, or corporation is authorized to work in a street through a duly executed permit from the District, the Contractor shall allow parties bearing such permits, and only those parties, to make openings in the street. When ordered by the Chief Engineer, the Contractor shall make all necessary repairs due to such openings and the Work will be paid for as provided in the Contract Documents or as extra Work, and will be subject to the same conditions as similar Work performed.

### **107.02 FEDERAL PARTICIPATION (FEDERAL-AID PROJECTS)**

Title 23 of the U.S. Code provides that when the U.S. Government participates in the cost of the Work covered by the Contract, the Work shall be under the supervision of the District but subject to the inspection and approval of the appropriate officials of the U.S. Government and in accordance with the applicable Federal Statutes, rules and regulations.

Such inspection will in no case make the Federal Government a party to this Contract, nor will it subject the Contractor to compliance with the Federal laws relative to labor on government contracts other than such labor requirements as are contained in the Contract Documents for the individual projects.

### **107.03 SANITARY, HEALTH AND SAFETY PROVISIONS**

The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of employees as necessary to comply with the requirements and regulations of the District.

The Contractor and any Subcontractors shall furnish to each of his employees safe working conditions which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees. The Contractor shall comply with the current Federal Safety and Health Regulations for Construction.

### **107.04 PUBLIC CONVENIENCE AND SAFETY**

The Contractor shall at all times conduct the Work in such manner as to ensure the least possible obstruction to traffic. The safety and convenience of the general public and of the residents within the Project limits shall be provided for to the satisfaction of the Engineer.

### **107.05 RAILWAY-HIGHWAY PROVISIONS**

If the Contract Documents require that materials be hauled across the tracks of any railway, the Department will arrange with the railway for any new crossings required for or the use of any existing crossing. If the Contractor elects to use crossings other than those shown on the Plans the Contractor shall make arrangements for the use of such crossings.

All Work to be performed by the Contractor on the railroad Right-of-Way shall be performed at such times and in such manner as not to unnecessarily interfere with the movement of trains or traffic upon the track of the railway company. The Contractor shall use all care and precaution in order to avoid accidents, damage, or unnecessary delay or interference with the railway company's trains or other property.

It is the sole responsibility of the Contractor to coordinate, plan, facilitate, and schedule all construction coordination with any railroads or transit agencies that impact the Project. Any delays that result from the Contractor's failure to coordinate properly are the Contractor's responsibility. The Department accepts no liability for delays created by any railroad or transit agency during the construction of the Project. The Department may consider an authorized time extension as a remedy to any third party railroad or transit agency delay.

### **107.06 CONSTRUCTION OVER OR ADJACENT TO NAVIGABLE WATERS**

All Work over, on, or adjacent to navigable waters shall be so conducted that free navigation of the waterways will not be interfered with and that the existing navigable depths will not be impaired except as allowed by permit issued by the U.S. Coast Guard and/or the U.S. Army Corps of Engineers, as applicable.

**107.07 BARRICADES AND WARNING SIGNS**

The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs and other traffic control devices, and shall take all necessary precautions for the protection of the Work and safety of the public. Highways closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to properly control and direct traffic.

The Contractor shall erect warning signs in advance of any place on the Project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be placed and maintained in accordance with the Plans furnished. No signs, barricades, lights, or other protective devices shall be dismantled or removed without permission of the Chief Engineer.

All barricades, warning signs, lights, temporary signals, and other protective devices shall conform with the Manual on Uniform Traffic Control Devices for Streets and Highways and 612 Traffic Control of these Specifications.

**107.08 EMERGENCY PROCESS**

The following is the process all companies shall follow when responding to emergency situations, defined as a threat to public safety or a situation in which a vital service\* has been disrupted:

- A. Send notification through the online permitting system [tops.ddot.dc.gov](http://tops.ddot.dc.gov) using Emergency Work Request function to the Public Space Inspections Division of the Public Space Regulation Administration. Include location, size of cut (if known) and nature of work.
- B. Apply a public space permit within four (4) hours after the Department's offices are first opened.

\*Vital Service means providing electricity, gas, water, sanitary sewers, storm sewers, or telephone services to a premises.

**107.09 USE OF EXPLOSIVES**

No blasting shall be performed without written authorization from the Chief Engineer.

**107.10 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE**

The Contractor, including those under contract with the District and those operating under a public space permit, shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all Coast and Geodetic Survey, National Park Service, Metro or other survey markers or monuments. The Contractor shall not remove same until the respective authorities have been notified and the Contractor has received approval to remove. The markers or monuments will be relocated by the respective authority. In the event they cannot be relocated in time for the Contractor to continue his operations without delay, the Contractor will be responsible for properly referencing their location. The Contractor shall be responsible for all damage or injury to property of any character during the prosecution of the Work resulting from any act, omission, neglect, or misconduct in this manner or method of executing the Work or at any time due to defective work or materials, and the Contractor's responsibility will not be released until the Project has been completed and accepted.

The Contractor shall not disturb in any way trees, fences, utility poles, wires, structures and other appurtenances, public or private, without the explicit consent of the appropriate authority.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work, or in consequence of the non execution thereof by the Contractor, the Contractor shall restore at the Contractor's own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed or shall make good such damage or injury in an acceptable manner.

When approaching utilities, the Contractor shall give the owner thereof sufficient advance notice so the owner may accomplish any special measures needed. The Contractor shall provide any required access to utilization.

**107.11 NATIONAL HISTORIC PRESERVATION ACT OF 1966**

The Contractor agrees to contribute to the preservation and enhancement of Structures and objects of historical, architectural, or archeological significance when such items are found and/or unearthed during the course of project construction. The Contractor shall act

immediately to temporarily suspend work at the site of the discovery and to notify the Chief Engineer, who will immediately consult with the District of Columbia Historic Preservation Officer for recovery of the items.

All articles of historical or scientific value, including but not limited to coins, fossils, and articles of antiquity which may be uncovered by the Contractor during the progress of work, shall become District property.

### 107.12 TREE PROTECTION AND REPLACEMENT

**A. DESCRIPTION** - In carrying out the Work of the Contract the Contractor shall protect trees from damage during construction operations. Trees that are damaged or killed through neglect or failure to provide the necessary tree protection shall be replaced or compensation made as specified herein.

**B. CONSTRUCTION METHODS AND MATERIALS** - Protection from damage caused by equipment, fire, or carelessness shall include the following methods or measures:

1. All trees to be preserved shall be protected against damage during construction operations by fencing or armoring. The tree protection shall be placed before any excavation or grading has begun.
2. No material shall be stored within 20 feet of any tree designated to be saved.
3. Individual trees near heavy construction traffic shall, in addition to the fencing described below, be wrapped with burlap and 2 x 4 inch planks applied vertically and wired horizontally as armor around trunks. Spacing between planks shall be no more than 4 inches. Planks shall be 5 feet in length and their bottoms shall extend to 5 inches above ground level.
4. All trees near construction traffic shall be protected by fencing. Fences shall be comprised of 6 foot tall chain link material.
5. Trees having low-hanging branches liable to injury shall be fenced around the outer perimeter of the spread of their branches. Fences shall be standard 6 foot chain link fence mounted on standard steel posts set not more than 6 feet apart.
6. Any damage done to existing tree crowns or root systems shall be repaired immediately by the Contractor under the direction of the Chief Engineer.

Topsoil or well-rotted manure shall then be spread over the exposed area to a depth of 2 to 4 feet in a trench 1 foot wide in order to induce fibrous root system regeneration. Reconditioning of trees shall include application of growth regulators (such as palobutrizol or equivalent) applied as injection directly into the tree's rooting zone, soil aeration and vertical mulching to reduce any compaction which may have occurred, removal of dead wood and suckering growth and pruning where necessary to promote proper growth in terms of form, branching, and foliage conservation. Trees shall be thoroughly watered at ten (10) day intervals throughout the growing season.

7. Fires for any reason shall not be made within 50 feet of any trees selected to remain.
8. If any trees designated to be saved are severely injured or killed by mechanical equipment or through neglect, they shall be replaced in kind by the Contractor at no cost to the District, or by the payment of a sum of dollars in fixed liquidated damage according to the following schedule:

\$650 per inch of diameter

The caliper or diameter of the tree trunk shall be measured at 4.5 feet above grade. Trees to be replaced in kind shall be planted in accordance with 608.02.

### 107.13 INSURANCE

The Contractor shall procure and maintain, during the entire period of performance under this Contract, the types of insurance specified below. The Contractor shall submit a certificate of insurance giving evidence of the required coverage prior to commencing Work. All insurance shall be written with companies licensed by the District of Columbia's Department of Insurance, Securities and Banking. The Contractor shall require all Subcontractors to carry the insurance required herein, or the Contractor may, at its option, provide the

coverage for any or all Subcontractors, and if so, the evidence of insurance submitted shall so stipulate. All insurance provided by the Contractor as required by this section, except comprehensive automobile liability insurance, shall set forth the District as an additional named insured. In no event shall Work be performed until the required certificates of insurance have been furnished. The insurance shall provide for thirty (30) days prior written notice to be given to the District in the event coverage is substantially changed, canceled or non-renewed. If the insurance provided is not in compliance with all the requirements herein, the District maintains the right to stop Work until the proper evidence is provided.

- A. COMMERCIAL GENERAL LIABILITY INSURANCE** - \$1,000,000 limits per occurrence, including coverage for Explosion, Collapse and Underground (XCU) and Incidental Pollution coverage, District added as additional insured.
- B. AUTOMOBILE LIABILITY INSURANCE** - \$1,000,000 per occurrence combined single limit.
- C. WORKER'S COMPENSATION INSURANCE** - According to the statutes of the District of Columbia, including Employer's Liability, \$100,000 per accident for injury, \$100,000 per employee for disease, \$500,000 policy limit disease; if Work is on or near navigable waterways, USL&H coverage (federal statutory limits) must be included
- D. UMBRELLA/EXCESS LIABILITY INSURANCE** - \$5,000,000 limits per occurrence. Magnitude of Contract may require higher limits. Contractor shall confirm required coverage with DCORM.
- E. ARCHITECT'S AND ENGINEER'S ERRORS AND OMISSIONS LIABILITY INSURANCE** - Limits of \$1,000,000 per claim.

The Department reserves the right to make amendments to the insurance requirements on any contract at its sole discretion.

#### **107.14 OPENING OF SECTIONS OF PROJECT TO TRAFFIC**

Whenever, in the opinion of the Engineer, any roadway, or portion thereof is in acceptable condition for travel, it shall be opened to traffic, as may be directed, and such opening shall not be held to be in any way an acceptance of the Roadway or any part of it, or as a waiver of any of the provisions of these Specifications and Contract.

The Contractor shall not expose the public and/or traffic to any form of suspended overhead load in which the load is supported by a crane or other type of equipment. Written authorization is required from the Chief Engineer in order to swing or move a suspended load over any roadway, sidewalk, or other pathway in which the public is exposed.

#### **107.15 CONTRACTOR'S RESPONSIBILITY FOR WORK**

Until final acceptance of the Project by the Engineer, the Contractor shall be responsible for the Project and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the Work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the Work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the Work due to unforeseeable cause beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God, or acts of the public enemy or of governmental authorities. In the event that damage occurs attributable to one of the conditions above, at the discretion of the Engineer, the Contractor will be advised of actions to be taken accordingly.

In case of suspension of Work from any cause whatever, the Contractor shall be responsible for the Project and shall take such precautions as may be necessary to prevent damage to the Project, provide for normal drainage and shall erect any necessary temporary structures, signs, or other facilities. During such period of suspension of Work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seeding, and sodding furnished under the Contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

#### **107.16 UTILITY PROTECTIVE ALERT**

At least seventy-two (72) hours, but not more than ten (10) days (excluding Saturday, Sunday and holidays) in advance of proceeding with excavation or demolition work necessitated by this Contract, the Contractor shall notify the following parties, by telephone, of the impending excavation or demolition and the location thereof:

**TABLE 107.16 UTILITY PROTECTIVE ALERT CONTACT INFORMATION**

NAME	TELEPHONE NO	FACILITIES
"Miss Utility"	1-800-257-7777	gas, telephone, electric, water, sewer, and communications, and Department utilities (streetlight and traffic signal)
GSA*	202-690-9720	steam piping, steam tunnel, and condenser water conduit

\*GSA shall be contacted only if excavation work will occur within the following areas:

Northwest	Southwest
South of H Street West of First Street East of Rock Creek Parkway	North of D Street West of Third Street East of Seventeenth Street

The Contractor shall not proceed with Work until utility facilities have been located, disconnected or otherwise adjusted by utility representatives. Hand digging is required within 18 inches from the nearest point of any located utility. The Contractor shall hand dig a test pit to locate the line. In either case, the Contractor shall use care to avoid damage to all underground facilities. If an underground facility is damaged, under no circumstances shall a contractor backfill an excavation without first receiving permission from the utility operator whose facility was damaged.

**107.17 ENVIRONMENTAL PROTECTION**

**A. WATER QUALITY**

- 1. Description** - The Contractor shall provide temporary measures to control soil erosion and sediment through the use of swales, dikes, sediment basins or traps, berms, silt fences, dams, paved chutes or flumes, riprap, fiber mats, netting, gravel, mulches, grasses or other devices or methods. Permanent control provisions, contained in the Contract shall be coordinated with the temporary control provisions to the extent practical to assure economical, effective and continuous control throughout the construction and post-construction periods.

The Department has adopted the D.C. Department of Health (DOH), Environmental Health Administration, Bureau of Environmental Quality, Watershed Protection Division "2003 Standards and Specifications for Soil Erosion and Sediment Control" and the District of Columbia "Erosion and Sediment Control Handbook". All Work described herein shall be performed in strict conformance with the requirements of Standards and Specifications and in accordance with the erosion control regulations in the current Title 21 of D.C. Municipal Regulations (DCMR 21). Copies of the referenced publications are available to persons at the DCRA Permit Office, 1100 4th Street SW Washington, DC 20024 (202-442-4400).

- 2. Construction Requirements** - Prior to the start of any land disturbing activity, the Contractor shall submit schedules for accomplishment of soil erosion and sediment control work. No Work on land disturbing activities is to be started until the control proposals, schedules, and methods of operation have been received and reviewed by the Engineer.

The Engineer has the authority to limit the surface area of erodible Earth material exposed by clearing and grubbing, and by excavation, borrow and fill operations. The Engineer may direct the Contractor to provide immediate permanent or temporary control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment, and to prevent damaging erosion or sediment deposits into the sewer system or on neighboring lands. Such Work may involve the construction of interim berms, dikes, dams, sediment basins, and slope drains, and use of interim mulches, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Fill and cut slopes shall be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable. In some instances, incremental heights of slopes for sequential seeding and mulching will be specified.

The Contractor shall be required to incorporate all permanent erosion and sediment control features into the Project at the earliest practicable time as outlined in his accepted schedule. Temporary erosion and sediment control measures will be used as needed to correct conditions that develop during construction that were not foreseen during the design stage; as needed prior to

installation of permanent control features; and as needed temporarily to control erosion or sedimentation that develops during normal construction practices but are not associated with permanent control features on the Project.

Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion and sediment control features can follow immediately thereafter if the Project conditions permit; otherwise, temporary control measures may be required between successive stages. Under no conditions shall the surface area of erodible Earth material exposed at one time by clearing and grubbing exceed 50,000 square feet without approval of the Engineer. The limitation will apply to clearing operations only unless exempted by the Engineer.

The Engineer will limit the area of excavation, borrow, and Embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent erosion and sediment control measures current in accordance with the approved schedule. Should seasonal limitations make such coordination unrealistic, temporary control measures shall be taken immediately to extent feasible and justified.

Under no conditions shall the amount of surface area of erodible Earth material exposed at one time by excavation, borrow, or fill within the Right-of-Way exceed 50,000 square feet without prior approval by the Engineer. This is in addition to the limitation on clearing and grubbing previously set forth.

The Engineer may increase or decrease the surface area of erodible Earth material to be exposed at one time by clearing and grubbing, excavation, borrow, and fill operations as determined by an analysis of project conditions. The Roadbed area will be included in the surface area limitations if Site conditions are judged to be unfavorable by the Engineer. Erosion and sediment control measures shall be required on construction work outside the Right-of-Way where such work is necessary as a result of Roadway construction. Included are borrow pit operations, haul roads and equipment storage sites within the District of Columbia.

The erosion and sediment control features installed by the Contractor shall be acceptably maintained by the Contractor until accepted by the District.

In the event of conflict between these requirements and laws, rules, or regulations of other Federal or State or local agencies, the more strict laws, rules, or regulations shall apply.

The Contractor shall be fined \$1,000.00 per day/per occurrence for failure to provide and/or properly maintain approved erosion and sediment control, as determined by the Chief Engineer. Additional fines or requirements may be imposed by the District Department of the Environment.

- 3. Measure And Payment** - Unless otherwise provided in the Special Provisions, all measure or payment will be made according to 628.

Temporary erosion control measures required due to Contractor negligence, carelessness, or failure to install permanent controls as scheduled shall be at Contractor expense.

The Engineer reserves the right to employ outside assistance or to use District forces to provide needed erosion control measures if the Contractor fails to do so. Such incurred direct cost plus project engineering cost will be charged to the Contractor.

## **B. STORMWATER MANAGEMENT**

- 1. General** - The Contractor shall be responsible for providing a stormwater management plan which complies with all aspects of Section 509-518 of D.C. Law 5-188. In general, the plan shall be designed in accordance with the D.C. Department of Health (DOH), Environmental Health Administration, Bureau of Environmental Quality, Watershed Protection Division "Stormwater Management Guidebook". Included shall be plans, details, computations and related data for the design and construction of stormwater infiltration, detention, retention or attenuation structures or any other devices necessary to abate pollution or control runoff from the Site.

Copies of the Stormwater Management Guidebook may be obtained from the One-Stop Permit Office, 1100 4th Street SW Washington, DC 20024 (202-442-4400)..

- 2. Measure And Payment** - Unless otherwise provided in the Special Provisions, no measure or payment will be made and the cost of meeting requirements of this article shall be reflected in and distributed among the Contract Pay Items.

### C. AIR QUALITY CONTROL

1. **General** - The Contractor shall take necessary action to comply with requirements of the air quality control Regulations in the current Title 20 of the District of Columbia Municipal Regulations (DCMR 20), "Environment and Energy", available at the Publication Office in the District Building.

2. **Control Of Fugitive Dust** - All Work and storage space shall be designed and maintained so that fugitive dust (solid, airborne particulate matter emitted from any source other than through a stack) is kept to a minimum.

The Contractor shall take necessary precautions to assure that no person will cause, suffer, allow or permit any materials to be handled, transported, or stored, or a building and its appurtenances, or a road, to be used, constructed, altered, repaired, or demolished without taking reasonable precautions to prevent particulate matter from becoming airborne. The Contractor's reasonable precautions shall include, but are not limited to the following:

- a. Use of water or chemicals, where possible, for control of dust in the demolition of existing Structures, construction operations, the grading of roads, or the clearing of land;
- b. Application of asphalt, oil, water, or suitable chemicals on dirt roads, materials, stock piles, or other surfaces which can create airborne dusts;
- c. Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials, and employment of adequate containment methods during sand blasting or similar operations;
- d. Covering, at all times when in motion, the contents of open bodied trucks transporting materials likely to become airborne;
- e. Paving of roadways and their maintenance in a clean condition;
- f. Prompt removal of Earth or other material from a paved street, where the Earth or other material has been transported thereto or accidentally deposited by trucking or Earth moving equipment or erosion by water.

3. **Visible Emissions** - All construction equipment used on the construction project shall meet the following emission requirements of the DC Air Quality Control Regulations:

Except as otherwise provided in the DC Air Quality Control Regulations, no person shall cause, suffer, or allow to be emitted into the outdoor atmosphere, visible emissions from stationary sources: Provided that discharges not exceeding forty percent (40%) capacity (unaveraged) shall be permitted for two (2) minutes in any sixty (60) minute period and for an aggregate of twelve (12) minutes in any twenty four (24) hour period. These discharges shall be allowed only for "start-up", cleaning, soot blowing, adjusting combustion controls, or malfunction of equipment. Where the presence of uncombined water is the only reason for failure of an emission to meet the requirements of this section, this section shall not be applicable.

4. **Exhaust Emissions** - No person, nor his employees nor agents, shall cause, suffer, permit or allow the engine of a gasoline, or diesel powered motor vehicle including private passenger vehicles, on public or private space to idle for more than three (3) minutes while such motor vehicle is parked, stopped or standing, except as follows:

- a. To permit the operation of power takeoff equipment such as, but not limited to dumping, cement mixers, refrigeration systems, content delivery, winches, or shredders.
- b. To permit the operation of heating equipment when the local temperature is 32°F or below.

5. **Equipment** - The Contractor shall use, where possible, diesel powered vehicles and equipment.

#### 6. Open Burning

- a. *Prohibition of Open Burning* - Except as otherwise provided by subsection (b), no person shall ignite, cause to be ignited, permit to be ignited, or maintain, any open fire.



- b. *Exceptions* - Open fires may be permitted for one or more of the following reasons or purposes:
  - i. Prevention of a fire hazard which cannot be abated by other means; or,
  - ii. Providing warmth for construction or other workers by use of salamander heaters or other heating methods approved by the Engineer.

**D. NOISE**

1. **General** - The Contractor shall conduct all operations for the prosecution of the Work in compliance with the regulations set forth below controlling maximum noise levels due to construction work. At the Site of the Work special precautions and noise abatement measures shall be taken by the Contractor in order to reduce exposure to noise. In addition to the specified sound measurements required herein, the Contractor shall conduct measurements whenever the Engineer determines any noises to be excessive.
2. **Health And Safety Act** - The Contractor is required to meet the standards of the Federal Occupational Safety and Health Act of 1971 or most recent revision thereof.
3. **Measuring Sound Levels** - Sound levels as specified herein shall be measured on a sound level meter conforming to American National Standard Specifications for Sound Level Meters, S 1.41971 or its latest revision for Type I (Precision) or Type II (General Purpose) Sound Level Meters.
4. **Public Noise Exposure** - Sound levels for public noise exposure due to construction will be measured at the point adjacent to the Site of the Work in normal use by the public while construction work is in progress. These sound levels shall be measured on the A Scale of a sound meter at slow response. These sound levels may not exceed the following:

DURATION PER DAY IN HOURS	SOUND LEVEL IN DBA
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

Sound level for impulsive or impact noise (noise of duration less than one (1) second) shall not exceed a peak sound pressure level of 140 dB when measured on an approved impact noise analyzer. In lieu of the above procedure, 125 dB measured on the C Scale of a sound level meter at fast response will be accepted as an equivalent measure of the peak sound pressure level.

Impact noise generating equipment may only be used during the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday unless approved in writing by the Engineer.

5. **Additional Sound Levels** - Additional sound levels for noise due to construction will be measured at the street line of the Structure adjacent to and along the area of the Contractor’s operations and Plant. Sound levels measured on the A Scale of a sound level meter set for slow response shall be at the street line and shall not exceed the following:

a. *Residential Structures*

Daily, except Saturday and Sunday, 7:00 a.m. to 10:00 p.m.	75 dBA
Daily 10:00 p.m. to 7:00 a.m. and 10:00 p.m. Friday to 7:00 a.m. Monday	60 dBA

b. *Factory – Commercial Structures*

90 dBA, unless otherwise permitted by the Engineer.

**6. Noise Control Requirements** - In connection with the observance of noise control requirements the Contractor shall provide such equipment, sound deadening devices and take such noise abatement measures that are necessary to comply with the requirements of the Contract, consisting of, for example, the following:

- a. Shields or other physical barriers to restrict the transmission of noise.
- b. Sound proofing housing or enclosures for noise producing machinery.
- c. Use of electrically operated hoists and compressor plants, unless otherwise permitted by the Engineer.
- d. Silencers on air intakes of equipment.
- e. Maximum sized intake and exhaust mufflers on internal combustion engines.
- f. Gears on machinery designed to reduce noise to a minimum.
- g. The prohibition of the use of air or gasoline driven saws, unless otherwise permitted by the Engineer.
- h. Conducting the operation of hauling construction materials in trucks so that noise is kept to a minimum.
- i. Routing of construction equipment and vehicles carrying rock, concrete or other materials over streets that will cause the least disturbance to residents in the vicinity of the Work.

#### **107.18 WATER SUPPLY**

The Contractor shall obtain a permit from the D.C. Water and Sewer Authority Representative at 941 North Capitol Street, N.E., Washington, D.C. (202-442-4648) to use water for construction purposes from public hydrants or to connect to the water system with a temporary tap.

If the Department determines that fire hydrant water may be used, the Contractor shall be charged the WASA-designated rate per working day.

If the Department determines a temporary water main tap is required, the Contractor shall excavate a pit for a tap as directed, excavate the trench and install water service piping. The District will make the tap, furnish and install a meter at no cost to the Contractor. Temporary water taps require a \$250.00 permit fee plus a \$1,000.00 deposit. At completion of the Contract, the Contractor shall excavate a pit for tap removal by the District, excavate and remove water service piping and backfill to the satisfaction of the District. The District will remove the water meter at no additional cost to the Contractor.

The District will keep an account for direct payment by the Contractor of water and sewer charges.

On EPA funded projects, the District will install a meter on water services to the Contractor's Field Office and the Engineer's Facilities (field office). The Contractor will not be charged for this water usage.

River and stream water shall not be used. Water from a source other than a hydrant or tapped water main will be subject to test per AASHTO T26.

#### **107.19 CIVIL RIGHTS**

The applicable provisions of Title VI of the Civil Rights Act of 1964, as amended, apply to this Contract for the Contractor, all Subcontractors, and all suppliers, vendors and/or manufacturers.

## 108 PROSECUTION AND PROGRESS

### 108.01 SUBLETTING OF CONTRACT

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the Contract or Contracts or any portion thereof, or of the right, title, or interest therein, without the consent of the Contracting Officer. If such consent is given, the Contractor will be permitted to sublet a portion of the Work. For Federal-Aid projects, the Contractor shall perform with his own organization, Work amounting to not less than 30 percent of the total Contract cost, unless a different percentage is specified in the Contract. Any items designated in the Contract as "Specialty Items" may be performed by subcontract and the cost of any such specialty item may be deducted from the total cost before computing the amount of Work required to be performed by the Contractor's own organization. No subcontracts, or transfer of Contract shall relieve the Contractor of his liability under the Contract and bonds.

The request to the Contracting Officer for subcontracting approval shall contain the following information:

- A. Subcontractor's name, address, telephone number and Federal Social Security Number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
- B. Estimated dollar amount of the subcontract.
- C. Estimated starting and Completion Dates of the subcontract.

When specifically required in the Contract Proposal the prime Contractor shall Award at least 50 percent of his subcontracts to Certified Minority Business Enterprises; bid documents will contain a certification form to be signed by Bidders to this effect.

### 108.02 NOTICE TO PROCEED

The Contractor shall start Work on the date specified in a written Notice to Proceed issued by the Contracting Officer, and shall complete the Work within the period specified in the Contract Documents.

### 108.03 CONSTRUCTION SCHEDULING

Prior to commencing any Work, the Contractor must have an approved Baseline Schedule.

#### A. GENERAL

1. All schedule submissions shall include printed 11 x 17 inch format, electronic copy of the printed format, and an electronic file output produced by the scheduling software. 3 color copies of the printed format shall be submitted. The printed copy of the electronic version format shall be an exact color copy. The electronic file output, or export, shall be produced using the original scheduling software.
2. Primavera scheduling software by Oracle is the preferred scheduling software of the Department but other software platforms may be used with approval from the Engineer.
3. All schedules shall include a network diagram that depicts the relationships between activities. All schedules shall include the required milestones (including start and finish), key constraints, and predecessors/successors for all activities. The network diagrams shall be time-scaled to show a continuous flow of information from left to right. The critical path shall be clearly and graphically identified on the network diagrams.
4. No activity shall have a duration of more than fifteen (15) working days unless approved by the Engineer.
5. No negative float may be indicated in the schedule unless accompanied with a narrative explanation demonstrating why there is negative float being shown in the schedule.
6. All float is a common resource available to either the Contractor or Department but in no case shall it be used in such a way as to create a delay event for the other party.
7. All days will be in working days. No work shall be indicated on holidays, weekends, or other special days in which the Contractor is not allowed to work until the Department has first granted permission to work on one (1) of these days.
8. All major submittals shall be reflected in the schedule. The Contractor shall allow no less than twenty (20) working days for the review of these submittals by the Engineer unless otherwise noted. All major material tests to be provided by the Department and are critical to the Project timeline shall be indicated.

9. On projects with a Contract value equal to or greater than \$3,000,000.00, all activities shall be resource cost loaded. Resource allocations for each type of labor craft, equipment class, and material quantity shall be included for each activity. For each activity in the network, the Contractor shall determine the Contract value of the Work activity. The summation of the costs of all activities shall be equal to the total value/cost of the Contract, or the Contractor's approved bid for the construction of the Project.
- B. PRE-CONSTRUCTION SCHEDULING CONFERENCE** – No later than twenty-one (21) Calendar Days after Contract Award, the Contractor shall attend a Pre-Construction Scheduling Conference with the Engineer. The Contractor shall supply for use and review a Preliminary Baseline Schedule. The Contractor shall use the Preliminary Baseline Schedule to explain the methodology for completing the Work.
- C. PRELIMINARY BASELINE SCHEDULE** – The Preliminary Baseline Schedule shall use the Critical Path Method (CPM), and indicate all major activities of Work required under the Contract, from Notice-to-Proceed to Contract Completion Date. The activities included shall be detailed in order to demonstrate a logical progression of the elements of the Work. The schedule shall include sufficient detail in order to explain the relationships between the aspects of the Work including but not limited to mobilization, submittal process, material ordering and delivery, phasing of the Work, maintenance of traffic, subcontract work, utility work, and other important aspects of the Project. The schedule shall include any special Project requirements for MOT phasing, utility coordination and installation, submittal review, material procurement, and other significant elements to the Project schedule. The preliminary baseline schedule shall demonstrate the completion of all Work within the Contract Time.
- D. APPROVED BASELINE SCHEDULE** – Within fourteen (14) Calendar Days after the Pre-Construction Scheduling Conference, the Contractor shall submit a Baseline Project Schedule to the Engineer for review and approval. The Engineer will review the Baseline Project Schedule and return to the Contractor within twenty-one (21) Calendar Days. The Contractor shall incorporate the established Notice-to-Proceed date and all other comments provided by the Engineer.
- E. PROGRESS SCHEDULE UPDATES** – The Contractor shall submit a progress schedule update every month in conjunction with the monthly progress payment invoice. In the event the Contractor chooses not to submit a monthly progress payment invoice, a monthly schedule update shall be submitted regardless. The monthly progress schedule update shall reflect the progress achieved by the Contractor in the previous period and which corresponds to the invoiced Work. If the Contractor fails to provide a monthly progress schedule update, the progress payment invoice shall be held until a schedule update is received. Submission of the monthly progress schedule update is a condition precedent to the payment of the monthly invoice. The Engineer will review the monthly progress schedule update within ten (10) Calendar Days and return comments to the Contractor for inclusion in the subsequent month's progress schedule update. Should the Engineer determine that the Contractor has failed to update the schedule in accordance with the Contract Documents, the schedule shall be returned for revision by the Contractor. Until such time the schedule update is accepted by the Engineer, no further progress payments will be made to the Contractor.
- Any time the Contractor falls more than twenty (20) working days behind the approved schedule, he shall promptly upon written notice from the Engineer provide a recovery plan indicating a remedy to the noted delay including but not limited to an increase in work force, equipment and working hours in order to demonstrate the Project will be completed in accordance with the stated Contract Time. For delays or portions of delays for which the Contractor is responsible, no payment will be made for increase in work force equipment and working hours needed in order to complete the Project in accordance with the stated Contract Time.
- F. FINAL PROJECT SCHEDULE** – At the conclusion of the Work and no later than ten (10) Calendar Days before acceptance in accordance with Section 103.01 Article 12, the Contractor shall submit a final Project schedule that reflects the completion of all Project related Work. This schedule shall function as an as-built Project schedule.

#### 108.04 MOBILIZATION

- A. DESCRIPTION** - This Work shall consist of preparatory work and operations needed to mobilize for the Project. Work includes but is not limited to:
1. Movement to, placement and set-up on Project Site of personnel, equipment, supplies, and accessory items;
  2. Establishment of offices, buildings, and other needed project facilities as well as utility work and connections needed for these facilities;

3. Scheduling details, coordination and any other work and expense appropriate that is prior to the start of Work under other Contract Pay Items.

This work, however, does not include establishing Engineer’s field facilities, construction fence around work and storage areas, nor preparations for maintaining highway traffic.

Mobilization includes demobilization at completion of the Project.

**B. MEASURE AND PAYMENT** - The unit of measure will be lump sum with no actual measure taken.

Payment for mobilization will be made at the contract lump sum price, subject to allowable limits under this section, which payment will include all operations and expense needed to mobilize, remobilize, and demobilize. lump sum price for mobilization shall not exceed applicable amounts determined as follows:

Original Contract Total Including Mobilization	Maximum Lump Sum For Mobilization
More Than \$0 To and Including \$200,000	10% of Contract Total
More Than \$200,000 To and Including \$1,000,000	\$20,000 plus 7.5% (of Contract Total minus \$200,000)
More Than \$1,000,000	\$80,000 plus 5% (of Contract Total minus \$1,000,000)

If the lump sum shown in the Pay Item Schedule for any bid for Mobilization exceeds the allowable amount shown in the table above, the District reserves the right to adjust the amount and total bid accordingly when checking bids. Said adjustment will in no way invalidate bids.

Payment for Mobilization will be made in two installments. First payment of 50 percent of lump sum will be made following mobilization and initiation of construction work. The second and final payment will be made after 20 percent of Contract work is complete.

No additional payment will be made for demobilization and re-mobilization due to shutdowns, suspension, partial suspensions or other interruptions in project progression.

When no Pay Item is listed for Mobilization, no payment will be made; costs shall be reflected and distributed in other Contract items.

**108.05 ENGINEER’S FIELD FACILITIES**

- A. **FIELD OFFICE** - The Contractor shall provide and maintain a suitable field office for the sole use of the Chief Engineer and his representatives, which shall contain not less than 600 square feet in gross area, with electricity, heat, telephone service, running water, acceptable sanitary facilities, and daily janitor service. An ambient air temperature of 70°F ±5°F shall be maintained. Water connections and water meter cost to be charged to the Contractor. The Contractor shall provide acceptable access to the office. The field office shall include one or more office trailers with a minimum of 2 separate rooms of 120 square feet each, and one conference room with a minimum area of 300 square feet.

Furniture and equipment for the office shall include 2 fireproof, locking 4 drawer legal file cabinets, 4 desks with locking drawers, 4 swivel chairs, 10 folding chairs, one hanging file for full-size drawings, one 36 inch x 72 inch drawing table per trailer, one new digital camera capable of displaying the date and time, a Type III First Aid kit in accordance with ANSI Z308.1 Minimum Requirements for Workplace, 3 radio/telephone communications systems with carrying cases, one FAX machine with dedicated phone line, and one heavy duty, electric, dry-process photocopying machine. The machine shall be capable of duplex copying paper sizes of 8-1/2 x 11 inches, 8-1/2 x 14 inches, and 11 x 17 inches, and have separate trays for each paper size. It shall have a document feeder, collator and the capability to reduce/enlarge copies between each paper size. One case (5,000 sheets, 20 lbs, white), of each paper size shall be provided as initial stock.

The field office shall include 2 personal computer systems, complete with printers, color scanners and software, configured as follows:

1. 2 workstation computers of a model which has been on the market for less than one (1) month. Each computer will include a 21” Flat Panel Color Monitor, Wireless and direct connect to Internet service, 87 Key Keyboard, 2 Button Mouse, and CD/DVD+/-RW Drive.
2. 2 Laser Printers, 10-15 pages per minute, 2-3 Input Trays – 750 pages, monthly volume of 50,000 pages. Support legal,

A4, letter, and 11x17 prints. Remote management and configuration, built-in network card, support laser technology, cables, toner, cartridge, developer and fuser kits, as needed.

3. The following software (new and unopened, latest available version) with full documentation: Microsoft Windows, Microsoft Office Professional Suite, McAfee Virus Scan, Microsoft e-mail/calendar client, ADOBE Professional, Norton Utilities, and WinZip.
4. The scanner must be single pass, USB and Parallel Port Capable, 600 dpi to 2400 dpi optical resolution. Capacity at least 100 sheets. Support letter (8-1/2x11), legal and 11x17 paper.
5. The FAX Machine shall hold at least 250-500 sheets of plain paper. Memory buffer for minimum of 100 sheets. Provide confirmation page, 14.4-33.6 Data/FAX mode, Print/Copy in multitude, i.e., fine, superfine.
6. Miscellaneous items including Power strip, surge Protector and Security enclosure with lock computer, monitor and printer.

The Contractor shall confirm computer and software requirements with the Department prior to purchasing.

The equipment shall be maintained in such a condition that it is always available for immediate use. An adequate supply of batteries, copier paper, FAX paper and spring water shall be made available.

Adequate bathroom facilities with running water and drainage shall be maintained in each trailer.

Telephone service shall be supplied to each trailer including 2 separate phone lines, and one fax line with a minimum of four telephone instruments per trailer. A security alarm system shall be installed in each trailer.

The Contractor shall be responsible for District equipment placed in field offices, and shall promptly replace in kind or acceptably repair such equipment removed without permission or damaged.

The field office shall be set up in an acceptable location, equipped and made ready for use three (3) work days prior to start of any Work, and shall remain until field records pertinent to the Project have been completed, not to exceed thirty (30) consecutive Calendar Days after acceptable completion of all Work and project close-out. The field office including facilities and furnishings supplied by the Contractor shall be removed when designated.

In addition, the Contractor shall furnish, maintain and replace, as necessary for the duration of the Contract the following equipment for the exclusive use of the Chief Engineer:

1. 2 Asphalt thermometers
2. 2 Concrete thermometers
3. Set of sighting tees
4. Slump mold and tamping rod meeting requirements of AASHTO T 119
5. Chase indicator meeting requirements of AASHTO T 199
6. Pressure type air meter with necessary accessories meeting requirements of AASHTO T 152. The air meter shall be properly calibrated by an independent laboratory with certification furnished to the Chief Engineer
7. 10 foot rolling straightedge
8. 10 foot static straightedge
9. Calibrated measuring wheels

The Contractor shall furnish, construct and maintain walkways, platforms, ladders, stairways, and other facilities of suitable character and adequate strength as necessary for all operations of construction inspection, and provide 4 parking spaces at the field office for the Engineer and his representatives.

At the conclusion of this Project, all trailers, furniture, equipment, and inspection facilities furnished under this item shall remain the property of the Contractor.

**B. MEASURE AND PAYMENT**

The unit of measure will be the job, with no actual measure taken.

Payment for Engineer's Field Facilities will be made at the Contract lump sum price, which payment will include specified requirements stated above and in the Contract Documents. The first partial payment will not be made until all field facilities and associated utilities are complete and operating.

**108.06 LIMITATION OF OPERATIONS**

The Contractor shall conduct the Work at all times in such a manner and in such sequence as will assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

**108.07 METHODS AND EQUIPMENT**

All equipment necessary for the completion of the Work shall be of sufficient size and in good working condition. The equipment shall be maintained in good operating condition throughout its use on the Project for which it is approved. If equipment does not properly perform the Work, is not properly maintained, or is unacceptable in any way, the Engineer will order the discontinued use and removal of the unacceptable equipment.

When the Contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than specified in the Contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing Work in conformity with Contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the Work produced does not meet Contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining Work with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in Contract Time as a result of authorizing a change in methods or equipment under these provisions.

**108.08 DETERMINATION OF CONTRACT TIME AND PARTIAL SUSPENSION**

- A. CONTRACT TIME** - The number of days allowed for completion of the Work included in the Contract will be stated in the Contract Documents and will be known as Contract Time.

When the Contract Time is on a Calendar Day basis, it shall be counted from the effective date on the Notice to Proceed and shall include all working days and non-working days, including Sundays and Holidays.

All Calendar Days elapsing between the effective dates of any orders of the Contracting Officer to suspend Work and to resume Work for suspensions not the fault of the Contractor shall be excluded.

Adjustments will also be made for periods of partial suspensions as defined below.

- B. PARTIAL SUSPENSION** - The performance of Work under the Contract may, by written order of the Contracting Officer, be partially suspended during the period from December 1st to April 1st inclusive, or during such other periods as the Contracting Officer may determine necessary due to weather, soil or other conditions considered unsuitable for prosecution of the Work. Suspension of Work on some but not all items of Work shall be considered partial suspension.

During periods of partial suspension, the number of Calendar Days to be charged as Contract Time shall be computed by multiplying the number of Calendar Days of original Contract Time by the ratio of the amount earned during the period of partial suspension to the original Contract amount. In no case shall the number of Calendar Days charged as Contract Time for a period of partial suspension exceed the total elapsed time of the partial suspension.

- C. UTILITY DELAYS** - The Contractor shall consider the location of existing utilities in determining Contract Time. The Contractor is warned that delays of a minor nature, encountered through required utility adjustments by others or imprecise utility location information, have been considered, and delays resulting there from may not serve as a basis for time extensions.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions and that no additional compensation will be allowed for delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them.

The Contractor shall have responsibility for notifying all affected utility companies prior to the necessity of performing any Work on their utilities and shall cooperate with them in achieving the desired result. All damage to utility facilities caused by the Contractor's operations shall be the responsibility of the Contractor.

### **108.09 SUBSTANTIAL COMPLETION AND FINAL ACCEPTANCE**

The Contract contains two significant completion milestones: Substantial Completion and Final Acceptance. The Contract shall indicate the number of calendar days from the beginning of the Contract (i.e. Notice-to-Proceed) until each completion milestone. The number of days between Substantial Completion and Final Acceptance may be 30 days but the Department may elect to have a longer duration of time between the milestones based on unique project issues.

**A. SUBSTANTIAL COMPLETION** - The Contractor shall achieve Substantial Completion on or before the Substantial Completion Date as defined in the Contract, subject to adjustment in accordance with the Contract.

The Contractor shall submit a request in writing to the Department indicating he believes he has satisfied all elements of the Work in order to achieve Substantial Completion and thus requesting the Department review the Work and concur that Substantial Completion has been achieved.

The Department, based upon the Contractor's written request, its independent assessment, and independent inspection of the state of the Work, will issue a letter (certificate) of Substantial Completion at such time as Substantial Completion occurs. If the Department approves the issuance of a Substantial Completion Certificate, the Department will provide with its Substantial Completion Certificate a punch list of items to be completed in order to achieve Final Acceptance.

The date the Department declares Substantial Completion is achieved shall be the official defined date.

Substantial Completion is achieved when each of the following conditions have occurred for the entire Project:

1. All lanes of vehicular, pedestrian, bicycle, or other forms of traffic (including ramps, interchanges, overpasses, underpasses, sidewalks, bike paths, and other crossings) set forth in the Contract Documents are in their final configuration as designed and are available for normal operation and safe use;
2. All major safety features are installed and functional, including as required, shoulders, guard rails, striping and delineations, concrete traffic barriers, bridge railings, cable safety systems, metal beam guard fences, safety end treatments, terminal anchor sections and crash attenuators;
3. All required illumination and lighting for normal and safe use and operation is installed and functional in accordance with the Contract Documents;
4. All required signs, lane indicators, message boards, traffic signals, pavement markers, and all other such indication for normal and safe use and operation are installed and functional in accordance with the Contract Documents;
5. The need for temporary traffic controls or for lane closures at any time has ceased (except for any required closures needed for routine maintenance, and except for temporary lane closures in accordance with and as permitted by a Department-approved traffic management plan solely in order to complete punch list items);
6. The Contractor has otherwise completed the Work in accordance with the Contract Documents such that the Project is in a physical condition that it can be used for normal and safe vehicular, pedestrian, bicycle, or other travel in all lanes and at all points of entry and exit, subject only to punch list items.

The Contractor shall provide the Department with the request for Substantial Completion at least 14 Calendar Days prior to the date in which Substantial Completion is anticipated. During such 14 Calendar Day period, the Contractor and the Department will meet, confer, and exchange information on a regular basis with the goal being the Department's inspection of the Project, review of the Contract Documents, and any other review of the completion of the Work in order to determine whether or not Substantial Completion is achieved. The Department will provide the Contractor with a determination of whether or not Substantial Completion is achieved.



**B. FINAL ACCEPTANCE** - The Contractor shall achieve Final Acceptance of the Project on or before the Final Acceptance Date, subject to adjustment in accordance with this Agreement.

The Contractor shall provide the Department with written notification when it has determined that the following conditions to Final Acceptance of the Project have been satisfied:

1. Substantial Completion has occurred;
2. The Project is free and clear of all liens, claims, security interests or encumbrances arising out of or in connection with the performance of the Work;
3. All punch list items have been completed and delivered to the satisfaction of the Department;
4. All Project documentation, including as-built drawings of the Project, is submitted and approved by the Department;
5. The Contractor has delivered all required certifications to all necessary governmental authorities and to the Department;
6. The Contractor has made all deliveries of Work product to the Department that are required to be made pursuant to the Contract.

During the period following the establishment of Substantial Completion and the Final Acceptance Date, the Contractor and the Department will meet, confer, and exchange information with the goal being the Department’s inspection of the Project and the Department’s issuance of a Final Acceptance Certificate. The Department will conduct an inspection of the punch list items, a review of the final as-built drawings and such other investigation as may be necessary to evaluate whether the conditions to Final Acceptance have been satisfied. If the Contractor fails to complete all punch list work, fails to have the as-built drawings approved by the Department, or fails to complete any other aspect of the Work to the satisfaction of the Department, the Department shall not declare Final Acceptance of the Work until such time the Contractor has satisfied all elements of the Work to the satisfaction of the Department.

**C. LIQUIDATED DAMAGES** - The Department reserves the right to modify the Liquidated Damage amounts in the Contract at its sole discretion and will announce any such modifications in the Contract Documents.

For failure to achieve Substantial Completion by the date stipulated in the Contract Documents or as may be modified by Change Order, the Contractor shall pay the following amounts for each Calendar Day until such time Substantial Completion is achieved:

**TABLE 108.09(A) SUBSTANTIAL COMPLETION LIQUIDATED DAMAGES**

ORIGINAL CONTRACT MORE THAN	ORIGINAL CONTRACT TO AND INCL.	CALENDAR DAY CHARGE
\$0	\$100,000	\$750
\$100,000	\$1,000,000	\$1,000
\$1,000,000	\$5,000,000	\$1,500
\$5,000,000	\$10,000,000	\$2,000
\$10,000,000	\$20,000,000	\$3,500
\$20,000,000	-----	\$5,000

For failure to achieve Final Acceptance by the date stipulated in the Contract Documents or as may be modified by Change Order, the Contractor shall pay the following amounts for each Calendar Day until such time Final Acceptance is achieved:

**TABLE 108.09(B) FINAL ACCEPTANCE LIQUIDATED DAMAGES**

ORIGINAL CONTRACT MORE THAN	ORIGINAL CONTRACT TO AND INCL.	CALENDAR DAY CHARGE
\$0	\$100,000	\$300
\$100,000	\$1,000,000	\$500
\$1,000,000	\$5,000,000	\$900
\$5,000,000	\$10,000,000	\$1100
\$10,000,000	\$20,000,000	\$1800
\$20,000,000	-----	\$2500

### 108.10 PROGRESS PHOTOGRAPHS

Suitable digital photographs shall be taken by the Contractor at each Project Site. View locations will be designated. 150 photographs will be required before the commencement of any field work in order to document the field condition. These digital photographs shall be submitted to the Engineer prior to the start of Work. Approximately 50 photographs shall be taken each month and submitted to the Engineer monthly.

Digital photographs shall be of sufficient megapixel detail as approved by the Engineer. Each photograph will include a date stamp and have sufficient clarity in order to determine all elements in the picture. Each photograph shall be accompanied by a short narrative explaining the location and perspective of the photograph.

Measurement for Progress Photographs will be the job.

Payment for Progress Photographs will be at the Contract Lump Sum price, which payment will include all labor, tools, equipment and incidentals necessary to produce the required photographs.

### 108.11 DIMENSIONS OF EXISTING FACILITIES

Dimensions and locations of existing facilities are not necessarily exact. Where installation or connection of any part of the Work to existing facilities are required, the Contractor shall verify such dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

### 108.12 ADVERSE WEATHER PRECAUTIONS

During adverse weather, the Contractor shall take necessary precautions so that the Work may progress properly and is satisfactory in all respects.

During hot weather, and cold weather below 40°F, any part of the Work that is temperature dependent shall be properly protected.

### 108.13 PRECONSTRUCTION SURVEY

Prior to starting any Work, the Contractor shall make a detailed inspection of buildings, structures, roadways, sidewalks, retaining walls, landscaping, and related surface improvements adjacent to and in the vicinity of the proposed Work, wherever located. The inspection shall include notes, measurements, digital photographs, and digital video, with audio sound track narrative, of all facilities prior to the start of construction. The audio description of the inspection shall include the date, time, weather conditions, address/stationing/location, brief description of the facility, and description of physical conditions encountered.

2 copies of all notes, measurements, photographs, video disks, reports, and data shall be submitted to the Engineer as soon as these records are complete and prior to start of any construction activity. Progress payments will not be made until this requirement is met.

No additional compensation over and above that reflected in the Schedule of Prices will be allowed for complying with this provision.

### 108.14 FIELD LAYOUT

**A. GENERAL** - Work under this item consists of furnishing all lines, including baselines /control lines, grades and measurements as shown on the Contract Documents and as directed by the Engineer. The Contractor shall perform all Engineering layouts from baselines and benchmarks indicated in the Contract Documents, and shall be responsible for all measurements in connection therewith. The Contractor shall verify all dimensions and elevations shown in the Contract Documents before construction begins, and shall be responsible for the accuracy of the finished Work.

Layout for all projects shall be performed by competent surveyors under the direction of a Registered Professional Civil Engineer.

The Contractor shall furnish at his expense all stakes, nails, equipment, tools, materials and labor as may be required in laying out any part of the Work from the bench marks and base lines as shown in the Contract Documents. The Contractor shall protect and preserve established benchmarks and control points and make no changes in location without the approval of the Engineer. Benchmarks and control points lost or destroyed or which require relocation because of necessary changes in grades or alignment shall be replaced and accurately located at the Contractors expense.

The Contractor shall accurately record all field notes and data in appropriate field books for the Engineer. The Engineer shall be informed when measurements are to be taken for the purpose of determining excavation and fill quantities. At the end of the Project, all notes and field books shall become the property of the District of Columbia Department of Transportation.

Work shall be performed only using approved lines and grades; operations outside approved areas will not be included for measure and payment.

Stakes or marks the Engineer sets for guidance shall be preserved by the Contractor. If, in the opinion of the Engineer, stakes are displaced, removed or lost due to Contractor’s negligence, they will be replaced by the Contractor at his own expense.

- B. MATCH EXISTING WORK** - The Contractor shall assume full responsibility for successfully carrying out the complete construction and the fitting of all members. Where proposed work is to be fitted to existing work, the Contractor shall be responsible for checking all dimensions and conditions in the field. If the parts do not fit properly, the Contractor shall inform the Engineer immediately and upon receipt of approval, make alterations to the new parts necessary to assure proper fit and connection in accordance with instructions of the Engineer, at no additional expense to the District.

Prior to preparing his bid, the Contractor shall visit the Project and carefully examine the existing conditions and then include in his bid, costs for making measurements necessary or convenient for the proper completion of the Work.

- C. MEASURE AND PAYMENT** - The unit of measure will be lump sum. No direct measure will be taken for this Work. Payment for Field Layout will be made at the Contract lump sum price, which payment will include all labor, tools, materials, equipment, and incidentals necessary to complete the Work as specified.

**108.15 AS BUILT DRAWINGS**

- A. GENERAL** - During the entire construction period, the Contractor shall maintain one complete record set of Contract Drawings on which he shall annotate daily all deviations, field changes, changes accomplished by Change Order, as constructed depths of footings and structural elements, horizontal and vertical locations of underground electrical and utility facilities referenced to survey data and temporary construction left in place (if permitted). The Contractor shall make this annotated record set of Contract Drawings available for review upon the request of the Engineer.

The Engineer will furnish to the Contractor electronic files of the Contract Drawings for reproduction. The Contractor shall make permanent modifications to the reproducible set by adding the revisions from the annotated record set. The completed as built drawings shall be certified by an officer of the Contractor using a stamp as follows:

**AS BUILT**

(Date)

I certify that this drawing accurately depicts the Work as constructed.

(An Officer of the Contractor’s Company)

Signature \_\_\_\_\_ Title

CONTRACTOR’S NAME

When the Contract is completed and the revisions have all been digitally transcribed to the reproducible set, the Contractor shall copy the electronic files on a CD ROM. The Contractor shall then prepare and deliver to the Department-IPMA 2 CD ROM copies of the electronic files of the final as built drawings, the modified reproducible set, five (5) bound half-size sets on bond paper and one additional CD ROM with as built drawing information of street lighting Plans only. All as built drawings shall be submitted in Microstation, AutoCAD and PDF formats.

- B. DC WATER WORK** - The Contractor shall submit as built drawings for water and sewer work in accordance with the requirements from the DC Water Specifications.
- C. UNDERGROUND UTILITIES** – All underground utilities installed as part of this Contract shall be surveyed by a Registered Professional Land Surveyor or Registered Professional Engineer. Survey information, including horizontal location and vertical elevation shall be included on the as built drawings.
- D. PARTIAL SUBMISSIONS** - To facilitate inspections and partial acceptance, the Engineer may request the submission of as built drawings for all or part of the Work after those work elements have been completed, but prior to Contract completion.
- E. MEASURE AND PAYMENT** - Unit of measure for As Built Drawings will be the job. No measure will be made for this Work. Payment for As Built Drawings will be made at the lump sum price, which payment will include all performance of Work as specified herein.

## 109 MEASURE AND PAYMENT

### 109.01 MEASUREMENT OF QUANTITIES

All Work under the Contract will be measured by the Engineer according to United States standard measure.

Measure will be taken only within designated limits as indicated or intended by the Plans or as directed or computed to provide correct limits in accordance with intent of Work and the Project.

Pay items with units of measure on a linear or area basis will be computed from actual surface measure and/or plan dimensions, as altered to meet field conditions.

No deduction will be made in area measure for any individual fixture with an exposed area of 9 square feet or less.

Materials measured or proportioned by weight shall be weighed on accurate approved scales by qualified personnel at approved locations unless theoretical weights are permitted. Ton measure shall mean 2000 pounds avoirdupois.

Net certified scale weights, or rail shipment weights based on certified volumes, will be basis of weight measure subject to correction for loss as determined.

When volume measure is specified, material may be weighed when approved and converted to volume measure. Factors for conversion from weight measure to volume measure, unless provided in Specifications, will be determined by the Engineer.

Volume measure will be computed at 60°F or corrected to volume at 60°F, using ASTM D 1250 for asphalts and ASTM D 633 for tars.

Pay items with a job unit measure shall include all necessary fittings and accessory work needed to complete intent of the Work.

Unless more rigid tolerances are required by Specifications, established industry manufacturing tolerance will be accepted.

### 109.02 SCOPE OF PAYMENT

The Contractor shall receive and accept compensation provided by Contract Pay Items as full payment for furnishing all materials and for performing all Contract Work in a complete and acceptable manner including all labor, Plant and incidentals needed, and for all risk, loss, damage or expense of whatever nature arising from the Work and its prosecution, subject however to Contract provisions.

If payment clauses require that payment include compensation for certain work or material accessory to Pay Item, the amount of this included work or material will not be measured nor will payment be made under any other Contract Pay Item.

Where 2 or more Pay Item areas overlap either by discrepancy in definition or by the intricate nature of work, payment will be made at the lowest Contract unit price of overlapping Pay Items involved.

The phrases “work includes” and “as part of work” are sometimes used to clarify that referenced requirements shall be included as part of the Pay Item involved; no separate or additional payment will be made.

The phrase “at Contractor expense” means the Contractor shall meet requirements as his sole expense with neither liability nor expense to the District. The phrase normally refers to repair of unacceptable work due either to the Contractor’s operation or to the Contractor’s failure to take reasonable or specified precautions.

### 109.03 EXTRA AND FORCE ACCOUNT WORK

Whenever the parties fail to agree on an equitable adjustment in price for Change Order work or in the processing of claims, the following supplements the basis of the cost breakdown defined in subsections 1 through 7 of Section D, Article 3 of the Contract General Provisions.

- A. **MATERIALS** – Payment for cost of required materials will be F.O.B. the job Site with an allowance of up to 15 percent to cover overhead and profit. For landscape plantings, up to 25 percent will be allowed to cover overhead and profit.
- B. **RENTED EQUIPMENT** – The current edition of the Rental Rate Blue Book for Construction Equipment published by Data Quest shall be used to determine the equipment rental rates in lieu of the AED specified in Article 3, Section D, paragraph 4 of the Contract General Provisions.

- C. CONTRACTOR'S EQUIPMENT** – Payment for required equipment owned by the Contractor or an affiliate of the Contractor will be based solely on an hourly rate derived by dividing the current appropriate monthly rate from the Rental Rate Blue Book for Construction Equipment published by Data Quest by 176 hours. No payment will be made under any circumstance for repair cost, freight and fuel, lubricants, insurance, any other costs and expenses, or overhead and profit. Payment for such equipment made idle by delays attributable to the District will be based on ½ the derived hourly rate under this subsection. Approved transportation charges will be paid (one way) from the nearest source if the equipment is brought up to the Project specifically for use on the Change Order work and is not to be used on any other work.
- D. LIABILITY INSURANCE** – When additional liability insurance is required the payment for the additional insurance will be based on the additional premiums, to which up to 5 percent of additional premium will be allotted to cover handling.

#### **109.04 ELIMINATED ITEMS**

Should any Pay Items contained in the Proposal be found unnecessary for the proper completion of the Work, the Engineer may, upon written order to the Contractor, eliminate such Pay Items from the Contract, and such action shall in no way invalidate the Contract. When the Contractor is notified of the elimination of Pay Items, he will be reimbursed for actual Work done and all costs incurred, including mobilization of materials prior to said notification.

#### **109.05 PROGRESS PAYMENTS**

Progress payments will be made at least once a month based upon invoices prepared by the Contractor and verified by the Engineer detailing the value of Work performed and materials complete in place in accordance with the Contract and for materials delivered in accordance with 109.07.

No partial payment will be made when the total value of Work performed since last invoice amounts to less than \$300.00.

#### **109.06 PAYMENT TO SUBCONTRACTORS AND SUPPLIERS CERTIFICATE**

The Contractor shall submit to the Contracting Officer certification that the Contractor has made and will make timely payments to his Subcontractors and suppliers no later than thirty (30) Calendar Days after receiving payment from the Department.

Certification shall be made on the form prescribed and submitted with the progress payment invoice.

#### **109.07 PAYMENT FOR STOCKPILED MATERIALS**

Payment for stockpiled materials shall be included in the monthly progress payments providing the following conditions are met:

- A.** The stockpile Site is under the control of either the District or the Contractor and will remain so until the material is incorporated in the Work. If the Site is under the control of the Contractor, proof of such control shall be submitted to the District.
- B.** Appropriate test reports, if required, shall be submitted to the District which show that the materials meet the requirements of the Contract.
- C.** Contractor requests for payment shall be in writing and shall include the written consent of the Surety.
- D.** Copies of suppliers' invoices shall accompany all requests for payment. Copies of paid invoices for materials shall be submitted to the District within one (1) month after the Contractor has received payment for the materials. Failure to provide timely submissions of paid invoices shall be cause to deduct payment for the materials from the subsequent monthly progress payment.
- E.** Payment shall be limited to the following stockpiled materials unless specifically approved by the Engineer: sewer pipe, water pipe, water and sewer valves, guiderail, electrical work materials, mechanical work materials, piling, PCC form materials, reinforcing steel, prestressed concrete beams, structural steel, paint, stone masonry, railing, bridge deck drainage, steel sign structures, and wall tile.

No payment will be made for invoices less than \$2,000.00. No payment greater than \$100,000.00 shall be for stockpiled materials, for any given month.

**109.08 ACCEPTANCE AND FINAL PAYMENT**

When the Project has been accepted as provided in ARTICLE 12, of the General Provisions, the Engineer will prepare the final estimate for the Work performed. If the Contractor approves the final estimate and does not file an exception to the quantities therein final payment will be made.

With approval of such final estimates by the Contractor, payment will be made for the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the provisions of the Contract.

If the Contractor files a claim in accordance with Contract requirements, it shall be submitted in writing in sufficient detail to enable the Engineer to ascertain the basis and amount of such claim. In such cases the final sum determined by the Engineer to be due will be paid pending study of the claim. Upon final adjudication of the claim any additional payment determined to be due the Contractor will be placed on a supplemental estimate and processed for payment.

All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

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## 201 CLEARING AND GRUBBING

### 201.01 DESCRIPTION

Clearing shall consist of the removal from above the surface of the existing ground of all trees, shrubs, brush, down timber, rotten wood, heavy growth of grass, rubbish and other objectionable debris or deleterious material as directed by the Engineer, as well as the removal of fences, signs and incidental Structures.

Grubbing shall consist of the removal from below the surface of the existing ground of all stumps, roots, root mats, stubs, buried logs and other objectionable debris or deleterious material as directed by the Engineer. Prior to beginning grubbing operations, the Contractor shall install approved erosion and sediment control devices.

Materials obtained from clearing and grubbing shall be disposed of as provided herein, except that such materials as the Engineer may designate shall be salvaged. If necessary, salvaged materials shall be stockpiled within the Project limits but away from any proposed construction. Any additional charges or payment for hauling or delivering salvaged materials shall be negotiated in accordance with Division 100.

### 201.02 LIMITS

This Work shall be performed within the limits of earthwork operations as described herein. Within areas where Common Excavation is to be performed, the ground shall be totally cleared as described above, and grubbing shall be done to a depth of not less than 1 foot below the Subgrade or finished slope surfaces. This is not intended to include removal of unsuitable roadbed material.

Within areas where Embankment is to be constructed, the ground shall be totally cleared for a width of 2 feet outside of the toe of the Embankment. When the Embankment is 8 feet or more in height, stumps shall be removed as close to the ground as possible, but no stump shall be left higher than 12 inches above the existing ground surface.

Within areas where the Embankment is less than 8 feet in height, the ground shall be totally grubbed to a depth of not less than 1 foot below the original ground surface.

Within areas where structural excavation is to be performed, total clearing and grubbing shall be performed prior to start of structural excavation.

Areas beneath the structure and for a transverse distance beyond the outermost side limits of the structure, not to exceed 20 feet, shall be cleared and grubbed as directed by the Engineer.

The Contractor shall perform the Work of clearing and grubbing so as to remove only the material herein specified.

### 201.03 CONSTRUCTION REQUIREMENTS

Before clearing and grubbing operations are started, the Engineer will designate and clearly mark any trees, shrubs and plants to remain. All such trees, shrubs and plants shall be carefully trimmed and protected from scarring, barking or other injury during construction operations. All cuts and scars on trees shall be painted and treated with an asphalt base paint especially prepared for tree surgery, as directed by the Engineer. All timber, logs, trees, stumps, brush, materials from demolished Structures and other rubbish shall be disposed of satisfactorily by the Contractor so as to leave the disturbed areas with a neat and finished appearance, free from debris. Burning will not be permitted. All materials removed during the clearing and grubbing operations shall become the property of the Contractor, except for designated salvaged material.

All depressions made in fill areas by the removal of stumps or similar objects shall be backfilled with suitable on-site or borrow materials, as directed, and compacted in accordance with 203.03.

Fences, shrubs, ornaments and other privately owned articles that are in the line of the paving and in public space are to be removed by the property owner in advance of paving. However, in the event the owner has not removed these items when the Work is ordered commenced, the Contractor, at the direction of the Engineer, shall remove and set these ornamental objects on the private properties affected, well out of the way of construction.

### 201.04 MEASURE AND PAYMENT

The unit of measurement for Clearing and Grubbing will be the acre or square yard. Payment will be made at the Contract unit price, which payment will include all labor, materials, disposal of materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

## 202 ROADWAY EXCAVATION

### 202.01 DESCRIPTION

This Work shall consist of excavation for the roadways, alleys, parking areas, driveways, sidewalks, approaches, storm drain ditches, and stream channels to the lines and grades indicated in the Contract Documents. The Work also includes the flattening and rounding of slopes, removal of slides, excavation for ditches and cutting of existing pavement and base to neat lines at the limits of proposed pavement construction.

It shall include excavating material in the Subgrade (undercutting) and beneath Embankment areas that are determined to be unsuitable by the Engineer. The Work shall also include the hauling and disposal of excavated material.

In the event that there is no item for Clearing and Grubbing included in the Schedule of Prices, all requirements of 201 shall be included as excavation. All excavation will be classified as hereinafter described.

### 202.02 COMMON EXCAVATION

Common Excavation shall consist of the excavation and removal of all materials encountered exclusive of Hard Surface Pavement Excavation per 202.03, Structure Excavation or excavation that is otherwise classified and paid for. When the Contract Documents include other classified excavation items, they shall be used as specified and paid for separately.

Common Excavation shall include undercutting to remove soft and/or unsuitable material that may be encountered in the Subgrade or base course within the limits prescribed by the Engineer. Also included is special or hand excavation, as necessary, over, around and under existing or new utility lines and appurtenances uncovered from such undercutting. The replacement material shall be furnished, placed and compacted as per Aggregate Base Course.

In the event that there is no item for Hard Surface Pavement Excavation included in the Schedule of Prices, all materials described in 202.03 shall be classified as Common Excavation.

Material from the excavation that has been sampled and approved in accordance with 804.01 and meets the requirements of 203 may be used as specified therein.

### 202.03 HARD SURFACE PAVEMENT EXCAVATION

Hard Surface Pavement Excavation shall include the removal and disposal of all asphalt surface and binder courses from concrete base; the complete removal of bituminous pavement, including concrete, asphalt block, asphaltic concrete or cobble bases; all stone curbing and concrete curb and gutter; all plain and reinforced cement concrete pavements and bases, driveways, alleys, concrete copings, and steps; concrete, brick and stone walls; concrete, brick, and asphalt block sidewalks not in replacement and/or repair areas; and any abandoned utilities encountered in the limits of the Work, and similar materials. Where the construction of new roadways and/or sidewalks meet existing roadways and/or sidewalks, this item shall include trimming the existing roadways and/or sidewalks to a neat, clean, vertical face, and the top surface, for a minimum depth of 1-1/2 inches, shall be trimmed to a neat line with a power saw where practicable.

When asphalt surface and binder courses are separately removed from existing concrete bases, this removal shall be designated as Pavement Profiling (Milling) as per Section 410.

The removal of bituminous (penetration) macadam, water-bound macadam, and old material roadway when removed and disposed of separately from base course shall be designated as Pavement Profiling (Milling) as per 410 and shall include the disposal of all surplus material.

The removal of scaled and deteriorated Portland Cement Concrete and/or asphaltic concrete from existing pavements to the depth specified or as directed by the Engineer shall be designated as Pavement Profiling (Milling) as per 410 and shall include the disposal of all surplus material.

### 202.04 CONSTRUCTION REQUIREMENTS

The Contractor shall notify the Engineer a sufficient length of time in advance of its intent to begin any excavation. The Contractor, as part of the field layout, shall prepare all cross-sections, Elevations and measurements of the undisturbed ground needed to compute excavated quantities. Elevations shall be taken prior to the beginning of any roadway excavation. Quantities for excavation shall be computed using the average end area method and shall be provided to the Engineer before payment for excavation will be made.

Excavation shall be cut accurately to grade and cross-section as required, within the limits designated. All Earth slopes shall be finished to neat lines, with toe and top of slopes appropriately rounded. Work shall be done in proper sequence with all other operations involved.

Prior to the removal of existing roadways, paving, sidewalks, curbs, gutters, and wheelchair ramps, the portion to be removed shall be saw cut to the full depth thereof as shown in the Contract Documents or as directed by the Engineer and shall include any base courses. The Contractor shall use tools, equipment, and methods that shall be approved by the Engineer for cutting, breaking, and trimming, and the removal of materials shall be to a neat, clean line, with minimum damage to adjacent pavement, sidewalk, and curbs that are to remain. Any excessive damage done at these locations shall be repaired and restored by the Contractor at no cost to the District.

In replacing existing pavements, the Contractor shall saw cut all pavement within 1 foot of the walls or roofs of public or District utility Structures. Proper care shall be taken by the Contractor to protect these Structures against damage and to maintain them in good condition.

All rocks, abandoned walls or piers and similar structures encountered within the area of the Roadbed shall be removed to a depth of at least 1 foot below Subgrade and backfilled with approved material.

Excavated areas shall be properly drained at all times. Roadbed soil that is softened by water shall be corrected to the satisfaction of the Engineer at the expense of the Contractor.

The use of explosives shall be by permit only and under conditions as directed by the Engineer. When pre-splitting of rock slopes is specified in the Contract Documents, the pre-splitting operation shall be carried out in such a manner as to produce a uniform plane of rupture in the Rock to prevent subsequent blasting and excavation operations within the section affecting the back slope face. The initial pre-split shot shall not be longer than 100 feet and shall be used to establish the spacing of drill holes and the proper blasting charge to be used in the pre-splitting operation. The initial pre-split shot shall be excavated for inspection by the Engineer prior to further pre-splitting operations. If the Engineer approves the results, the pre-splitting may continue using the approved drilling and loading pattern. If the pre-splitting is found to be unsatisfactory, the Contractor shall make adjustments in the operation and repeat the inspection procedure used for the initial pre-split shot.

The pre-split holes shall be drilled on maximum 3 foot centers and to a maximum depth of 20 feet unless otherwise directed by the Engineer. If the vertical depth to the plan grade is greater than 20 feet, the blasting shall be done in 2 or more lifts and the drill holes shall be set back a sufficient distance from the slope line to allow for a 1 foot offset for each succeeding line of drill holes.

No excavation shall be deposited or stockpiled at any time so as to endanger portions of the new or an existing structure, either by direct pressure or indirectly by overloading banks contiguous to the operation. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction or future work by others as determined by the Engineer. If there is not sufficient area available for stockpiling within the limits of the Project, the Contractor will be required to furnish its own area for stockpiling.

All excess and unsuitable material shall be removed from the limits of the Work and be disposed of by the Contractor. The Contractor will be required to furnish its own disposal area.

## **202.05 MEASURE AND PAYMENT**

The unit of measure for the various classes of Roadway Excavation will be the cubic yard. The number of cubic yards will be computed by the average end area method; however, at locations where end area measurements cannot be taken that will produce the requisite accuracy, the Engineer may substitute other methods to determine the correct quantities.

Cross sections will be taken of the undisturbed ground. Any materials removed or excavated before these measurements have been taken will not be included in the number of cubic yards measured. Unless it is ordered by the Engineer, material excavated below specified Elevations will not be measured. If so ordered, such additional cross-sections as are necessary will be taken.

Any excavation beyond specified limits will not be measured.

The cross-sectional area measured shall not include water or other liquid, but shall include mud, muck, or similar semisolid material that has not been disturbed by the Contractor and that cannot be drained away.

The number of cubic yards of Roadway Excavation removed will be paid for at the Contract unit price per cubic yard, which payment will include the excavation of all material, all grading, draining cut areas, undercutting soft and unstable areas in the Roadbed and/or Embankment, the removal and disposal of all material, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein. Pre-splitting will not be measured but the cost will be incidental to the cost of excavation.

## 203 SOILS CONSTRUCTION – GENERAL

### 203.01 DESCRIPTION

These Specifications include general requirements that are applicable to all types of soils construction. The Work shall consist of the formation of Embankments, Roadbeds, and backfilling of trenches, Structures, etc., to the lines, grades, and cross sections specified including trimming and finishing.

Payment for Work required by this section shall be under the various Pay Items in these Specifications.

Terms used in these Specifications for the construction of soils foundations are in accordance with AASHTO M 146.

### 203.02 MATERIALS

Materials for earthwork shall meet the following requirements:

- 804.02: Soils for Embankments
- 804.05: Soils for trench backfill
- 804.04: Soils for base courses and structural backfill
- 213: Geotextile fabrics and membranes

Graded aggregate from a quarry producing aggregates containing asbestos is prohibited.

### 203.03 CONSTRUCTION REQUIREMENTS

#### A. DENSITY AND MOISTURE REQUIREMENTS

1. **Density Requirements** - The Standard Density requirements for soils and aggregate base courses and recycled materials shall be defined as the Maximum Dry (Laboratory) Density obtained by AASHTO T 180: Method D.

The in-place or required density shall be determined in accordance with AASHTO T 191 or AASHTO T 310, and is expressed as a percentage of the Standard Density. If the in-place density sample contains material larger than 3/4 inch, the field density shall be adjusted for the material retained on the 3/4 inch sieve before direct comparison with the Standard Density.

The minimum compaction density shall be as specified in Table 203.03, Density Requirements.

Prior to any concrete or asphalt placement, the Contractor shall conduct 3 field density tests per lift in each lane. The tests shall be conducted in each block. If the Project is less than 1 block, only 2 tests are required.

2. **Moisture Requirements** - Soils materials used in construction shall have uniform moisture content suitable for compaction to the specified density. When necessary, the Engineer may direct that the soil be moistened or dried to obtain suitable uniform moisture content.

If the materials are of such nature that heaving, pumping, rutting, or shearing occurs in the compacted soil under the action of the construction equipment, even though the density of the soil satisfies the above requirements, the moisture content of the soil will be considered unsatisfactory and shall be adjusted such that no heaving, pumping, rutting, or shearing occurs in the compacted soils under the action of the construction equipment.

- B. **PROOF ROLLING OF IN-SITU MATERIAL** - Prior to placing any base course material and after the in-situ material has been properly compacted and fine graded to the correct Elevation, the Subgrade shall be checked under the action of a loaded tandem or 10-wheeled dump truck or similar equipment. If soft spots are detected, or pumping, rutting, or heaving occurs at the Subgrade, the Roadbed shall be considered unsatisfactory, and the soil in these areas shall be replaced to the depth indicated by the Engineer. Materials used to replace unsatisfactory soil material in the Subgrade shall meet the requirements of 804.04 and 213. The improved Subgrade shall then be compacted to the density specified in Table 203.03 and fine graded to the correct Elevation.

Upon satisfactory completion of the Subgrade layer, the base course layer shall be placed meeting the requirements of 209.06, properly compacted and fine graded to the correct Elevation as shown the Contract Documents.

Where shallow utilities or similar construction conditions prohibit proof rolling or correction by replacement and the soils foundation is not suitable for hauling over directly, the Contractor shall provide approved means for protecting the soils foundation against damage caused by equipment moving over it. If an approved means is used for protecting the soils foundation around shallow utilities or similar construction against damage caused by equipment moving over it, the unsatisfactory soil in these areas shall be replaced, as directed by the Engineer, to a depth below the utilities or similar construction by material meeting the requirements of 804.04 and 213 and compacted to the density specified in Table 203.03.

**C. FORMATION OF EMBANKMENTS** - All excavated material meeting the applicable requirements of 203.02 may be used in the formation of any Embankment, or similar construction. The Contractor shall dispose of all other materials outside the limits of the Project.

During the construction, the Embankment shall be maintained in such condition that it will be well drained at all times, and the grade shall be shaped and rolled to drain when precipitation is imminent and at the end of each day.

After precipitation, all soft wet material on the grade shall be removed at the Contractor’s expense before additional material is placed. No fill shall be placed in natural drainage ditches until necessary pipes or Culverts have been installed.

No material used in Embankments shall be placed in a loose lift thickness in excess of 6 inches. Each loose lift shall be compacted to the density requirements of Table 203.03 before another loose lift is placed. Frozen material shall not be used nor shall material be placed on frozen Embankment foundation, Embankment or base course.

Compacting equipment shall meet the requirements of 902.06. Any portion of the Embankment or Embankment foundation that is not accessible to the roller shall be compacted to the specified density by an approved mechanical tamper. Puddling or jetting is prohibited. The Engineer may permit compaction with types of equipment other than those specified above, provided that the use of the alternate equipment will consistently produce requisite densities. The Contractor shall submit proposed compaction methods for approval by the Engineer.

The Contractor shall be responsible for the stability of all constructed soils foundations and shall replace any portions that, in the opinion of the Engineer, have become displaced or disturbed due to careless or negligent work, or to damage resulting from any kind of storms and not attributable to the unavoidable movement of the natural underlying ground on which the constructed soils foundation rests. No pavement materials shall be placed on any base, roadbed, or soils foundation until it has been approved by the Engineer.

**TABLE 203.03 DENSITY REQUIREMENTS**

DESCRIPTION	MINIMUM DENSITY REQUIRED, PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY AASHTO T 180 D
Embankments, Trench Backfill and Borrow Trench Backfill	93% per each layer up to 6 inches below Subgrade.
	95% for top 6 inch layer of Subgrade.
	95% for full depth of Embankments in confined areas where the use of clean sand is permitted.
Upper 6 Inches of Roadway Base (Top 6 Inches Subgrade)	93% under curb, gutter, sidewalk, driveway, and ally entrances.
	95% under PCC roadway pavement.
	100% under full depth bituminous concrete pavement.
Existing and New Aggregate Base Courses, Base, Pavement, or Sidewalk	95% for PCC pavement and sidewalk.
	100% for final lift for bituminous concrete pavement
Structural Backfill	95%
Backfill for Undercut Areas	95%
Backfill for Undercut Areas Underneath Footing and Mat Foundation	100%
Tree Space	85%
Aggregate Base Course for Bike Trail Path.	95%

## 204 EMBANKMENT FILL

### 204.01 DESCRIPTION

This item shall consist of the construction of Embankments to the lines, grades, and cross sections shown in the Contract Documents or as directed by the Engineer. Approved sources of material may include suitable excavated materials from the Project location that meet specification requirements and have been sampled and approved in accordance with 804.01.

Approved fill materials excavated from the Project location and incorporated into the finished work shall be known as Embankment Fill. Embankment materials obtained from other approved locations shall be known as Borrow Embankment Fill.

### 204.02 MATERIALS

Material shall conform to 804.02.

### 204.03 CONSTRUCTION REQUIREMENTS

Embankment Fill and Borrow Embankment Fill shall be constructed and tested in accordance with 203 and the following: Where Embankments are to be made on, or merge with, a slope or an existing Embankment having a slope steeper than 3 to 1, the existing slope shall be cut in benches or steps as each lift is placed and to the depth directed by the Engineer.

Where the thickness of the Embankment to be placed is less than 2 feet, any existing hard surface pavement shall be removed and the area compacted as in-situ soil immediately following the excavation and prior to placing any fill material; any soft spots revealed by this compaction shall be removed and replaced to the depth indicated by the Engineer. Where the thickness of the Embankment to be placed is greater than 2 feet, any existing hard surface pavement shall be thoroughly scarified or broken prior to placing any fill material.

Areas that have been cleared and grubbed shall be compacted as in-situ soil before placing any Embankment material; any soft spots revealed by this compaction shall be removed and replaced to the depth indicated by the Engineer.

### 204.04 MEASURE AND PAYMENT

The unit of measure for Embankment Fill or Borrow Embankment Fill will be the cubic yard. The number of cubic yards will be computed by the average end area method; however, the Engineer may substitute other methods to determine the requisite quantities.

The actual number of cubic yards of Embankment Fill or Borrow Embankment Fill as determined will be paid for at the Contract unit price per cubic yard, which payment will include labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein, including furnishing, stockpiling, hauling, and compaction.



**205 STRUCTURE EXCAVATION AND DEMOLITION****205.01 STRUCTURE EXCAVATION**

- A. GENERAL** - Structure Excavation shall consist of excavation for the foundations of Structures below the natural ground line and/or below the Elevation of the finished Roadway or Roadways and appurtenances, railroad roadbed, and stream channels, as shown in the Contract Documents.

Structure Excavation shall be excavation as shown and specified in the Contract Documents and/or Standard Drawings, including portions of existing Structures encountered.

Excavation shall include removal of all materials and objects, of whatever nature encountered in excavation; disposal of excavated materials as specified herein: the construction and maintenance and subsequent removal of cribbing, sheeting, shoring and bracing; all necessary bailing, draining, and pumping; and all precautions and Work necessary to prevent damage to adjacent properties resulting from this excavation.

Material from the excavation that meets the requirements of 203 may be used as specified therein.

The Elevations of the bottom of footings, as shown in the Contract Documents, shall be considered as approximate only and the Engineer may order in writing such changes in Elevations of footings as may be necessary to secure a satisfactory foundation. Payment for additional depth will be made in accordance with 205.04.

**B. CONSTRUCTION REQUIREMENTS**

- 1. General** - The Contractor shall notify the Engineer a sufficient length of time in advance of the beginning of any excavation, so that cross sections may be taken of the undisturbed ground.

The Contractor shall submit, in accordance with 105.02, drawings showing his proposed method of sheeting, bracing and shoring construction and other pertinent features not shown in detail in the Contract Documents. Such drawings and features shall be approved by the Engineer before construction is started, but this approval shall not relieve the Contractor of any of its responsibility for constructing and maintaining this construction. The determination of sheet piling lengths shall be the sole responsibility of the Contractor.

All excavation adjacent to existing pavements and structures shall be sheeted, shored, braced, and supported in a substantial manner to prevent settlement, movement, or damage to the existing pavement or structure.

The Contractor, at his own expense, so as to provide necessary clearances and dimensions, shall correct any movement or bulging of shoring that occurs.

After each excavation is completed, the Contractor shall notify the Engineer, and no foundation piles shall be driven or concrete placed until after the Engineer has given his approval.

Material forced above the plan elevation of the bottom of the foundation or tremie seal by the pile driving shall be removed at the Contractor's expense.

The use of explosives shall be by permit and under conditions as directed by the Engineer.

All sheeting, shoring, and bracing involved shall be removed by the Contractor after the completion of the permanent structure, in a manner so as not to disturb or mar the structure. Sheeting may be left in place only by written permission from the Engineer, subject to such conditions as the Engineer may require. No payment will be made by the District for such sheeting, shoring, and bracing so left in place.

No excavated material shall be deposited at any time so as to endanger portions of the new or an adjacent structure, either by direct pressure or indirectly by overloading banks contiguous to the operation, or in any other manner. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction or future work by others as determined by the Engineer. If there is not sufficient area available for stockpiling within the limits of the Project, the Contractor will be required to furnish his own area for stockpiling.

All material shall be removed from the limits of the Work and be disposed of by the Contractor. The Contractor will be required to furnish his own disposal area.

- 2. Preparation of Foundations** - It is intended that all footings shall be constructed in open excavations, where practicable, and that all such excavations shall be completely dewatered and kept dewatered for the placing of all concrete and backfill. Elevations for the bottom of the footings shown on the Contract Documents shall be considered approximate only. The Engineer may, during construction, direct changes in dimensions or elevations of footings to achieve a satisfactory foundation.

All rock or other hard foundation material shall be free of all loose material, cleaned and cut to a firm surface, either level, stepped, or roughened, as may be directed by the Engineer. All seams shall be cleaned out and filled with concrete, mortar, or grout.

When masonry is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed. If in the event the foundation becomes wet and spongy or otherwise unsatisfactory prior to the placing of concrete thereon, the Contractor shall, at no additional cost to the District, remove the unsuitable material and replace it with suitable material to secure an adequate foundation, as determined by the Engineer.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete, or for a period of at least twenty-four (24) hours thereafter, unless done from a suitable sump separated from the concrete work by a watertight wall or by means of well points.

Faces of footings shall be placed plumb against undisturbed material, rock, sheeting, shoring, or forms. Faces of footings in rock shall bear against a minimum 1 foot depth of rock. If the excavation will not stand plumb, the Contractor shall furnish and install sheeting, shoring, or forms as required.

- 3. Cofferdams** - In the event that the construction of the foundation requires underwater construction, the Contractor shall submit drawings for approval, in accordance with 105.02, showing his proposed method of cofferdam construction and other pertinent features. Cofferdams shall be constructed so as to protect green concrete against damage from sudden rising of the stream or river. Bracing shall not extend into the Substructure masonry.

The areas included within cofferdam construction shall be such that forms can be placed inside the sheeting for the sides of the concrete footings and so that any leakage into the enclosed area may be conducted to pumps outside of the footing forms. Cofferdams shall be of such dimensions that there will be no reduction in the net size of concrete base or tremie seal course shown in the Contract Documents and also to insure that, with the pile driving equipment proposed for use, all piles can be driven in their correct position with the batter specified. Should any sheet piles or other walls of cofferdams encroach upon the net minimum dimensions of tremie seal course shown in the Contract Documents, the cofferdams shall be reconstructed as necessary to clear the minimum lines. Sheet piles, if used, shall be driven sufficiently below the bottom of excavation and of concrete to provide adequate lateral support for the piles and to allow excavation to the full depth required. The effect of such penetration on the position of battered piles shall be provided for in the cofferdam design. In no case shall horizontal wales extend more than 12 inches inside the net concrete dimensions of the seal courses as shown in the Contract Documents.

Any pumping from the interior of the foundation enclosure that may be permitted shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least twenty-four (24) hours thereafter, unless it is done from a suitable sump separated from the concrete by a watertight wall. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressures.

Removal of sheeting, shoring, and bracing shall be as specified in 205.01(A), except that, at the Contractor's option, all parts of cofferdams and similar temporary construction below the level of top of concrete tremie seal course may be allowed to remain in place, but no payment will be made for such sheeting, shoring, or bracing so left in place.

Unless permitted by the Engineer, no excavation shall be made outside of the cofferdam. If any excavation or dredging is made at the Site of the structure before caissons, cribs, or cofferdams are sunk or are in place, the Contractor shall, at no additional cost to the District, after the foundation base is in place, backfill all such excavation to the original ground surface or riverbed with material satisfactory to the Engineer. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction thereby.

**205.02 DEMOLITION**

- A. GENERAL** - Demolition shall consist of complete or partial removal and disposal of various materials from existing Structures as shown and specified in the Contract Documents.
- B. CONSTRUCTION METHODS** - All items designated to be wholly or partially removed shall conform to the Contract Plans and Specifications, unless otherwise approved by the Engineer. Any material removed beyond authorized limits, or any portion of remaining structure damaged as a result of negligence on the part of the Contractor, shall be replaced or repaired by the Contractor at his own expense. Before cutting or disconnecting members the Contractor shall assure himself that members are adequately supported. The Contractor shall also construct and maintain protection shields about the trees in the vicinity of the Work to prevent inadvertent damage during the length of the Project. The use of explosives and blasting procedures is prohibited, unless specifically granted by permit.

Prior to partial concrete removal, the perimeter of the area to be removed shall be carefully saw cut to a neat line. The cut lines shall be made down to the outside layer of reinforcing steel, making sure that bars to be retained are not damaged. No debris shall be deposited, dropped, placed or secreted within the waters or land beneath or adjacent to the structure. Material shall be removed daily and not allowed to accumulate on or adjacent to the Project site.

- 1. Protection Shield** - Prior to any removal, a protection shield, meeting the requirements of 610, shall be properly installed in the work zone area. The shield shall remain in place until all construction activity related to the appropriate phase is completed.
- 2. Support of Existing Structural Elements** - Particular care shall be exercised in all operations to prevent collapse or damage to portions of the structure which are to remain or reused. The Contractor shall assure the Engineer that all structural elements are adequately supported before disconnecting or removing them.

Prior to removal of any structural elements, the Contractor shall design adequate temporary supports in accordance with 703.16, Falsework and Centering. Working drawings with calculations prepared and stamped by a Registered Professional Engineer shall be submitted to and approved by the Engineer showing all temporary supports prior to beginning Work.

- 3. Reinforcing Steel** - Existing reinforcing steel to be retained for splicing with new steel shall be cleaned, straightened or bent as required, and cut to the desired length. New steel shall be spliced to existing steel as per AASHTO requirements.

When existing reinforcing steel to be retained is damaged during demolition, the Contractor shall, at his own expense, substitute a bar of equal size drilled in and grouted to the required lap as per AASHTO requirements.

Where projecting bars are not to extend into the new construction, they shall be cut off flush with the surface to which the concrete has been removed. Cleaning reinforcing steel and removal of excessive length of bars shall be included as part of this Work. All material removed shall be disposed of outside the construction area.

**205.03 STRUCTURE HARD SURFACE EXCAVATION**

- A. GENERAL** - This Work shall consist of removal and disposal of concrete from existing Structures such as retaining walls, median barriers and concrete islands to the limits as specified in the Contract Documents. Included in this Work are saw cutting to a neat line the perimeter of the area to be removed and carefully removing the material to the indicated depth so as not to damage electrical conduits and reinforcing steel to remain in place. Also included are cleaning, bending or straightening as required, and cutting existing reinforcing steel to remain in place as shown on the Contract Plans and as directed by the Engineer.
- B. CONSTRUCTION REQUIREMENTS** - Prior to the removal of any concrete, the perimeter of the area to be removed shall be carefully saw cut to a neat line. The cut shall be sufficiently shallow to avoid damaging the existing reinforcing steel to remain in place. Concrete shall be carefully removed so as not to damage the structure to remain. Restrictions may be placed in the Contract Specifications on the type and size of demolition equipment to be used.

Concrete shall not be removed beyond the specified limits without the approval of the Engineer. Concrete that is removed or damaged by the Contractor beyond the limits of removal shall be saw cut, removed and replaced at the Contractor's expense.

Existing Reinforcing Steel - Existing reinforcing steel to be retained for splicing with new steel shall be cleaned, straightened or bent as required and cut to the desired length. When existing reinforcing steel to be retained is damaged during removal of concrete, the Contractor shall, at his own expense, substitute a bar of equal size drilled in and grouted in the existing concrete to achieve the required 30 bar diameters or spliced length as specified on the Plans.

In areas where the required length for splicing cannot be achieved, the Contractor shall use a mechanical bar splice, equal to 125 percent of the strength of the bars, to connect the new bar to the existing bar. Welding of reinforcing steel shall not be permitted.

Where projecting bars are not to extend into the new construction, they shall be cut off flush with the surface of the existing concrete.

#### 205.04 STREETCAR TRACK REMOVAL

**A. GENERAL** - Work under this item consists of the complete removal and disposal of existing streetcar tracks and concrete foundation, within the Project limits as shown on the Plans and/or where as directed by the Engineer. Work includes removal and disposal of all rails including sheet rails, slot (center) rails and contact rails including all the appurtenances thereto. Work also includes removal and disposal of manhole and hand hole frames and cover, yokes and all concrete placed to support the track including channels, hand holes, manholes, and yoke enclosures. Work also includes removal and disposal of intervening hard surface pavement, including asphalt surface covering the tracks, to a distance laterally 2 feet beyond outer edge of each wheel rail.

**B. CONSTRUCTION METHOD** - Excavated rails and accessories shall become the property of the Contractor and shall be removed from the Site to the satisfaction of the Engineer. Methods of removal will be optional to the Contractor, subject to approval of the Engineer. The void below sub grade where removal was performed shall be backfilled to Subgrade with soils base material meeting requirements of 804.04 and compacted in accordance with applicable requirements of Division 200.

Extreme care shall be exercised when streetcar tracks are removed in the vicinity of existing utilities and completed work. The Contractor shall be responsible for any damage to utilities, completed Work, and private property during removal of the streetcar tracks and concrete support.

**C. MEASURE AND PAYMENT** - Unit of measure will be linear foot, with measure made along centerline of the rails.

Payment for Streetcar Track Removal will be made at the Contract unit price per linear foot, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete the Work specified including backfilling below sub-grade level.

#### 205.05 MEASURE AND PAYMENT

**A. STRUCTURE EXCAVATION** - The unit of measure for Structure Excavation will be the cubic yard. The number of cubic yards will be computed by the average end area method. However, at locations where end area measurements cannot be taken which will produce the requisite accuracy the Engineer may substitute other methods to determine the correct quantities.

Cross sections will be taken of the undisturbed ground. Any materials removed or excavated before these measurements have been taken will not be included in the number of cubic yards measured. Trenches or foundation pits for structures or structure footings shall be excavated to the Elevations shown, and any material excavated below that Elevation, unless ordered in writing by the Engineer, will not be measured.

Excavations will be computed from the actual dimensions of the excavated area, limited by vertical planes 18 inches outside of and parallel to the footings and a horizontal plane at the bottom of footings or tremie seals to limits as shown in the Contract Documents.

The number of cubic yards of Structure Excavation, as measured, will be paid for at the Contract unit price per cubic yard, which payment will include the excavation, removal, and disposal of all material, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

When it is necessary, in the opinion of the Engineer, to carry the excavation below the Elevations shown on the Plans, the excavation for the additional depth will be paid for as follows:

The first 3 feet below plan Elevation will be paid for at the Contract unit price. From 3 to and including 6 feet below plan Elevation will be paid for at 125 percent of the Contract unit price. From 6 to and including 9 feet below plan Elevation will be paid for at 150 percent of the Contract unit price. Excavation in excess of 9 feet below plan Elevation will be paid for as extra Work subject to the provisions of the Contract.

- B. STRUCTURE HARD SURFACE EXCAVATION** - The unit of measure will be the cubic yard. Payment for Structure Hard Surface Excavation will be made at the Contract unit price per cubic yard, which payment will include saw cutting the perimeter to a neat line, removal and disposal of all materials, cleaning, bending, and cutting of reinforcing steel to remain and all labor, tools, equipment, and incidentals needed to complete the specified Work.
- C. COFFERDAM** - The unit of measure for Cofferdam will be lump sum. No direct measure will be made. Payment for Cofferdam will be made at the Contract lump sum price, which payment will include furnishing all materials, construction of the cofferdam, underwater cleaning, dewatering, required treatment of effluent and sediments, maintenance of the cofferdam during construction, removal and disposal of all materials, and all labor, tools, equipment, and incidentals necessary to complete the Work.
- D. DEMOLITION** - The unit of measure for Demolition will be lump sum. No direct measure will be made. Payment for Demolition will be made at the Contract lump sum price, which payment will include preparation of required Working Drawings, furnishing all materials, installing and disposing of temporary supports, removal and disposal of all materials, saw cutting the perimeter to a neat line, and furnishing all labor, tools, equipment, and incidentals needed to complete the specified Work.

## 206 STRUCTURE BACKFILL

### 206.01 DESCRIPTION

The Work shall consist of the backfill of abutments, piers, walls, and Culverts to the lines, grades and cross sections shown on the Plans or as directed by the Engineer. This shall include any additional area outside the excavation pay limits for construction of the Structures. It shall be limited to the area between the bottom of the footing and the original ground or Subgrade, whichever is lower. Fill may be obtained from excavated material meeting specification requirements or from any approved source. Fill obtained from sources outside the Project limits shall be designated as Borrow Structure Backfill.

### 206.02 MATERIALS

Materials shall conform to the requirements of 804.04(A)

### 206.03 CONSTRUCTION REQUIREMENTS

Structure Backfill or Borrow Structure Backfill shall be constructed in accordance with the requirements of 203 and the following:

The minimum in place density of structure backfill shall be 95 percent.

Where backfill is to be placed on both sides of abutments, piers, walls, and Culverts, the fill shall be placed and compacted on both sides to approximately the same Elevation at the same time.

As soon as practicable, all excavated or open spaces resulting from the excavation shall be backfilled. Areas adjacent to footings shall be backfilled and compacted to the top of the footings within forty-eight (48) hours after placing footing concrete.

Jetting or puddling of backfill will not be permitted.

Where sheeting, bracing, and supporting of any type has been used in constructing the structure, it shall be so removed that no voids are left in space occupied by it.

Backfill behind abutments, piers, and walls of Structures will not be permitted until the concrete in the Structures has aged for fourteen (14) days, except that backfill may be placed earlier if results of tests show that the concrete has obtained 85 percent of the design strength and the concrete in the structure is at least seven (7) days old.

Structure backfill shall be placed in uniform horizontal layers of not more than 6 inches in loose depth and for the full width of the fill.

Heavy compaction equipment will not be permitted to operate closer than 4 feet from the structure, unless permitted by the Engineer and in accordance with his direction. Special care shall be taken to prevent any wedging action against the structure and the existing slopes shall be stepped or serrated as necessary to prevent such wedge action.

Backfill within 4 feet of the structure shall be compacted by means of mechanical tampers. The tamped fill shall be brought up in conjunction with the layers in the adjacent fill.

Any damp-proofed surface or membrane waterproofing damaged by the placing of backfill shall be repaired by the Contractor at his expense.

### 206.04 MEASURE AND PAYMENT

The unit of measure for Structure Backfill or Borrow Structure Backfill will be the cubic yard, limited by vertical planes 18 inches outside of and parallel to the footings and from a horizontal plane at the bottom of footings to the existing or finished grade and/or proposed Subgrade exclusive of the volume occupied by the structure and previous backfill.

The number of cubic yards of Structure Backfill or Borrow Structure Backfill will be paid for at the Contract Price per cubic yard whether on-site or borrow material is used. Payment will include all labor, material, equipment, and incidentals necessary to complete the Work, including stockpiling, furnishing, hauling, placement, and compaction.

## 207 TRENCH EXCAVATION AND BACKFILL

### 207.01 DESCRIPTION

Work consists of excavation, shoring, supporting utilities, and backfilling, as required in open trenches to specified widths and depths for the construction of sewers and water mains and their connections. It shall also include disposal of unsuitable and excess materials.

### 207.02 TRENCH SHORING

The Contractor shall furnish, place, maintain, and remove such sheeting, bracing and other supporting material required to properly support trench side walls and side walls of cuts. The Contractor shall prevent the movement of any supporting material that might in any way injure persons or negatively impact the Project other Structures near the Project, or reduce trench dimensions below those needed for proper construction.

Where excavation depth exceeds 4 feet, adequate shoring is required. For deep trench cuts, adequate trench shields, braced or un-braced sheeting may be necessary.

Working drawings for the proposed method for trench support, maintenance, and shoring removal shall be prepared under the direction, and bear the seal, of a Registered Professional Engineer with a valid P.E. license. Working drawing submittals will be for information only and shall be submitted in advance of Work. The Engineer shall be notified in advance of any change in method of trench support and maintenance.

If the Contractor elects to use sheeting, the sheeting shall be removed in conjunction with trench backfilling; however, if approved in writing, sheeting may be cut off and left in place below a line 1 foot above the top of the pipe.

Voids that may develop outside the sheeting, shoring, and bracing shall be promptly filled with appropriate material such as gravel, sand, or other approved material. If at any point sufficient or proper supports have not been provided, the Engineer may order additional supports to be installed at no cost to the District.

### 207.03 TRENCH EXCAVATION

Trench excavation shall include removal of all materials and objects of whatever nature encountered in excavation, excluding Rock and existing steel sheeting left in place, unless otherwise directed by the Engineer.

Sewer and water main trench operations shall be coordinated with other utility work and scheduled to meet maintenance of traffic provisions.

Trench width for payment at all sewer and water main trench cross sections will be based on requirements of 207.05(A).

Surface materials of whatever nature shall be removed within trench limits unless otherwise directed by the Engineer.

Before excavating, cuts through existing hard surface roadways shall be made by saw cutting through the full depth of the hard surface along the trench limit line. The types of paving materials to be cut are indicated in the Contract Documents but are not guaranteed.

Trench repairs shall be made by saw cutting a 6 inch shoulder along the trench limit lines to 1/3 of the depth of the adjacent pavement, then using pneumatic tools as required to make even, neat edges. The trench shall be paved with 10 inch reinforced PCC Base or finished PCC pavement and topped with an asphalt surface as needed. Payment for trench repair shall be made using appropriate repair/replace items.

Use of impact type breakers for PCC and AC removal over trenches shall be restricted to the hoe ram type or approved equivalent. This equipment may be restricted or prohibited when in the public interest.

Operations shall be conducted so as to avoid injury to tree trunks, branches, and roots. Excavations within limits of tree root spread shall proceed with care either by use of hand tools or with equipment that will not cause tree root damage. Exposed roots 2 inches and larger in diameter shall be wrapped in burlap or other approved material and kept moist at all times. Roots 2 inches and larger in diameter outside the actual space occupied by the sewer or structure shall not be cut; excavation shall be tunneled under these roots. When utilities must be installed in the rootzone, tunneling shall be used in lieu of trenching and root pruning. Pneumatic excavation tools or hydroexcavation techniques shall remove soil under and around roots to create openings for pipes, cables, or other utility lines. When approved by the District's Department of Transportation Urban Forestry Administration, tree branches that interfere with construction may be trimmed in advance of excavation. Root cutting and branch trimming shall be performed in accordance with accepted horticultural practice.

When excavating trench through lawn, park, or other tillable areas, sod and topsoil shall be removed with care as directed and salvaged if suitable for reuse in restoring disturbed surfaces.

When approaching existing underground construction that may be in proximity to sewer grades, or approaching existing sewers or water mains for connections, the trench shall be opened a sufficient distance ahead of the Work, test pits made per 212, or other approved exploratory methods employed to allow for authorized changes in line and grade. Changes in line and grade plus excavation and pipe removal caused by failure to take such precautions shall be made at the Contractor's expense.

The Contractor shall support all exposed underground pipes or conduits along their entire exposed length using timber or steel in such a manner that backfilling may be performed without dislodging such pipes or conduits. No additional payment will be made for support material left in place or for installing and maintaining supports.

At the Contractor's option, the actual width of trench above the top of the pipe may exceed the permissible width below the top of the pipe, if approved by the Engineer. No additional payment will be allowed for the additional excavation and backfill.

Utility service connections and appurtenances to individual premises may not be shown in the Contract Documents, and the Contractor shall determine the exact location of, and maintain, these services.

With prior approval, portions of trench excavation may be removed as tunnel at the Contract Price for Trench Excavation measured from the surface as if open cut. Tunnel bracing and all repair shall be included as part of Work.

Tunnel excavation shall meet requirements of safety standards, Rules and Regulations for Work in Tunnels and Work Under Compressed Air. In tunnel excavation, Work includes backfilling the void between the sewer structure and the tunnel roof with PCC of approved mix design. If there is any sign of settlement or loose material in the tunnel roof or walls during tunnel work, the excavation shall be made in open trench as directed. Tunneling will not be permitted when the outside of the tunnel roof is within 2 feet of the bottom of PCC or AC base.

The tunnel bottom shall be excavated approximately flat and square with trench walls. When material at trench grade is suitable, trench bottom shall be protected and maintained. Extra excavation and disposal, furnishing, and placing undercut gravel to maintain trench bottom shall be at the Contractor's expense.

If material found at the bottom of the trench is unsuitable for a foundation for pipe bedding, it shall be removed by the Contractor as directed and replaced with gravel or crushed stone per 207.06(A). Payment will be per 207.06(B).

Except in downtown and other congested areas, trench excavation shall be completed at least 25 feet in advance of pipe-laying. At the end of a work day or at the discontinuance of Work, the pipe laying shall be completed to within 5 feet of the end of the open trench.

All suitable trench excavation material meeting requirements of 804.05, as determined by the Department Field Inspector based upon samples submitted to the Department by the contractor as required in 804.01, shall be stockpiled, protected, and maintained. Excavated materials shall be neither deposited nor stockpiled so as to endanger new or existing structures or utilities, nor to interfere with the Project construction sequence and work by others.

The Contractor shall remove and dispose of all excess and unsuitable materials and shall furnish its own disposal areas.

- A. ABANDONED UTILITIES** - Work includes removal of abandoned utilities, or utilities to be abandoned, within limits of trench excavation. Open ends of abandoned utilities or utilities to be abandoned, shall be bulk-headed by either 9 inch thick brick masonry in large size openings, 9 inch thick brick masonry or PCC of approved mix design in small size openings, or 9 inch thick PCC of approved mix design or cast iron plugs or caps in small diameter abandoned water mains.

All abandoned in-place sewers with a 36-inch or larger diameter shall be filled with suitable material prior to bulk-heading.

Water mains and water appurtenances shall be abandoned in place as directed. Frames and covers of manholes and valve casings to be abandoned shall be salvaged and returned to the DC Water property yard. Abandoned manholes and water valve casings shall be backfilled to grade with approved trench fill. Abandoned fire hydrants including standpipe and boot shall be removed and delivered to the DC Water property yard; hydrant lateral shall be plugged. Water mains to be salvaged shall be severed as directed with a smooth cut at a joint or at an intermediate point if approved.

Where water valve casings or manholes to be abandoned are isolated from trench excavation limits, they shall be abandoned in place as indicated above and payment made per 303 or 313 as applicable.

Breakage will not be permitted. 24-inch and larger diameter mains must be cut normally. Any loss of value resulting from damage to usable and surplus water main materials resulting from Contractor operations will be charged to the Contractor.



- B. DEWATERING** - Trench dewatering and drainage of all surface and ground water, including pumping and well points when needed, shall be included as part of trench excavation.
- C. TEMPORARY PLATING OVER TRENCHES** - To maintain traffic and safety, steel protection plates per 612.19 shall be used to temporarily Bridge trench excavations as directed by the Engineer. Plates shall be of a size and positioned to provide adequate bearing at plate edges and shall be securely anchored. Plates shall be of sufficient thickness to safely carry heavy traffic without detrimental deflection. Plate edges exposed to traffic shall be feathered with temporary asphalt mix.

Work includes surveillance and adjustment of plating over trenches that shall be provided by the Contractor during non-work hours, weekends and holidays.

Plating and asphalt around plates shall be removed when directed.

#### **207.04 TRENCH BACKFILL**

When pipes and connections are complete and approved, trenches shall be backfilled per 203. Suitable excavated materials meeting requirements of 804.05 and density and moisture per 203.03(A) and (B) shall be used as directed for trench backfill. Approved base materials shall be used in that portion of the trench projecting through soils base layers.

Each lift shall be compacted to density requirements herein before the next lift is placed.

The minimum in place density of trench backfill shall be 93 percent for each layer up to 6 inches below Subgrade and 95 percent for the top 6 inch layer of Subgrade. In trenches outside of the roadbed areas, all layers shall be compacted to at least 93 percent of standard density. The use of "Hydra-Hammer" for compacting backfill in trenches is prohibited. Compaction by hand will be required where necessary.

Trench fill soils shall have a uniform moisture content suitable for compacting to specified density. If rutting, pumping, heaving, or shearing occurs under action of compaction equipment even though soil meets density requirements, affected material shall be replaced to limits as directed.

Trench fill material shall be dumped outside the trench excavation and not end-dumped directly into trench. Fill shall be placed in uniform horizontal layers of not more than 6 inches loose depth and for full trench width. Any fill placed on frozen trench soils shall be removed at the Contractor's expense.

Backfilling shall proceed without displacement of the grade and alignment of the pipeline. Settlement of backfill shall be considered evidence of improper workmanship or inclusion of unsuitable backfill materials, or both, and will require re-grading and realigning the pipeline and removing and re-compacting settled material at no cost to the District.

Puddling and jetting will not be permitted. All trench shoring and supports shall be so removed that trench cave-in and settlement are minimized and no voids remain. Voids caused or left by sheeting and shoring removal shall be backfilled with pervious fill or other approved material and compacted at the Contractor's expense. All material displaced by slides, settlement and trench cave-in shall be removed and replaced with specified soils at the Contractor's expense.

The Engineer may require trench backfilling over completed pipelines at any time if, in his judgment, such action is necessary. Extra compensation will not be allowed for such trench backfilling.

The Engineer reserves the right to limit the amount of pipe laid in advance of backfilling, but in no case shall these amounts exceed 100 feet for sewer work and 50 feet for water main work.

#### **207.05 MEASURE AND PAYMENT**

The unit of measure for Trench Excavation and Backfill will be the cubic yard. Space occupied by abandoned utilities will not be deducted. Volumes will be computed from the following dimensions:

- A. WIDTH** - The width for payment at all sewer trench cross sections will be based on the Department Standard Drawings 314.01 and 314.04, or as shown on the Contract Drawings.

The width at all water main trench cross sections will be based on the Department Standard Drawings 305.05, or as shown on the Contract Drawings.

The trench width may be less than, but shall not exceed, the trench pay width for the trench section from trench Subgrade to a point 1 foot above the top of pipe.

At the Contractor's option, the actual trench width more than 1 foot above the top of the pipe may exceed trench pay width if conditions will permit and are approved by the Engineer. No additional payment will be allowed for additional excavation, backfill, and temporary paving or for support, or additional support, of underground pipes or conduits that may be required as a result of the Contractor exceeding trench pay width. Should the Contractor elect this option, the Engineer shall be notified prior to Work so that he/she may estimate the additional cost of permanent paving. Monies due the Contractor shall be retained to cover temporary and permanent paving repair beyond trench pay widths.

If the value of W on the Department Standard Drawings listed above is exceeded below a horizontal plane 1 foot above top of the pipe, the Contractor shall submit to the Engineer pipe design reevaluation computations, certified by a Professional Engineer, to assure that the allowable load on the pipe will not be exceeded. Computations shall reflect any additional Work required such as concrete bedding, concrete encasement of pipe, higher class of pipe, or any other proposed Work to solve the problem. The Contractor shall perform all necessary Work at no extra cost to the District.

- B. DEPTH** - The depth at any cross section will be based on mean depth from surface where trench excavation started to outside the bottom of the sewer cradle, water pipe, or structure at that section.
- C. LENGTH** - The length will be based on the horizontal projection of the completed sewer or water main without deduction for manholes, valves, and fittings. Other types of sewer structures will be deducted from length measure.

Payment for Trench Excavation and Backfill will be made at the Contract unit price per cubic yard, which price and payment will include disposal of unsuitable excavated material, backfill and compaction with suitable excavated material, shoring, trench plating as needed, barricades, maintaining and supporting utilities and structures, and all labor, materials, tools, equipment, and incidentals necessary to complete Work specified. Payment will not be made for sheeting and shoring left in place at the Contractor's option.

When water service and/or building sewer connections are part of Contract, payment for trench excavation and backfill for water service and/or building sewer connections will be made per 308.05 and/or 316.05.

#### **207.06 TRENCH UNDERCUT EXCAVATION**

- A. GENERAL** - When material at trench grade is unsuitable, trench bottom shall be undercut to depth and width as directed by the Engineer. Undercut volume shall be backfilled with gravel or crushed stone per 804.06, compacted with a vibratory compactor, protected, and maintained. Work includes disposal of excavated material.
- B. MEASURE AND PAYMENT** - The unit of measure for Trench Undercut Excavation will be the cubic yard, with volumes computed from approved undercut dimensions. Provisions of 202.05 apply.

The unit of measure for Gravel for Trench Undercut will be the cubic yard, with volumes computed from approved undercut dimensions.

Payment for Trench Undercut Excavation below 3 feet of undercut Trench Excavation limits will be made at 125 percent of Contract unit price per cubic yard for Trench Excavation. Payment for excavation exceeding 5 feet average depth will be negotiated.

Payment for Gravel for Trench Undercut shall be made at the Contract unit price per cubic yard complete in place as measured above, which payment will include labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein, including furnishing, hauling, and compaction.

#### **207.07 BORROW TRENCH BACKFILL**

- A. GENERAL** - Trench excavation soils meeting requirements of 804.05 shall be used as trench fill, and shall be protected and maintained; furnishing approved borrow soils to replace approved trench excavation soils that become unsuitable shall be at the Contractor's expense.

When trench excavation soils fail to meet requirements of 804.05 or when the quantity of approved trench excavation soils is insufficient, approved borrow trench backfill per 804.05 shall be used and payment made under Borrow Trench Backfill.

Flowable fill meeting the requirements of 804.07 may be used for trench backfill if approved by the Engineer.

- B. MEASURE AND PAYMENT** - The unit of measure for Borrow Trench Backfill will be the cubic yard. The number of cubic yards will be computed by the average end area method; however, the Engineer may substitute other methods to determine the exact quantity. Measurement for Borrow Trench Backfill shall be limited to the trench pay width outlined in 207.05 although its use beyond these limits will be required to properly backfill the trench as excavated. The space occupied by the pipe and cradle will not be included in the measurement.

The actual number of cubic yards as determined above will be paid for at the Contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein including furnishing, hauling and compaction.

## **208 PERVIOUS FILL**

### **208.01 DESCRIPTION**

This item shall consist of furnishing all materials, labor, tools, and equipment necessary to place the Pervious Fill at the locations shown in the Contract Documents and/or as specified herein.

### **208.02 MATERIALS**

Materials for this Work shall conform to 805.02.

### **208.03 CONSTRUCTION REQUIREMENTS**

This Work shall be carried on in conjunction with the placement and compaction of the adjacent fill. The pervious fill material shall be placed in contact with the back of the walls and abutments as shown in the Contract Documents. The fill shall be compacted in horizontal layers not more than 1 foot in depth, to a minimum of 100 percent of the dry unit weight as determined by AASHTO T 19.

The Pervious Fill shall be placed so as not to mix with the Earth backfill. If a form is used between the pervious fill material and Earth backfill, none of it shall remain in the completed fill. Any Earth backfill removed to place the Pervious Fill will be at the sole expense of the Contractor.

### **208.04 MEASURE AND PAYMENT**

The unit of measure for Pervious Fill will be the cubic yard. The number of cubic yards will be the volume of Pervious Fill placed as determined from plan dimensions.

The number of cubic yards placed will be paid for at the Contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

## 209 AGGREGATE BASE COURSE

### 209.01 DESCRIPTION

This item shall consist of constructing a base course to the specified depth on a prepared foundation conforming to the lines, grades, and cross sections shown in the Contract Documents.

### 209.02 MATERIALS

Materials shall conform to the requirements of one of the following:

- 804.04(A): Crushed Stone
- 804.04(B): Recycled Crushed Concrete

Note: Recycled Crushed Concrete shall not be used in areas where subsurface drainage problems exist in the Roadbed; in areas where the roadbed soil is unstable; within undercut roadbed areas; over backfill in areas where unsuitable materials have been removed; or under full depth flexible pavements.

Fly ash and other pozzolans, when used with lime in a mixture of soil, soil aggregate, or aggregate, shall conform to the requirements of ASTM C 593.

### 209.03 CONSTRUCTION REQUIREMENTS

Aggregate Base Course shall be constructed and tested in accordance with Section 203.03(B). Except as required in excavating and replacing soft spots, the ground shall not be plowed scarified, or disturbed below the Base Course layer.

Proof rolling, as defined in 203.03(B), is required.

### 209.04 PLACING

After the grade has been properly shaped and compacted, the aggregate material shall be evenly placed and spread to a uniform depth without segregation. If the required compacted depth of the Base Course exceeds 6 inches, the base shall be compacted in 2 or more layers of approximately equal thickness. The maximum compacted thickness shall be 6 inches.

### 209.05 MIXING

After the material has been placed, water shall be added, if needed, to provide the optimum moisture content and the material uniformly mixed by means of a motor grader or other approved equipment.

### 209.06 SHAPING AND COMPACTION

Upon satisfactory completion of the Subgrade layer, as per 203.03, and placement and mixing, if necessary, of the aggregate base course layer, compaction and fine grading shall occur using approved rollers to achieve the correct Elevation as shown on the Plans. Prior to the placement of any pavement section layer, the aggregate base course layer shall be proof rolled under the action of a loaded tandem, or 10-wheeled dump truck, or similar equipment. If any ruts or irregularities occur in the base course layer, it shall be considered unsatisfactory and replaced to the depth indicated by the Engineer. Materials used to replace unsatisfactory base course material shall meet the requirements of 804.04 and 213. The Contractor shall rework the aggregate base to the specified density, line, and grade. Tamping instead of rolling is prohibited.

Compaction shall continue until the maximum densities, determined in accordance with AASHTO T 180: Method D, are obtained of not less than 95 percent under a rigid pavement, and 100 percent under a bituminous pavement.

New base course for sidewalk foundations shall be compacted to a density of 95 percent. As directed by the Engineer, any unsuitable materials shall be removed and replaced with materials meeting the requirements of 804.04.

**209.07 MEASURE AND PAYMENT**

The unit of measure for Aggregate Base Course will be the cubic yard. The actual number of cubic yards of base course of variable dimensions, measured complete in place, will be paid for at the Contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein. Payment will also include all re-compaction and/or scarifying necessary to achieve the required density.

If the Engineer determines any volume measurement to be inappropriate, a value of 3,800 pounds per cubic yard will be used to convert verified weights to a cubic yard basis.

## **210 RE-COMPACT EXISTING BASE COURSE**

### **210.01 DESCRIPTION**

This Work shall consist of reshaping and re-compacting the existing base course material. If the existing base course layer is found to be composed of soil base material, it shall be removed and reconstructed as per 203 and 209 after treatment of the new Subgrade layer as per 203.

### **210.02 MATERIALS**

If existing base material is to be left in place and used, the Contractor must take a representative sample and conduct laboratory tests to verify that it meets the requirements of 804.04.

### **210.03 CONSTRUCTION REQUIREMENTS**

Construction methods and requirements shall conform to 203 and 209. After the existing pavement has been removed, including all AC and PCC chips exceeding 1 inch in diameter, and all other foreign material, the existing base course shall be redistributed and re-compacted to the lines, grades, cross sections and densities required in the Contract Documents. Proof rolling, as defined in 209.06, will be required. Any existing base course material that is found to be unsuitable shall be removed and replaced in conformance with 209. Material that is found unsuitable, because of contamination caused by the method of pavement excavation or because of precipitation after pavement excavation, shall be removed and replaced at the Contractor's expense.

If the Roadbed or other courses being prepared was constructed under the same Contract, the Work shall be performed at the expense of the Contractor without any direct compensation being made.

### **210.04 MEASURE AND PAYMENT**

The unit of measure for Re-compact Existing Base Course will be the square yard. The actual number of square yards of existing base course redistributed and compacted will be paid for at the Contract unit price per square yard, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

The removal of existing unsuitable material will be paid for under the appropriate excavation item. Additional aggregate base material required to obtain the required line, grade, and cross section, or to replace excavated unsuitable material, will be paid for under the appropriate base course item.

## **211 SCARIFYING**

### **211.01 DESCRIPTION**

Scarifying shall consist of plowing, scarifying, or otherwise loosening the old gravel or macadam roadway to the depth specified or as directed by the Engineer, redistributing the loosened material across the full width of the soils foundation, and compacting to the density requirements for roadbed subgrade and/or base course as appropriate. These 3 operations shall be accomplished in sequence without an appreciable time interval between each.

### **211.02 CONSTRUCTION REQUIREMENTS**

When scarification results in a loose depth of material in excess of 6 inches, re-compaction shall be accomplished in 2 or more lifts in accordance with the requirements of 203 and/or 209 for roadbed subgrade and/or base course as appropriate.

Proof rolling as specified in 203.03(B) or 209.06 will be required.

### **211.03 MEASURE AND PAYMENT**

The unit of measure for Scarifying will be the square yard.

The actual number of square yards measured at the Site prior to start of scarification will be paid for at the Contract unit price per square yard, which payment will include the distribution of the loosened material throughout the full width of the soils foundation and compacting to the required density, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.



## 212 TEST PITS

### 212.01 DESCRIPTION

Work consists of excavation, backfill, compaction and restoration as required to excavate test pits necessary to locate or determine type and/or condition of materials of construction of underground utilities.

### 212.02 SUBMITTALS

Each test pit location and estimated size shall be submitted to the Engineer for approval.

### 212.03 MATERIALS

Materials shall conform to the requirements of : 607.02: Sodding

### 212.04 CONSTRUCTION REQUIREMENTS

When water service work is included in proposed sewer pipe construction projects, trench excavation under 207.03 will uncover those water service connections crossing the trench when the proposed sewer will run between the water main and the curb line. Test pits will be required to determine the condition and material of the water service connections for the opposite side of the street where the water main runs between the proposed sewer and opposite curb line.

Pit size shall be approximately 2 feet x 4 feet or as directed by the Engineer.

Pit depth shall generally be 4 foot minimum and approximately 5 foot maximum unless otherwise directed by the Engineer.

Test pits shall be scheduled as directed so that pit backfilling can be completed within the workday.

Test pits shall generally be located within the Tree Space. Test pits shall be required on both sides of a water meter to identify water service line materials.

All sod, bushes, etc., shall be salvaged and reinstalled to restore area to acceptable condition. Where salvaged items will be inadequate for restoration, provide new sod and other features.

It may be necessary to hand excavate portions of test pits in order to protect utilities. Excavated material shall be stored and used for backfill unless the excavated material is unsuitable. Borrow fill shall be used only if the quantity of suitable excavated material is insufficient, and shall be included as part of the Work.

When the pit is outside of the Roadway and Sidewalk areas, backfill shall be thoroughly compacted in 12-inch layers with pneumatic tampers. When the test pit is within the Roadway or Sidewalk area, compaction shall be per 207.04.

### 212.05 MEASURE AND PAYMENT

The unit of measure for Test Pits will be each.

Payment for Test Pits will be made at the Contract unit price per each, which payment will include hand excavation as needed, backfill including borrow fill as needed, restoration including asphalt, concrete, and sod as needed, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## 213 GEOSYNTHETIC STABILIZED SUBGRADE USING GRADED AGGREGATE BASE

### 213.01 DESCRIPTION

This Work shall consist of furnishing and installing a layer of geotextile fabric membrane or geogrid and a minimum of 6 inches of graded aggregate base at undercut areas in the Roadbed. The geotextile should be placed between the backfill material and the underlying soils subgrade in order to bridge unstable material and minimize the use of undercutting. This item shall only be used when specified in the Contract Documents or as directed by the Engineer. In extremely unstable areas, the Engineer may increase the thickness of the graded aggregate base course material.

### 213.02 MATERIALS

- A. GEOTEXTILE FABRIC** – The geotextile fabric shall meet the requirements of the Contract Documents and AASHTO M 288 for Stabilization Applications and shall be listed in the National Transportation Product Evaluation Program (NTPEP) for geotextiles. The fabric shall be a woven fabric manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum 95 percent by weight of polyolefins or polyesters. The fibers shall be formed into a stable network so that the filaments or yarns retain their dimensional stability relative to each other, including selvages. Geotextile fabrics manufactured with polyamide will not be allowed. The fabric shall be inert to commonly encountered chemicals and hydrocarbons, be mildew and rot resistant, and conform to the following minimal physical property requirements:

**TABLE 213.02 (A) REQUIRED GEOTEXTILE PROPERTIES**

Grab Strength (ASTM D 4632)	300 lbs
Puncture Strength (ASTM D 4833)	110 lbs
Trapezoid Tear Strength (ASTM D 4533)	110 lbs
Permittivity (ASTM D 4491)	0.05 sec <sup>-1</sup>
Apparent Opening Size (ASTM D 4751)	.15 mm (minimum)
Elongation at Failure (ASTM D 1682)	15%
Ultraviolet Stability (ASTM D 4355)	At 500 hours exposure, 50% strength retained

All values are based on minimum average roll values in the weakest principle direction.

Geotextile fabrics used for subsurface drainage, erosion control, sediment control, or as a permeable separator shall meet the requirements of 822.09. Geotextile fabrics used for soils reinforcement shall be approved as part of Special Provisions for structural systems.

- B. GEOGRID** - The geogrid is a geosynthetic material formed by a regular network of integrally connected elements with apertures of sufficient size to allow interlocking with surrounding soil, stone, or other geotechnical material to function primarily as reinforcement. Furnish geogrid that is resistant to damage during construction, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil on which it is placed. Furnish geogrid that conforms to the properties presented in Table 213.02 (B).

**TABLE 213.02 (B) REQUIRED GEOGRID PROPERTIES**

Property	Test Method	Required Value <sup>a</sup>	
<b>Reinforcement Properties</b>			
Strength at 5% Strain	ASTM D 6637	1000 lb/ft	14.5 kN/m
Minimum Opening Size	Direct Measure	0.75 in <sup>b</sup>	19 mm
Maximum Opening Size	Direct Measure	3.0 in <sup>c</sup>	76 mm
<b>Survivability Index Values</b>			
Ultimate Tensile Strength	ASTM D 6637	2000 lb/ft	29.3 kN/m
Junction Strength	GRI <sup>d</sup> GG2	25 lb	110 N
Ultraviolet Stability	ASTM D 4355	70% at 500 hrs	

- (1) Values, except ultraviolet stability, are minimum average roll values, MARV (average value minus 2 standard deviations). Strength in the machine and cross-machine directions must both meet the required value.
  - (2) Minimum opening size must be  $\geq D_{50}$  of aggregate above geogrid to provide interlock
  - (3) Maximum opening must be  $\leq 2 \times D_{85}$  to prevent aggregate from penetrating into the Subgrade.
  - (4) GRI – Geosynthetic Research Institute
- C. SEAM AND OVERLAP** - When geotextile fabrics are joined by sewing, the geotextile seam shall conform to the following:
1. The seams shall be either “J” or Butterfly type and shall utilize a lock stitch.
  2. The seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.
  3. The durability of the thread for seaming shall be at least equal to the geotextile itself.
- D. SECURING PINS OR STAPLES** - Securing pins or staples shall have a minimum 10 inch length and shall be designed to securely hold the geotextile fabric in place during construction.

### 213.03 CONSTRUCTION REQUIREMENTS

- A. TEST STRIP** - In extremely unstable areas, the Engineer may direct that a test strip be constructed to determine the thickness of aggregate base layer required to stabilize the area. The test strip shall be a minimum of 100 feet in length and at least 1 lane wide. The Engineer will determine the depths of aggregate base to be used in the test strip. Based on the results of the test strip, the Engineer will determine the thickness of the aggregate base to use in subsequent construction.
- B. GRADE PREPARATION** - When geosynthetic stabilized subgrade using graded aggregate base is specified, the area where the geotextile is to be placed shall be cut to the depth shown on the Contract Documents or as directed by the Engineer. The grade upon which the geotextile is to be placed shall be brought to the line, grade and cross section specified. The grade shall be as smooth as practical and free of debris. Construction traffic on the grade shall be minimized. When ruts are formed by construction traffic, they shall be removed by reshaping the affected area. The grade shall not be overworked and shall be approved by the Engineer prior to placement of the geotextile. Adequate surface drainage shall be maintained in conformance with 203. The Engineer may waive the compaction and moisture requirements for the underlying soil on which the geotextile is to be placed.
- C. GEOTEXTILE OR GEOGRID PLACEMENT** - Care should be taken in placing the geotextile or geogrid so that it is not damaged during construction. Geotextile or geogrid shall be placed on the prepared surface for the full width of the area to be treated. In areas where longitudinal under drain is to be placed, the geotextile or geogrid shall be placed up to the edge of the proposed longitudinal under drain trench but shall not be placed where the trench is to be excavated. The geotextile or geogrid shall be unrolled on the grade parallel to the base line without dragging it across the grade. Wrinkles and folds shall be removed from the geotextile by stretching and pinning. The geotextile or geogrid shall be overlapped a minimum of 3 feet at roll edges and ends. Overlaps at the end of the roll shall be in the direction of aggregate placement with the roll being covered on top of the next roll. Roll ends and roll end overlaps shall be pinned a minimum of 5 feet on center. Roll edges and roll edge overlaps shall be pinned a minimum of 50 feet on center. Securing pins or staples shall have a minimum 10 inch length and shall be designed to securely hold the geosynthetic in place during construction.
- For curves, the geotextile or geogrid shall be folded or cut and overlapped in the direction of the turn. Folds in the geotextile or geogrid shall be pinned a minimum of 5 feet on center. Damaged geotextile or geogrid shall be repaired or replaced immediately as directed by the Engineer at the Contractor’s expense. Geotextile or geogrid patches shall be overlapped a minimum of 3 feet into undamaged geotextile or geogrid. Traffic, including construction equipment, is prohibited on the bare geotextile or geogrid.
- D. GRADED AGGREGATE BASE PLACEMENT** - Placement of the graded aggregate base shall be in conformance with 209 with the following exceptions:
1. **Placement and Spreading** - Graded aggregate base shall be placed within three (3) working days of geosynthetic placement. The graded aggregate base course shall be placed with care so that the geotextile or geogrid is not damaged or displaced and to ensure that the proper laps and splices are provided. The graded aggregate base shall be placed as a single lift in the thickness required to provide the specified compacted depth. The graded aggregate base shall be placed by end dumping and spreading. Construction shall be parallel to the base line. The turning of construction equipment on the graded aggregate base shall be kept to a minimum.

2. **Density Requirements** - Immediately after placement, the graded aggregate base material shall be compacted to the required density in accordance with 203.
3. **Vibration** - Graded aggregate base shall not be vibrated unless otherwise specified or directed by the Engineer.

#### **213.04 MEASURE AND PAYMENT**

Geosynthetic stabilized subgrade or base using graded aggregate base will be measured and paid for at the Contract unit price per cubic yard.

The payment will be full compensation for furnishing and placing the geotextile or geogrid and graded aggregate base, compaction, test strip, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. In areas where additional undercut was approved by the Engineer, the additional graded aggregate base backfill, in excess of 6 inches compacted, will be measured and paid in conformance with 209.

Excavation will be measured and paid for in conformance with 201.

## 214 PERMEABLE BASE

### 214.01 DESCRIPTION

This Work shall consist of constructing a permeable asphalt base or permeable concrete base on a prepared Subgrade, in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical sections shown in the Contract Plans or as directed by the Engineer.

The permeable asphalt base shall consist of a mixture of aggregate, polymer modified asphalt cement, and approved anti-strip additive. The permeable concrete base shall consist of a mixture of aggregate, Portland Cement, admixtures, and water.

### 214.02 MATERIALS

**A. AGGREGATES** - The aggregates for both the permeable asphalt base and the permeable concrete base shall be 100 percent crushed stone per ASTM C 33, Grading Size No. 57.

**B. ASPHALT** - The asphalt for asphalt treated permeable base shall be an approved polymer modified asphalt cement complying with 802.09. The percentage of asphalt cement shall be 2.0 percent to 4.0 percent by weight (mass) of the total mixture. Asphalt cement content and mixing process shall be such that all aggregates are visibly coated. Qualification samples shall be tested, and the mixture shall retain a minimum of 90 percent coating when tested in accordance with an approved stripping test and anti-strip additive.

The job mix formula shall be submitted and approved in accordance with Section 400.

**C. ANTI-STRIP ADDITIVE** - The anti-strip additive shall be added at the minimum rate of 0.5 percent by weight of asphalt cement and shall be thoroughly mixed with the asphalt cement at the Plant. Additional anti-strip additive may be added up to 1.2 percent by weight (mass).

The proposed job mix formula shall indicate a single anti-strip additive rate that is 0.1 percent greater than the percentage that will yield a minimum of 90 percent coating when tested. The approved range shall be 0.2 percent by weight (mass) of asphalt, with the lower limit being the quantity determined during testing and the maximum limit not to exceed 1.2 percent by weight (mass) of asphalt.

**D. PERMEABLE PORTLAND CEMENT CONCRETE** - Cement for permeable concrete base shall be a Type I or Type I (B) Portland Cement complying with 500.

Permeable concrete base shall have a minimum cement content of 235 pounds of Portland Cement per cubic yard (140 kg/m<sup>3</sup>) of concrete. The water cement ratio of the mixture shall be not more than 0.37.

**E. ADMIXTURES** - Admixtures for the permeable concrete base shall comply with 814. The rate shall be as approved by the Engineer.

### 214.03 CONSTRUCTION REQUIREMENTS

**A. PERMEABLE ASPHALT BASE** - The permeable asphalt base shall be placed in accordance with 400. Compaction shall be with 2 to 3 passes or as directed by the Engineer of a 5 to 10 ton smooth steel wheel roller conforming to Section 902. Permeable asphalt base shall be placed at a temperature between 200°F to 260°F (90°C to 125°C) when measured in the hopper of the paving machine. Compaction shall begin when the temperature of the permeable asphalt base has cooled to approximately 160°F (70°C) and shall be completed before the temperature falls below 100°F (35°C).

**B. PERMEABLE CONCRETE BASE** - The permeable concrete base shall be placed in accordance with 501 or by an asphaltic concrete paver in accordance with 902. Compaction shall be performed by using vibrating screeds or plates as directed. No construction joints will be required. Immediately after concrete placement, the permeable concrete base shall be cured by covering the entire surface and exposed edges with white-pigmented curing compound in accordance with 501.17.

**214.04 PROTECTION**

The Contractor shall protect the permeable asphalt base and permeable concrete base from severe weather conditions and contamination by dust, dirt, mud, or other fine grained material. The base shall be protected by an approved method from the time of placement until placement of the following pavement layer. No traffic will be permitted on the permeable asphalt base or permeable concrete base. Equipment required to place the pavement will be allowed, provided that it enters and exits as near as possible to the paving operation. Any damage to the permeable bases caused by the Contractor's equipment shall be repaired by the Contractor at no expense to the District. Any portion of the permeable bases that become contaminated, to the extent that drainage is reduced or inhibited, shall be removed and replaced at no expense to the District. The permeable bases shall be covered with pavement within fifteen (15) working days after placement.

**214.05 TOLERANCES**

The finished surface of permeable asphalt base and permeable concrete base shall be uniform and shall not vary at any point more than 0.05 foot above or below the established grade. The cross-slope shall not vary by more than  $\pm 0.003$  feet/feet. Permeable asphalt base or permeable concrete base with a surface higher than 0.05 foot above the established grade shall be removed and replaced with permeable base that complies with these Specifications. When permitted, the high spots may be removed to within specified tolerance by any method that does not produce contaminating fines nor damages the base to remain in place. Grinding will not be permitted. Permeable base with a surface lower than 0.05 foot below the established grade shall be removed and replaced with permeable base that complies with these Specifications. When permitted, low areas not exceeding 1 inch shall be filled with pavement at the time and in the same operation in which the pavement is placed at no cost to the District.

**214.06 TESTING**

Before placing surfacing, the Contractor shall core the permeable bases at the locations determined by the Engineer. All cores taken by the Contractor shall be given to the Engineer for verification of base thickness.

**214.07 MEASURE AND PAYMENT**

Permeable asphalt base and permeable concrete base will be measured by the square yard from the design quantities shown on the Plans. Design quantities will be adjusted if the Engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary. Design areas of permeable base are based on the horizontal dimensions shown on the Plans, the length being along the centerline of the base.

Payment for permeable asphalt base and permeable concrete base will be made at the Contract unit price per square yard, which payment will include all labor, tools, equipment, and incidentals required to complete the specified Work.

## 215 EXCAVATIONS AND RESTORATIONS (UTILITY LINES)

### 215.01 DESCRIPTION

The Work performed in conjunction with the placement or repair of utility lines consists of trenching, shoring, subgrade replacement, surface course replacement, and pavement marking replacement for composite pavements, PCC pavements, and flexible pavements. The Work shall be performed by utility companies or their contractors and shall be subject to Chapter 34 of the Public Space Regulations (title 24, DCMR). In the event of any inconsistency with another provision of these Specifications, the most stringent requirement shall govern. These Specifications shall be used in conjunction with the Department of Transportation Standard Drawings for utility excavation repairs.

### 215.02 USE OF STEEL PLATES

The Contractor shall place the appropriate notification signs if steel plates are used at any point in the processes described herein. Further, the Contractor shall notify the Director, District of Columbia Department of Transportation, or his or her designee, before placing any steel plates in the Public Right-of-Way.

### 215.03 COMPOSITE PAVEMENTS

**A. TRENCH EXCAVATION** - The Contractor shall cut the full depth of pavement to a neat line by means of a power saw, as per the Standard Drawings.

**B. TRENCH BACKFILL FOR TEMPORARY RIDING SURFACE** - The Contractor shall backfill with approved materials placed in 6 inch lifts to within 4 inches of grade.

The Contractor may use flowable fill as a backfill. If this option is employed, then the 6 inch shoulder described in 215.03(D) is not required, and the new base course described in 215.03(D) shall be anchored to the existing base on one side, as per the Standard Drawings.

**C. TEMPORARY RIDING SURFACE** - The Contractor shall place 4 inches of hot mix asphalt to grade, as per the Standard Drawings.

#### **D. RESTORATION OF BASE COURSE**

**1. Restoration Cut** - The Contractor shall cut the pavement parallel to the roadway's longitudinal joints, with a minimum of 6 inches of Shoulder beyond the original cut. If this places the restoration cut within 2 feet of a joint in the base course, the cut shall be extended to the joint. The asphalt surface course shall be cut full-depth to a neat line by means of a power saw. The base course shall be cut in the same manner to a depth of at least 3 inches. Pneumatic tools shall be used to remove the remaining portion of the base course, as per the Standard Drawings.

**2. Replacement of Base Course** - The Contractor shall place Portland Cement Concrete Base Course to a minimum depth of 10 inches. The bottom of the new base course shall be even with the bottom of the existing in place base course. The top of the new base course shall be 2 inches below the riding surface, as per the Standard Drawings, so as not to be affected by subsequent milling and overlaying processes.

Steel plating is required for a minimum of seventy-two (72) hours to protect the concrete before opening to traffic. Payment for steel plating shall be in accordance with 612.19.

In the winter, the Contractor may bring the PCC Base Course up to the grade of the Roadway as a temporary measure, thereby eliminating the need for a temporary asphalt patch. In this event, the permanent restoration of the Site in the manner described in 215.03(E) must be completed no later than April 15 immediately following the winter months during which these measures were taken.

**3. Temporary Feathering** - Between the time that the concrete base course has cured and the placement of the final asphalt surface, the Contractor shall feather all edges from the existing pavement to the concrete base course with temporary hot mix asphalt or high-performance cold mix, as defined in 819, at a rate of 3 inches per inch of Elevation.

**E. SURFACE COURSE RESTORATION-MILL AND OVERLAY LIMITS**

1. **Width** - The Contractor shall mill and overlay the entire width of the affected lane or lanes.
2. **Length** - If the utility cut is less than 30 feet in length, the Contractor shall mill and overlay the length of the cut plus the sections from each end of the cut to the nearest traverse pavement joint. If the utility cut is 30 feet or greater in length, the Contractor shall mill and overlay the entire length of the block.
3. **Special Cases**
  - a. **Special Case 1** - Utility cut in 2 adjacent traffic lanes and crossing a longitudinal pavement joint
 

L<sub>1</sub> = distance in a traffic lane from the start of a utility repair to the transverse pavement joint nearest to the cross-over to the adjacent lane

L<sub>2</sub> = distance in an adjacent lane from the end of the utility repair to the transverse joint nearest to the cross-over from the adjacent lane.

    - i. If L<sub>1</sub> is less than 30 feet, the Contractor shall mill and overlay the length of L<sub>1</sub> plus the sections from each end of L<sub>1</sub> to the nearest transverse joints. If L<sub>2</sub> is less than 30 feet, the same paving requirements apply.
    - ii. If either L<sub>1</sub> or L<sub>2</sub> are greater than 30 feet in length, the Contractor shall mill and overlay the full length of the block.
    - iii. In all cases, the Contractor shall make all cuts in the base course parallel to either longitudinal or transverse joints.
  - b. **Special Case 2 – Diagonal Utility Cut** - If the utility cut is diagonal, the Contractor must replace the base course slab(s) through which the cut runs from joint to joint. The previous requirements on the length and width of milling and overlaying apply.
  - c. **Full Slab Replacement Option** - The Contractor may fully replace all base course slabs affected by utility cuts in lieu of the above option of partial replacement and milling and overlaying of the surface course.

**215.04 PCC PAVEMENTS**

- A. **TRENCH EXCAVATION AND BACKFILL** - The Contractor shall excavate and backfill the trench according to 215.03(A) and (B). Flowable fill is an acceptable option.
- B. **RESTORATION OF PAVEMENT** - The Contractor shall replace pavement from joint to joint for each section affected by a utility cut.

**215.05 FLEXIBLE PAVEMENTS**

- A. **TRENCH EXCAVATION AND BACKFILL** - The Contractor shall excavate and backfill the trench according to 215.03(A) and (B). Flowable fill is an acceptable option.
- B. **RESTORATION OF SUBBASE**
  1. **Restoration of Cut** - The Contractor shall cut the pavement with a 6 inch shoulder around the trench. All cuts shall be either parallel or perpendicular to the curb. All cuts shall be made to the pavement's full depth and shall be made to a neat line with a power saw.
  2. **Placement of Subbase** - The Contractor shall place 12 inches of stone based aggregate to within 7 inches of the riding surface. If the Contractor chooses to use flowable fill, aggregate sub base is not required. The flowable fill shall also be placed to within 7 inches of the riding surface.
- C. **RESTORATION OF PAVEMENT**
  1. **Restoration of Base Course** - The Contractor shall place 5 inches of approved base asphalt in 2 lifts.
  2. **Restoration of Surface Course** - The Contractor shall place 2 inches of approved surface asphalt to the same grade as the Roadway.



**215.06 CROSSWALKS AND SIDEWALKS**

- A. CROSSWALKS** - If a utility cut intersects 1 or more crosswalks of any material other than that of the surrounding Roadway, the permanent restoration of the crosswalk(s) must restore it to its original condition and shall be made with materials identical to those of the original crosswalk(s).
- B. SIDEWALKS** - Contractor must restore sidewalk to its original condition using original bricks taken from the sidewalk, where feasible, or using materials similar to those of the original sidewalk.

**215.07 PAVEMENT MARKINGS**

If any pavement markings are affected by a utility cut, the Contractor shall replace them with temporary pavement markings within forty-eight (48) hours. Immediately upon the completion of a permanent repair, the Contractor shall replace temporary pavement markings with permanent markings.

**215.08 REMOVAL OF PAVEMENT MARKINGS**

When the location of underground utilities must be temporarily marked on the overlying pavement, the party requesting the markings shall remove all markings immediately upon:

- Completion of the excavation;
- At the time the markings are no longer necessary; or
- Twenty (20) days after a permit is granted where excavation has not commenced.

**215.09 MEASURE AND PAYMENT**

The unit of measure for trench restoration shall be the cubic yard. The unit of measure for asphalt shall be the ton. The unit of measure for PCC shall be the square yard or cubic yard, as specified in the Contract Documents. Asphalt and PCC restoration shall be paid for through the appropriate Asphalt or PCC Standard Item.

## 216 IN-SITU SOIL STABILIZATION

### 216.01 DESCRIPTION

This Work shall consist of injecting the water blown 2-component urethane polymer into existing soil. This will improve the in-situ soil and raise and support the existing pavement. The urethane shall be injected in accordance with these Specifications and in reasonable close conformity with the lines and grades shown on the Plans or established.

### 216.02 CONSTRUCTION REQUIREMENTS

The Contractor shall have a minimum of three (3) years of experience in the Deep Injection of Polyurethane (DIP) process. At the pre-construction conference, the Contractor shall submit the name of the firm that will do the DIP process. No Work shall be done unless and until the firm is approved by the Engineer. The Contractor shall provide a work schedule outlining mobilization, and drilling (sequence, location, and depth). The Contractor shall provide a description of the program for monitoring the Work, including movement detection.

**A. EQUIPMENT** - The Contractor shall provide all necessary equipment to perform the Work including, but not limited to the following:

1. A pneumatic drill and an electric drill capable of drilling 5/8 inch diameter holes
2. A truck-mounted pumping unit capable of injecting the high density polyurethane formulation between the pavement and the subbase and capable of controlling the rate of rise of the pavement
3. A laser leveling unit to ensure that the pavement is raised to an even plane and to the required Elevations
4. A portable dynamic cone penetrometer for on-site soils investigation to assist in locating weak subgrade soils and determining the injection pattern through tubes to improve the density of in-situ soils

The material used for the DIP process shall be a high-density polyurethane material, such as URETEK 486 STAR or equivalent, conforming to the following:

**TABLE 216.02 ASTM TEST METHOD PER PROPERTY**

Property	Value	ASTM Test Method
Density, lbs/ft <sup>3</sup> minimum	3.6 – 4.2	D 1622
Compressive Strength, psi minimum	50	D 1621
Tensile Strength, psi minimum	50	D 1623

The polyurethane material shall reach 90 percent of full compressive strength within fifteen (15) minutes from injection. The material shall have water insoluble diluents which permits the formation of polyurethanes in excess water.

The Contractor shall supply certified test results to the Engineer on the above ASTM Test Methods for each lot used prior to placement on the Project. Lots not meeting these requirements shall not be used on the Project and shall be replaced and re-tested at the Contractor's expense.

- B. PREPARATION** - A preliminary profile shall be performed to determine where and how much pavement needs to be raised. The profile shall be taken in each wheel path of the area to be raised. At least 1 profile shall be taken in the Shoulders of the area to be raised. The interval between each point on the profile shall not exceed 6 feet. The plot of the preliminary profile shall be provided to the Engineer prior to raising any pavement. Dynamic cone penetrometer testing may be required by the Engineer on each lane of the Project to confirm the condition of the existing soils.
- C. DRILLING** - A series of 5/8-inch holes shall be drilled at a maximum of 8 foot intervals through the pavement. The exact location and spacing of the holes shall be determined by the Contractor. The holes shall be drilled to a minimum depth of 25 feet. The drilled holes shall not crack the pavement.

**D. INJECTING** - The high density polyurethane formulation shall then be injected through injection tubes inserted into the drilled holes, as required to improve the in-situ soils or raise the pavement to the required Elevations. The Contractor shall construct cofferdams or other temporary structures to ensure that excessive material does not escape. The amount of rise shall be controlled by regulating the rate of injection of the high density polyurethane material. When the nozzle is removed from the hole, all excessive polyurethane material shall be removed from the area and the hole sealed with a non-expansive cementitious grout, as approved by the Engineer.

**E. MONITORING** - A tight string line, continuous laser level, and/or dial indicator device shall be placed at locations on the walls and pavement. These locations shall be monitored by the Contractor during the DIP process.

All pavement blowouts, excessive pavement lifting or wall movement which may result from the process, and new cracks that form within forty-five (45) days of placement shall be repaired or replaced at the Contractor's expense.

**F. FINAL PROFILE** - Final Elevations shall be within 1/4 inch of the Elevations proposed by profile. A tight string line may be used to monitor and verify Elevations for areas with a length less than 50 feet. For longer sections, a laser level shall be used to monitor and verify Elevations. A final profile shall be performed to determine how much the pavement was raised. The profile shall be taken in each wheel path of the affected area. At least 1 profile shall be taken in the Shoulders of the affected area. The interval between each point on the profile shall not exceed 6 feet. The plot of the final profile shall be provided to the Engineer for the Project records.

### 216.03 MEASURE AND PAYMENT

Polyurethane will be measured by the pounds injected. Drilled holes will be measured by the actual number of linear feet of holes acceptably drilled, including depth of pavement.

Payment for drilling hole will be made for the number of linear feet, measured as provided above at the Contract unit price, and shall constitute full compensation for drilling holes, furnishing and installing casing, disposal of the drill cuttings, environmental protection, and all other Work necessary for completion of the Work.

Payment for polyurethane will be made for the pounds injected, measured as provided above, at the Contract Price. Payment shall constitute full compensation for all materials, labor, equipment, mixing, pumping, waste, cleanup, and environmental protection.

Any additional drilling and stabilization work directed by the Engineer will be paid for at the Contract unit prices.

Payment will be full compensation for all Work and materials necessary to stabilize the in-situ soils and bring the slabs to grade. All sampling and testing will not be measured and paid for separately, but shall be included in the Work.



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## 301 H PILES-THRUST BLOCK

### 301.01 DESCRIPTION

Work shall conform to DC Water Standard Specifications Section 33 11 23.

Work includes furnishing all labor, materials, tools and equipment needed to install a complete thrust block foundation pile system as shown in the Contract Documents.

All piles shall be installed by a Contractor qualified to install H piles. Minimum requirements for qualification shall consist of five (5) years pile driving experience and evidence of a satisfactory completion of at least 5 pile installations comparable to this Project in scope and subsurface conditions.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill.
- 317: Sewer/Water PCC Formwork Construction
- 318: Reinforcing Steel – Sewer/water Work
- 320: Sewer/Water PCC Construction

Reference Codes and Specifications:

- ASTM A 36: Specification for Structural Steel
- AASHTO M 31: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- AWS D1-1: Structural Welding Code

### 301.02 SUBMITTALS

Sufficiently in advance of the start of pile driving, the Contractor shall submit to the Engineer for review a description of equipment and any necessary existing structures monitoring schedules.

Prior to driving any pile, the Contractor shall submit written certification from the manufacturer that piles meet specification requirements. Certified mill test reports shall also be submitted.

Shop drawings showing pile layout details and pile splice details shall be submitted per 105.02. Pile hammer manufacturer's details and recommendations shall be submitted with Shop Drawings.

### 301.03 MATERIALS

Materials shall conform to DC Water Standard Specifications Section 33 11 23.

### 301.04 CONSTRUCTION REQUIREMENTS

Requirements of 701.03 through 701.06 apply for this Work. H Piles – Thrust Block shall be furnished and constructed in conformance with DC Water Standard Specifications Section 33 11 23.

### 301.05 MEASURE AND PAYMENT

The unit of measure for Steel H Piles will be the linear foot.

The number of feet measured will be the actual number of linear feet left in the completed structure of piles acceptably driven, as measured along the axis of the pile from the tip of the pile to the approved cutoff elevation. No measurement will be made for cutoffs, broken piles, or piles driven out of position.

Payment for Steel H Piles will be made at the Contract unit price per linear foot for size specified, which payment will include temporary and permanent pile splices and welding, all labor, materials, tools, equipment, and incidentals needed to furnish and drive piles complete in place.

## **302 VALVE CASINGS**

### **302.01 DESCRIPTION**

Work shall conform to DC Water Standard Specifications Section 33 06 20.

Work consists of excavation, backfill, compaction beyond trench excavation limits, disposal of excess material, furnishing and placing valve casings complete with concrete base, piers, precast concrete rings, and casing frames and covers at locations indicated in the Contract Documents and/or as directed.

Reference Codes and Specifications:

- AASHTO M 105: Standard Specification for Gray Iron Castings
- AASHTO M 91: Standard Specification for Sewer and Manhole Brick (made from Clay or Shale)
- ASTM C 361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
- AASHTO M 199: Standard Specification for Precast Reinforced Concrete Manhole Sections

### **302.02 SUBMITTALS**

Shop drawings per 105.02 shall be submitted for precast concrete items, cast iron frames and covers.

### **302.03 MATERIALS**

Materials shall conform to DC Water Standard Specifications Section 33 06 20.

### **302.04 CONSTRUCTION REQUIREMENTS**

Valve Casings shall be furnished and constructed in conformance with DC Water Standard Specification Section 33 06 20. Excavation and backfill shall be included as part of Work, and shall be per 207.

### **302.05 MEASURE AND PAYMENT**

The unit of measure will be each. Payment for valve casing will be made at the Contract unit price per each, which payment will include excavation and backfill beyond trench excavation pay limits, concrete base and piers, risers, frames and covers, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

### 303 ABANDONING VALVE CASING AND HYDRANTS

#### 303.01 DESCRIPTION

Work shall conform to DC Water Standard Specifications Section 33 01 20.

Work consists of abandoning water valve casings either by removal, partial removal, bulkheading, or any combination thereof, and removal of fire hydrants. Work includes excavation, disposal of unusable materials, bulkheads, and backfill and compaction.

#### 303.02 MATERIALS

- 806.01 (A): Brick
- 817, Class B: PCC
- 806.05 (B) (5): Mortar

#### 303.03 CONSTRUCTION REQUIREMENTS

- A. ABANDONING VALVE CASINGS** - Portions of valve casings within 3 feet below approved Roadway Subgrade shall be totally removed. Portions lower than 3 feet below Subgrade shall be abandoned in place. Open ends of abandoned water main at the manhole shall be bulk headed at the manhole by either 9 inch thick brick masonry in 36 inch diameter and larger openings or 9 inch thick brick masonry, or PCC of approved mix design, in smaller size openings. Work includes backfill with Embankment fill and its compaction to Subgrade per 203. Usable manhole frames and covers and precast manhole rings shall be removed with care and reused on the Contract or delivered to a District Property Yard as directed. Unusable items shall be included in disposal.
- B. REMOVE FIRE HYDRANT** - Remove Fire Hydrant shall include the removal of boot, standpipe, and hydrant completely. Work includes backfill with Embankment fill and its compaction to Subgrade per 203. Usable hydrant components shall be removed with care and delivered to a designated District Property Yard as directed. Unusable items shall be included in disposal.

#### 303.04 MEASURE AND PAYMENT

The unit of measure will be each.

Payment for Abandoning Valve Casings and Remove Fire Hydrant will be made at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## **304 BUTTERFLY VALVE MANHOLES**

### **304.01 DESCRIPTION**

Work shall conform to DC Water Standard Specifications Section 33 06 22.

Work consists of excavation, backfill, and compaction beyond trench excavation limits, disposal of excess material, and furnishing and placing butterfly valve manholes, complete with concrete base, frames, and covers, at locations indicated in the Contract Documents, and/or as directed. Butterfly valve manholes shall be built over butterfly valves 12-inches through 36- inches diameter.

Related Work specified elsewhere may include but is not limited to:

- 305: Pipe Water Main – Ductile Iron
- 306: Gate/Butterfly Valves

Reference Codes and Specifications:

- AASHTO M 105: Standard Specification for Gray Iron Castings
- ASTM A 74: Standard Specification for Cast iron Soil Pipe and Fittings
- AASHTO M 31: Standard Specification Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- AASHTO M 91: Standard Specification for Sewer and Manhole Brick (made from Clay or Shale)
- ASTM D 2146: Standard Specification for Polypropylene Plastic Molding and Extrusion Material
- AASHTO M 199: Standard Specification for Precast Reinforced Concrete Manhole Sections

### **304.02 SUBMITTALS**

Shop drawings per 105.02 shall be submitted for cast- iron frames and covers.

### **304.03 MATERIALS**

Materials shall conform to DC Water Standard Specifications 33 06 22.

### **304.04 CONSTRUCTION REQUIREMENTS**

Manholes shall be constructed over butterfly valves up to 36-inches in diameter, as shown in the Contract Documents. Excavation and backfill shall be per applicable subsections of 207.

Manholes shall be constructed in conformance with the construction requirements in DC Water Standard Specifications Section 33 06 22.

### **304.05 MEASURE AND PAYMENT**

The unit of measure will be each.

Payment for Butterfly Valve Manhole will be made at the Contract unit price per each, which payment will include excavation and backfill beyond trench excavation pay limits, concrete base, riser sections, castings, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## 305 WATER MAIN PIPE – DUCTILE-IRON

### 305.01 DESCRIPTION

Work shall conform to DC Water Standard Specifications Section 33 05 02.

Work consists of furnishing and placing water main pipelines complete and ready for continuous service, including: pipe, fittings, and specials (such as pipe for suction blow-offs and fire hydrants); jointing and harnessing; cutting and connection to existing system, including additional fittings not shown on Contract Documents or anticipated in the Work but required for a functional system, requisite retainer glands; reconnecting existing mains, testing operations, and providing disinfection, testing, and all incidental work needed for a complete installation.

The District reserves the right to furnish any additional fittings required to complete the Contract in a timely manner and in the District's interest.

Water main pipe 60-inches and smaller diameter shall be ductile-iron pipe unless otherwise specified.

Water main pipe 12-inches and smaller diameter shall be harnessed at all joints, unless otherwise specified.

When a water main is attached to a bridge or other structure, Work includes all pipe supporting members such as cross beams (other than diaphragms), bracing, rollers, hangers, connecting hardware, PCC inserts, expansion devices, and appurtenances.

Related Work specified elsewhere may include but is not limited to the following sections:

- 207: Trench Excavation
- 304: Butterfly Valve Manholes
- 306: Gate/Butterfly Valves
- 307: Fire Hydrants
- 703: Cast-In-Place Concrete
- 322: Concrete Thrust Block
- 324: Concrete In-Line Thrust Block
- 822.04: Precast Concrete Products

### 305.02 SUBMITTALS

Shop drawings per 105.02 shall be submitted for pipe laying schedule, closure pieces, fittings, specials, joint details, bevel pipe, restraint, harnessing, and special designs.

Mechanical and push-on joint restraint methods, including pressure rating from manufacturer, shall be submitted by the Contractor and approved by the Engineer prior to ordering or installing these materials.

Data, affidavits, and certifications shall be submitted per referenced AWWA Specifications and this Section.

Manufacturers' recommendations regarding joint deflection shall be submitted for all pipe and fittings.

### 305.03 MATERIALS

Materials shall conform to DC Water Standard Specifications Section 33 05 02.

### 305.04 MATERIALS SUPPLIED BY DISTRICT

No materials will be furnished by the District to the Contractor, unless the District deems it in the best interest of the Project to do so.

**305.05 CONSTRUCTION REQUIREMENTS**

Ductile-Iron Pipe Water Main shall be constructed in conformance with DC Water Standard Specifications Section 33 05 02. The Engineer shall retain all rights to inspect and approve all Contract Work. Where Work is noted in DC Water Standard Specifications Section 33 05 02 to be performed at no cost to DC Water, said Work shall be performed at no cost to the District.

**305.06 WATER MAIN TESTS**

Water main tests shall conform to DC Water Standard Specifications Section 33 05 02. The Engineer shall retain all rights to inspect and approve all Contract Work. Where Work is noted in DC Water Standard Specifications Section 33 05 02 to be performed at no cost to DC Water, said Work shall be performed at no cost to the District.

**305.07 MEASURE AND PAYMENT**

The unit of measure for Ductile-Iron Pipe Water Main will be the linear foot, with measure taken along the center line of pipe, including fittings, except Extra Fittings - Contractor Furnished, complete in place, with laying lengths of valves deducted. Reducers will be measured as pipe equivalent to the larger end size. When crossing a bridge, measure will also include pipe rollers, straps, and connecting hardware. Payment for Ductile-Iron Pipe Water Main will be made at the Contract unit price per linear foot, which payment will include all joints and fittings (except Extra Fittings – Contractor Furnished), specials and closure pieces, harnessing, lining and coatings, additional tests subsequent to first test, chlorination, testing, installation of Extra Fittings – District Furnished, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

The unit of measure for Extra Fittings - Contractor Furnished will be the pound, as determined from the nominal tabulated weight of the fitting before the application of any lining or coating other than standard coatings. Weight of retainer glands, bolts, nuts, and gaskets will not be measured. The weight of any fitting shall not be less than the nominal tabulated weight by more than 10 percent. No separate measure will be made for Extra Fittings – District Furnished. Payment for Extra Fittings - Contractor Furnished will be made at the Contract unit price per pound, which payment will include all extra fittings and requisite retainer glands, gaskets, bolts, nuts and all labor, materials, tools, equipment, tests, and incidentals needed to complete extra fittings work.

Payment for Extra Fittings – District Furnished will not be made. Payment for installation of District furnished fittings will be included in Contract unit price per linear foot for Ductile-Iron Pipe Water Main.

No separate payment will be made for air and drain blowoffs. Excavation required will be included in trench excavation; tees, bends, pipe, joints and standpipe will be included in water main work; 6-inch valve and valve casing(s) will be paid as separate items.

2 inch gate valve, caps, and standpipe on dead end units shall be included as part of water main work.

## 306 GATE/BUTTERFLY VALVES

### 306.01 DESCRIPTION

Work for Gate Valves shall conform to DC Water Standard Specifications Section 33 14 00. Work for Butterfly Valves shall conform to DC Water Standard Specifications Section 33 14 05.

Work consists of furnishing and installing gate and butterfly valves. Gate valves may be either standard or resilient-seated type. Work includes gate valves for drain blowoffs. Excavation and backfill, if necessary, and valve casings are included as part of Valve Casings per 302, harnessing is included as part of Pipe Water Main Ductile-Iron per 305; Butterfly Valve Manholes per 304 or Valve/Venturi Vaults, when applicable, per 321.

Related Work specified elsewhere may include but is not limited to the requirements of the following:

- 302: Valve Casings
- 304: Butterfly Manholes
- 305: Pipe Water Main – Ductile Iron
- 321: PCC Valve/Venturi Vaults

Reference Codes and Specifications:

- ASTM A 48: Standard Specification for Gray Iron Castings
- AASHTO M 91: Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
- ANSI B 16.1: Cast iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
- ASTM A 48: Specification for Gray Iron Castings
- ASTM A 153: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A 536: Specification for Ductile-Iron Castings
- ASTM B 584: Specification for Copper Alloy Sand Castings for General Applications
- AWWA C104: AWWA Standard for Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water
- AWWA C203: AWWA Standard for Coal-Tar Protective Coatings for Steel Water Pipelines – Enamel and Tape – Hot Applied
- AWWA C500: AWWA Standard for Gate Valves, 3 through 48-In. NPS, For Water and Sewage Systems
- AWWA C504: AWWA Standard for Rubber-Seated Butterfly Valves
- AWWA C509: AWWA Standard for Resilient-Seated Gate Valves, 3 through 12 NPS, For Water and Sewage Systems
- AWWA C550: AWWA Standard for Protective Interior Coatings for Valves and Hydrants
- U.S. Army Corps of Engineers C200

### 306.02 SUBMITTALS

Drawings per 105.02 shall be submitted for valve and joint details.

Affidavits, certificates, and manufacturer's test results shall be submitted per this Section, including:

#### A. GATE VALVES

1. **Catalog Data** – Prior to purchase of the valve, the Contractor shall submit to the Engineer, for approval, catalog data, net weight, and certified assembly drawings. No valve shall be furnished or installed unless approved in writing by the Engineer.

2. **Affidavit** – An affidavit of compliance shall be furnished by the manufacturer that specifies tests have been performed and that all components and the product comply in all respects with requirements of Specifications.
3. **Records Of Tests** – Record of physical and chemical properties, operating, and hydrostatic tests shall be furnished.

**B. BUTTERFLY VALVES** - Test data shall be furnished by the manufacturer.

The Contractor shall submit manufacturer's certified drawings of the valves, including valve operators, gear ratios, electrical schematics (where electrical operators are furnished), and parts lists.

An affidavit from the manufacturer shall be submitted stating that the valves furnished comply with all applicable provisions of this specification.

Certified test reports covering performance, leakage, and hydrostatic tests shall be furnished.

The Contractor shall submit a statement giving the required number of turns of the operating nut to move the disc from fully open to fully closed (or vice versa) position.

### 306.03 MATERIALS

- Materials for Gate Valves shall conform to DC Water Standard Specifications Section 33 14 00.
- Materials for Resilient-Seated Gate Valves shall conform to DC Water Standard Specifications Section 33 14 00.
- Materials for Butterfly Valves shall conform to DC Water Standard Specifications Section 33 14 05.

### 306.04 CONSTRUCTION REQUIREMENTS

- A. **PRIOR TO INSTALLATION INSPECTION** - Valves will be inspected at the time of receipt for damage in shipment, compliance with Specifications, direction of opening, size and shape of operating nut, number of turns, and type of end connections. A visual inspection of the bronze gate rings and body rings will be performed to detect any damage in shipment or scoring of the seating surfaces. Any foreign material in the interior portion of the valve shall be removed. The valve will be cycled through 1 complete opening and closing cycle.
- B. **INSTALLATION** – 6 inch through 12-inch diameter gate valves shall be installed vertically in the water main by means of standard mechanical joints per 305.  
  
Valves 16-inches through 24-inches diameter shall be butterfly valves installed with mechanical joints per DC Water Standard Specifications 33 05 02.  
  
Valves 30-inches in diameter and larger shall be butterfly valves installed with flanged joint ends bolted to accompanying flanged and plain-end pieces, such that the plain-ends will accommodate flexible rubber-packed mechanical sleeve couplings, and shall meet the requirements for tolerance of ends of steel pipe to be coupled in a similar manner as described in AWWA C 201 or C 202. The exterior of the flanged and plain-end pieces shall be coated with a suitable bituminous coating and the interior lined with cement mortar per AWWA C 104.  
  
Valves shall be installed in the closed position.
- C. **AFTER INSTALLATION INSPECTION** - After installation and before pressurization of the valve, all pressure-containing bolting (bonnet, seal-plate, bypass, and end connections) will be inspected for adequate tightness of all tapped and plug openings to the valve interior. The Contractor shall make any adjustments or alterations as directed.
- D. **TESTS** - Pressure test will be conducted as part of the water main test per DC Water Standard Specifications Section 33 05 02.

### 306.05 MEASURE AND PAYMENT

The unit of measure will be each.

Payment for Gate/Butterfly Valve will be made at the Contract unit price per each, which payment will include flanged and mechanical joint ends, flanged and plain-end pieces where needed along with sleeve couplings, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.



## 307 FIRE HYDRANTS

### 307.01 DESCRIPTION

Work shall conform to DC Water Standard Specifications Section 21 11 10.

Work consists of furnishing and setting fire hydrants, (boot with ductile iron retainer gland, standpipe and hydrant complete) adjusting hydrants to grade, relocating hydrants, converting fire hydrants to traffic type, plus constructing dry wells and thrust blocks complete, at locations indicated in the Contract Documents or as directed. Work includes restoration of landscape features and sodding per 607 and 608. Trench excavation and backfill, hydrant connecting pipe, restraint, water valve, and water valve casing are not part of Work.

- A. SET FIRE HYDRANT** - Work consists of furnishing and installing new traffic type fire hydrants, necessary tees, elbows, other fittings, and other incidental materials to complete Work.
- B. RELOCATE FIRE HYDRANT** - Work consists of relocating fire hydrants at new location. Work includes furnishing all items in (A) except for the fire hydrant. Work includes removal of the hydrant from its original location and reinstallation of existing hydrant, if traffic type, or installation of a new hydrant, furnished under (D), at new location. Work shall include installation of necessary fittings.
- C. ADJUST FIRE HYDRANT** - Work consists of adjusting fire hydrants to new grade at the existing location. Work includes removal of the existing hydrant and removal or addition of vertical pipe, and reinstallation of the existing hydrant, if traffic type, or installation of a new hydrant, furnished under (D), to new grade. Hydrant lowering may also require lowering of the dry well. However, when field conditions require lowering the connecting water line, Work shall be considered as "Relocate Fire Hydrant."
- D. FURNISH FIRE HYDRANT** - Existing fire hydrants to be relocated or adjusted, which are not traffic type or otherwise not suitable, shall not be reused. Work under this item consists of furnishing a new traffic type fire hydrant and reducer for use in completing the Work specified in (B) or (C). Work includes delivering the existing hydrant to the Bureau of Water Services property yard as directed, with a credit requisition furnished by the Engineer and approved by an authorized representative of the DC Water Utility Inspection Branch.
- E. CONVERT FIRE HYDRANT** - Work consists of replacing existing non-breakaway type fire hydrants with new traffic type fire hydrants at the original location and Elevation. Work includes the removal and hauling away of the existing hydrant, as specified in (D), and furnishing and installing a completely new hydrant.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 302: Valve Casing
- 305: Pipe Water Main – Ductile Iron
- 306: Gate/Butterfly Valves

Reference Codes and Specifications:

- AWWA C502: AWWA Standard for Dry-Barrel Fire Hydrants
- ASTM D 1682: Test Methods for Breaking Load and Elongation of Textile Fabric

### 307.02 SUBMITTALS

Shop drawings per 105.02 shall be submitted for hydrants and joint details.

Affidavits, certifications, catalog, and maintenance data shall be submitted per this section.

**307.03 MATERIALS**

- Fire Hydrants shall conform to the requirements of DC Water Standard Specifications Section 21 11 10.
- 803.02: Gravel for Dry Well – Grading No. 57 aggregate
- Filter Fabric – Woven filter fabric shall be composed of polypropylene monofilament yarns woven into sheets of approximately 16 mm thickness. The tensile strength of the fabric shall be per ASTM D 1682. The weave of the fabric shall be dense and tight so the openings are barely visible.

Test results shall indicate the filter fabric can effectively retain particles coarser than opening of U.S. 140-sieve mesh for all conditions.

Tests shall also demonstrate that the filter permeability is between 3.3 and 3.8 x 100 centimeters per second.

Filter fabric shall be manufactured by Mirafi Company or approved equal.

**307.04 CONSTRUCTION REQUIREMENTS**

Fire hydrant and dry well material, excavation, installation, and backfill shall be included in this Section. Fire hydrant connection pipe excavation and backfill shall be included as part of trench excavation per 207.

All related Work on hydrant water line including tests and chlorination shall be per applicable provisions of 305. Hydrants shall be set plumb with 4-1/2 inch nozzle normal to the curb line. When a hydrant is delivered with the nozzle facing in the improper direction, the hydrant shall be rotated to the correct orientation prior to placing the hydrant into service.

Joint and joint restraint between the boot and the connection pipe to the main shall be per 305.

Dry wells shall be excavated to dimensions as shown in the Contract Documents. Filter fabric shall be placed in the excavated dry wells' interior bottom, interior side walls, and placed on the top of the excavation, and secured around the hydrant's fittings before completing backfill.

Any items disturbed during construction, including shrubs and lawns, shall be restored by the Contractor upon completion of Work. Grassed areas shall be resodded per 607.02 as part of the Work.

**307.05 MEASURE AND PAYMENT**

The unit of measure will be each.

Payment for Set, Relocate, Adjust, Furnish and/or Convert Fire Hydrant will be made at the respective Contract unit price per each, which payment will include property restoration and sodding, and all labor, materials, tools, equipment, and incidentals needed to excavate, backfill, and complete Work specified.

The installation of a hydrant connection pipe, a gate valve, and a water valve casing will be paid under other Pay Items.

## **308 WATER SERVICE CONNECTIONS**

### **308.01 DESCRIPTION**

Work shall be per this Section, DC Water Standard Specifications Section 33 12 13, and the D.C. Plumbing Code and shall be performed by plumbers licensed in the District.

Where indicated in the Contract, water service components to abutting properties shall be adjusted, replaced and/or maintained for water service connection piping 2-inches in diameter and smaller, as needed to adapt water service connections to Project requirements. Work includes water service trench excavation and fill per 207 and restoration of landscape features to original condition and sodding per 607 and 608.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 212: Test Pits
- 305: Pipe Water Main – Ductile-Iron
- 607.02: Sod and Sodding with 3-Inch Topsoil

Quality Assurance – Reference Codes and Specifications:

- ASTM B 88-96: Seamless Copper Water Tube
- ASTM D 2146: Specification for Propylene Plastic Molding and Extrusion Materials
- ASTM D 2853: Standard Specifications for Reinforced Olefin Injection Molding and Extrusion Materials
- D.C. Plumbing Code

### **308.02 PERMITS**

The Contractor shall obtain a Water Excavation Permit from the Department of Consumer and Regulatory Affairs for each water service connection to be adjusted or replaced. The cost of permits will be at the Contractor's expense.

### **308.03 SUBMITTALS**

No submittals are required for this Work.

### **308.04 MATERIALS**

- 804.06: Size No. 57 or 67 Gravel
- 809.05 (E): Seamless Copper Water Tube
- Copper-to-Copper Couplings – Per D.C. Plumbing Code
- Copper-to-Non-Copper Couplings – Per D.C. Plumbing Code – 3/4 inch through 2-inch diameter
- Meter Yokes – Per D.C. Plumbing Code
- Reducers – Per D.C. Plumbing Code
- Angle Meter Stops – Per D.C. Plumbing Code
- Meter Valves – Per D.C. Plumbing Code

Curb Stops – Bronze alloy, with body and key precision, fitted and lapped as a pair for a precision seal, inverted key or solid tee-head style. Mueller Inverted Key or Tee-Head curb stops are acceptable or approved equivalent.

Curb Stop Boxes – Curb stop boxes shall be of the telescoping, 2 piece, and screw style. The lower section shall consist of a full externally threaded shaft over a Buffalo style bell that is arched and flanged. The upper section shall consist of a full internally threaded shaft that fits

over the lower section, with a cast iron rim on top of the shaft, accommodating a cast iron cover (lid) with "WATER" imprinted as specified.

Both the lower and upper section of the curb stop box shall be rigid acrylonitrile-butadiene - styrene (ABS) plastic, either injection molded or extruded per ASTM D 1788, with test specimens molded by the injection process in accordance with Recommended Practice D1897.

The cast iron lid and rim shall be of the standard Buffalo new style design with standard pentagon head bolt and shall be interchangeable with the old style cast iron Buffalo boxes already in use.

The Series 250 Screw Type curb stop box made by Bingham & Taylor, Culpeper, Virginia is approved as an acceptable equivalent.

Meter Boxes – Meter boxes shall be of durable, high density polyethylene, molded with solid walls (containing no foam or corrugations) and shall have flanged bottom not only for added strength but also to retard settling or sinking into the ground. The nominal wall thickness of the box shall not be less than 0.3 inch and the box shall have nominal dimensions of 20 inches in diameter by 30 inches in depth. Other sizes may be used, if needed, for larger settings.

The polyethylene (PE) plastic material specified for the box shall be Type III or Type IV High Density polyethylene per ASTM D 1248, with densities of 0.95 g/cc and above, as determined by the ASTM D 1505 test method. The interior color of the box shall be white (natural) to aid in meter reading, but the exterior shall be black, compounded to improve strength and to protect against deterioration below ground. The low temperature brittleness shall be a maximum of -76 degrees Fahrenheit per ASTM D 746. The vertical crushing strength, which is a measure of the magnitude of static vertical pressure a meter can withstand, shall be 3000 lbs. minimum.

A meter box such as MS 2030B, manufactured by Mid-States Plastics, Inc., Lexington, Kentucky, is acceptable or approved equal.

Meter box frames and covers to be used in conjunction with the meter boxes specified above shall be cast iron, Type A made by Meter Box Covers, or approved equal, having 1 1/2 inch clear openings with a bronze pentagon nut (standard size) swaged to an iron locking worm gear. The meter box frames and covers shall be made of gray cast iron treated with a coal tar epoxy coating, and the covers shall be labeled with a "WATER METER" imprint as specified.

### 308.05 CONSTRUCTION REQUIREMENTS

**A. NOTIFICATIONS** - Property owners/tenants shall be notified at least forty-eight (48) hours in advance of the Contractor's intent to work in their front yards in public space and the Contractor shall assure owners that disturbed property will be restored to its original condition, as shown in preconstruction photographs, upon completion of Work.

**B. WORK ON PRIVATE PROPERTY** - In general, most water service building connection work is in public space. The Contractor shall locate all existing water service piping and may be required to conduct some Work on private property. The Contractor shall obtain written approval from property owners before disturbing any private property and shall submit a copy of the approval to the Engineer. The Contractor shall make no claim for any time delay associated with obtaining permission to work on private property.

The District assumes no responsibility for any Work or trespass on private property.

**C. MAINTAINING WATER SERVICE** - Existing water service shall, in general, be kept in service until transfer connections are made. Existing water service will then be discontinued from the old water main, service pipe will be disconnected from the corporation cock on the old main by the Contractor or abandoned in place as directed, the service pipe shall then be adjusted or replaced as specified herein and connected to the new main by the Contractor within the time limits specified herein.

The Contractor shall contact the DC Water Manager, Distribution Division two (2) weeks prior to proposed scheduling of water service work. The Contractor shall coordinate his water service work with water main tap and any required meter relocation or new meter installation by the District.

No more than 3 separate shutoffs will be permitted for any single water service connection, and the duration of each shutoff shall not exceed two (2) hours, except in an emergency when the Engineer will grant a time extension. The Contractor shall give sufficient, advanced written notice to the Engineer, of the starting time and duration of proposed shutoff sufficiently in advance to provide for emergency water supply.

If the proposed shutoff time conflicts with essential consumer use, it shall be rescheduled to alleviate interference. The Engineer will determine the action to be taken for essential consumer use requests.

Overtime, weekend and holiday work may be ordered by the Engineer to promptly complete temporary and/or permanent water service.

- D. WORK BY DISTRICT** - DC Water will furnish and install DC meters at no cost to the Contractor. For privately owned meters (2-inch and smaller diameter water service, installed and owned by private parties), the District will either make the necessary adjustments or will make arrangements for the owner to do so. District Work includes connecting the meter at couplings to the existing meter yoke or new meter yoke furnished and installed by the Contractor. The Contractor shall furnish and install pipe, couplings, meter housings, frame, and cover and meter housing gravel foundation.

The District will make all new water service connection taps at the water main, and will make tap removals from the old main where indicated at no cost to the Contractor.

Where any unmetered water service is encountered, meters will be installed in public space by DC Water.

Wherever an existing meter is located on private property or inside the building, the District will relocate said meter in public space.

- E. PRECONSTRUCTION PHOTOS** – A minimum of 2 preconstruction photographs shall be taken of each property where water service will be adjusted or replaced. These photographs are in addition to, and shall meet the same requirements of 108.08. Views shall be taken as directed to show preconstruction existing conditions at each property within the area associated with the Work.
- F. ADJUST WATER SERVICE PIPE** - Work consists of adjusting water service connection pipe due to new water main work that affects water service.

If existing water service piping is copper with not less than 1-inch diameter and enough slack exists in the piping, the existing piping shall be connected to the new main without replacing any piping.

However, if the Engineer determines that slack is insufficient or pipe cannot be bent by approved means to meet new corporation cock, adjustment under this subsection will not be feasible, and a section of pipe shall be replaced per subsection (G) herein.

Work consists of trench excavation as needed within the street including excavation, backfill, and compaction for District Work to abandon old tap and install new tap, per 207, adjusting existing 1-inch through 2-inch diameter copper service pipe to bring pipe to the connection point at new corporation stop in main, making the connection at tap, backfilling, and compaction.

The backfilled street area shall receive temporary asphalt patching per 405.

- G. REPLACE WATER SERVICE PIPE** - Work consists of replacing water service connection pipe in the vicinity of and/or due to new water main work and/or new sewer work. Work shall meet requirements of Standard Drawing 308.01.

If the existing water service piping is copper, is not less than 1-inch diameter, and slack in the existing piping is insufficient to connect it directly to the new main, or else pipe cannot be bent by approved means to meet new corporation stop, the Contractor shall cut the pipe at a point behind the curblines as directed, install a new single section of same size copper pipe between the corporation stop (tap) and existing pipe, and connect new-to-existing water service pipe with a compression coupling.

However, if the point where existing pipe is to be cut is within 5 feet of the meter, unless otherwise directed by the Customer Service Manager, Meter Operations the entire length between the new main and the meter shall be replaced with copper pipe not less than 1-inch diameter; pipe shall be continuous with no joints, couplings, or fittings. Existing copper piping, if 1-inch minimum, between meter and property line shall remain. No curb stop will be required.

If the existing water service piping is not copper, or is copper pipe less than 3/4-inch diameter, the Contractor shall replace the water service piping (with a single section of copper pipe not less than 1-inch diameter with no joints, couplings, or fittings) from the new main to the meter, and from the meter to:

1. The property line, along with a curb stop and curb stop box at the property line, if there is no building projection (areaways, steps, porches, bay windows, etc.) into public space.
2. The face of building projection, along with a curb stop and curb stop box close to the face of projection, when projection occupies public space.

Replacement piping shall be the same size as piping replaced except that all existing 3/4-inch or smaller non-copper piping shall be replaced with 1-inch copper piping.

In such case where the new copper pipe between main and meter will be 1-inch diameter, but existing service between meter and dwelling is lead or galvanized pipe, the District will provide a new 1-inch meter, and the Contractor shall install 1-inch copper pipe between meter and property line (or building projection) along with a curb stop, curb stop box, and compression coupling and reducer at the property line.

Work consists of trench excavation of dimensions as directed to allow sufficient space for meter and meter box replacement per 207,

and preparation of new meter pit subgrade and gravel foundation, tunneling where feasible under curb/gutter, copings, walks, etc., removal and disposal of old service pipe and fittings, if needed, and, otherwise, abandonment (crimp ends) of existing pipe in-place, removal of top section of curb stop and box if present and abandonment of lower portion, installing new pipe and new riser pipe, providing new meter yoke with meter stop or meter valves and couplings, new meter box, and new frame and cover, connections at meter yoke, making connection at tap, curb stop and property line, backfilling and compaction, restoration of surface features including sodding per 607.02 and incidental work to restore water service.

A curb stop box shall be set plumb over the curb stop so that the stop is centered within the box. The top section of the box shall be rotated so that the box cover will be flush with the finished ground surface. Backfill shall be carefully placed to avoid disturbance of curb stop or curb stop box.

Work includes any excavation, backfill, and compaction for District Work at tap.

If the District determines that a meter requires relocation or a new meter is needed, the Contractor shall cut service pipe at a location as directed, provide new pipe, meter yoke and couplings, meter ox, frame and cover, and coordinate Work with meter installation by the District. If meter and housing adjustments in-place are needed, the Contractor shall furnish and install new pipe and couplings.

Work consists of trench excavation per 207 and preparation of new meter pit subgrade and gravel foundation, new pipe, and couplings as needed to meter yoke and to reconnect service in old meter location, providing new meter yoke with meter stop or meter valves and couplings, connecting meter yoke to service piping, backfill and compaction, restoration of surface features including sodding per 607.02, and incidental work to restore water service, after District installation of meter.

**H. RESTORATION** - Any items disturbed during construction including walls, fences, shrubs and lawns shall be restored by the Contractor upon completion of Work. Grassed areas shall be resodded as part of Work per 607.02.

Any paved areas removed within water service trench limits shall be patched with asphalt per 407.

### **308.06 MEASURE AND PAYMENT**

The unit of measure for adjust water service pipe will be each. Payment for adjust water service pipe will be made at the Contract unit price per each, which payment will include excavation or tunneling as needed, including excavation to abandon old tap, adjusting service piping, and connecting to new corporation stop in new main, backfill, compaction (excluding temporary asphalt patching which will be measured and paid separately), and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

The unit of measure for Replace Water Service Pipe will be the linear foot. Payment for Replace Water Service Pipe will be made at the Contract unit price per linear foot of pipe in place complete, which payment will include photographs, excavation, allowance of 2 linear feet for meter yoke, couplings, and riser pipe when needed, backfill and compaction, including backfill for meter pits and curb stop boxes (excluding Temporary Asphalt Patching, which will be measured and paid separately), replacing service piping, connections at corporation stop in new main, at water meter, at curb stop, and at connection and reducer as needed to connect to existing service pipe at property line, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified. Property restoration and sodding shall also be included if not included in 308.04 (H). Payment will be based on pipe in place, whether in open cut or in tunnel.

The unit of measure for Furnish and Install Curb Stop/Curb Stop Box will be each. Payment for Furnish and Install Curb Stop/Curb Stop Box will be made at the Contract unit price per each combined unit complete in place, which payment will include curb stop, curb stop box and its adjustment, securing cover, leakage test, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified. Trench excavation and backfill will be included in Replace Water Service Pipe work.

The unit of measure for Furnish and Install Water Meter Box, Frame and Cover will be each. Payment for Furnish and Install Water Meter Box, Frame and Cover will be made at the Contract unit price per each, which payment will include furnishing and placing meter pit foundation gravel, furnishing and installing water meter boxes, frames and covers, coordination with District installation of meters, and all labor, tools, materials, equipment, and incidentals needed to complete the Work specified. Property restoration and sodding shall also be included, if required, and there is no Adjust or Replace Water Service Pipe Pay Item.

## 309 SEWER MANHOLES

### 309.01 DESCRIPTION

Work shall conform to DC Water Standard Specifications Section 33 19 10.

Work consists of excavation, backfill, and compaction beyond trench pay limits, furnishing and placing manholes complete, either over existing or new sewers, including concrete base and manhole frames and covers. Manhole risers shall, in general, be constructed of precast concrete elements unless otherwise specified. Brick masonry may be used in lieu of precast riser units for conditions as approved by the Engineer.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 314: Pipe Sewer
- 317: Sewer/Water Formwork Construction
- 318: Reinforcing Steel – Sewer/Water Work
- 320: Sewer/ Water PCC Construction

Reference Codes and Specifications:

- ASTM A 48: Standard Specification for Gray Iron Castings
- AASHTO M 91: Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
- AASHTO M 315: Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- AASHTO M 199: Standard Specification for Precast Reinforced Concrete Manhole Section
- ASTM C 32: Standard Specifications for Sewer and Manhole Brick (made from clay or shale)
- ASTM C 443: Specifications for Joints for Circular Concrete Sewer and Culvert pipe, using Rubber Gaskets
- ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Sections

### 309.02 SUBMITTALS

Shop drawings per 105.02 shall be submitted for precast risers, cast iron frames, and covers.

### 309.03 MATERIALS

Materials shall conform to DC Water Standard Specifications Section 33 19 10.

### 309.04 CONSTRUCTION REQUIREMENTS

Sewer Manhole construction shall conform to the requirements of DC Water Standard Specifications Section 33 19 10.

### 309.05 MEASURE AND PAYMENT

The unit of measure for manholes on sewers 48-inches diameter or less will be the vertical linear foot, with measure taken from sewer outlet invert to top of frame for manholes over existing or new sewers. Payment for Precast Sewer Manhole and Brick Sewer Manhole will be made at the respective Contract unit price per vertical linear foot, which payment will include excavation, shoring, and backfill beyond trench pay width for manholes over new sewers; excavation, shoring, and backfill for manholes over existing sewers; furnishing and placing precast or cast-in-place reinforced concrete manhole base on all sewers 48-inches diameter or less, precast or brick manhole risers, precast reinforced concrete slab or eccentric cone top, brick masonry to adjust manhole frames and covers to correct grades; furnishing and placing manhole frames and covers, furnishing and placing manhole steps, maintaining sewer service, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

The unit of measure for manholes on sewers larger than 48-inches diameter will be the vertical linear foot, with measure taken from the sewer outlet invert to the top of frame. Payment for Reinforced Concrete Base for sewer manholes on sewers larger than 48-inches diameter will be made at the Contract unit price per each, which payment will include excavation, shoring, and backfill beyond trench pay width for manholes over new sewers; excavation, shoring, and backfill for manholes over existing sewers; furnishing and placing reinforced concrete manhole base; furnishing and placing pipe that protrudes into the manhole base; furnishing and placing manhole steps; maintaining sewer service, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

The unit of measure for the complete Reinforced Concrete Base for manholes on sewers larger than 48-inches diameter will be each.

The unit of measure for Replacing Manhole Invert will be each. Payment for Replace Manhole Invert will be made at the Contract unit price per each, which payment will include removal of existing invert, reshaping new invert, disposal of unusable materials, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.



## 310 CATCH BASINS AND CONNECTING PIPE

### 310.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specifications Section 33 44 00.

Work consists of excavation and backfill, disposal of excess excavated material, furnishing all materials, and constructing various types and sizes of reinforced concrete catch basins and connecting pipe to manholes complete as shown in the Contract Documents or as directed.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation
- 309: Sewer Manholes
- 314: Pipe Sewer

Reference Codes and Specifications:

- AASHTO M 111-03: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- AASHTO M 170-02: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- AASHTO M 315-03: Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe
- AASHTO M 199-99: Standard Specification for Precast Reinforced Concrete Manhole Sections
- ASTM A 36: Specification for Structural Steel
- ASTM A 48: Standard Specification for Gray-Iron Castings
- ASTM C 33: Specification for Concrete Aggregates
- ASTM C 478: Standard Specifications for Precast Reinforced Concrete Manhole Sections

### 310.02 SUBMITTALS

Shop drawings per 105.02 shall be submitted for reinforcing steel layout, reinforced concrete pipe, water seal casting, catch basin tops, and catch basin frames and covers.

### 310.03 MATERIALS

Materials shall conform to DC Water Standard Specifications Section 33 44 00.

### 310.04 CONSTRUCTION REQUIREMENTS

Excavation for catch basins and connecting pipe shall include removal of all materials and objects of whatever nature encountered in excavation, disposal of excavated materials as specified, construction, maintenance, and subsequent removal of any sheeting, shoring, and bracing, dewatering and precautions, and Work necessary to prevent damage to adjacent properties resulting from this excavation.

No excavated material shall be deposited at any time so as to endanger portions of the new or an adjacent structure, either by direct pressure or indirectly by overloading banks contiguous to the operation, or in any other manner. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of construction. If the area within Project limits is insufficient for stockpiling, the Contractor shall arrange for his own stockpiling area.

If the foundation becomes wet and spongy or otherwise unsatisfactory prior to placing PCC, the Contractor shall, at no additional cost to the District, remove the unsuitable material and replace it with size No. 57 gravel per 804.06 to secure an adequate foundation.

In case of underground obstruction at planned locations, proposed basins or connecting pipe shall be relocated as directed. Excavations at obstructed locations shall be backfilled per 207. Payment for excavation and backfill at obstructed locations will be made per 207.

Inlets may be either cast-in-place or precast; precast basins require advance approval. Outlet pipe shall project from the inlet

sufficiently to permit junction with connection pipe, and shall be cut flush with the inlet wall inside face; void between outlet pipe and wall shall be completely sealed on both sides of wall with non-shrink mortar. Water seal per 815.04 shall be aligned on same centerline as the outlet pipe.

If a catch basin is to connect to a combined system sewer, an approved water seal casting shall be installed in the basin wall, aligned on the same centerline as outlet pipe, and connected to the inlet connection pipe.

Trench excavation and backfill for basin connecting pipe per 207 shall be included as part of Work. If trench subgrade material is unsuitable, trench bottom shall be undercut and backfilled per 207.06(A); measure and payment shall be made per 207.06(B).

All connecting pipe shall be included as part of Work and shall be constructed as shown in the Contract Documents. All connecting pipe shall be furnished with rubber gaskets and the required concrete cradle with saddle blocks and mortar joints. Construction shall be per 314.04(D). Field leakage test is not required for storm drain pipe.

PCC Cradle shall meet the requirements for Class G PCC per 817.01. PCC shall cure for at least four (4) days prior to backfilling.

Where PCC pipe connects to existing clay pipe or to a water seal, a Class B PCC collar shall be constructed around the connection joint such that there is at least 3 inches collar thickness around the entire circumference of the joint. The collar shall overlap each side of joint by 6 inches. Collar shall cure for at least four (4) days prior to backfilling.

Connecting pipe trench shall be backfilled per 207.07(A).

Basin tops shall be precast with cast iron frames and covers as shown on the Contract Documents and Standard Drawings.

Basin tops and openings should be aligned parallel with roadway profile grade. Catch basin bottom shall be installed with no slope.

The basin top shall have 4 holes drilled or cast therein. Corresponding holes shall be drilled into the basin walls. Steel dowels shall be inserted through and into these holes and grouted to prevent lateral movement of top.

### **310.05 MEASURE AND PAYMENT**

The unit of measure for the various types and sizes of Catch Basins will be each.

The unit of measure for Basin Connecting Pipe will be the linear foot, measured from the inside face of catch basin or water seal to inside face of manhole, or to connection to existing connecting pipe.

Payment for the various types and sizes of Catch Basins will be made at the respective Contract unit price per each, which payment will include water seal castings, frames and covers, excavation and backfill, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for 15-inch and 18-inch Basin Connecting Pipe will be made at the respective Contract unit price per linear foot, which payment will include excavation for pipe and backfill, saddle blocks and concrete cradle, concrete collars at connection to existing clay pipe, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## **311 ADJUSTING MANHOLES AND ADJUSTING, REBUILDING, AND REPLACING CATCH BASINS**

### **311.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 19 14.

Work consists of adjusting and resetting existing sewer manhole frames and water valve casings to approved grade, adjusting drop inlet frames, standard basin tops and elongation tops to approved grade, furnishing basin tops and manhole frames and covers to replace units made unusable from conditions beyond the Contractor's control, repairing and modifying various types of sewer structures and manholes, and removal and disposal of excess materials.

Work includes adjusting or resetting, during emergencies only, existing PEPCO, DC Water, Verizon, Washington Gas Company, and Western Union utility manhole frames or similar structures to new grade; normally the respective utility will perform this Work at no expense to the Contractor. If private utility manhole frames or covers are unusable from conditions beyond the Contractor's control, replacement units will be furnished by the respective utility company at no expense to the Contractor.

### **311.02 MATERIALS**

Related Work specified elsewhere may include but is not limited to:

- 817: PCC, Class B
- 822.04: Precast PCC Manhole Rings
- 812.02: Reinforcing Steel, Grade 60
- 806:01 (A): Brick
- 815.01 (A): Steel Channels
- 815.04: Cast Iron Frames, Covers
- 806.05 (B) (4) and (5): Mortar
- 407: Temporary Asphaltic Concrete
- 822.05 (B): Manhole Adapter Rings

### **311.03 ADJUST MANHOLE FRAMES/DROP INLET FRAMES**

When an existing roadway is to be removed and rebuilt, water valve casing frames and sewer manhole frames shall be adjusted to proper grade either by the removal or addition of up to 3 full courses of sewer brick, or precast ring plus brick, and/or 2 precast PCC rings for water valve casings. Inlet frames shall be adjusted by removal and/or construction of inlet walls up to 8 inches high.

Manhole and inlet frames, grates, and covers shall be removed, stored for reuse, and reset with mortar.

Work may also involve adjusting private utility frames in an emergency.

Payment for excavation and pavement replacement surrounding the frame will be made under applicable Pay Items.

Manhole frames adjusted in flexible pavement areas shall be provided with a PCC collar of sufficient horizontal dimensions to provide a minimum width of 9 inches outside the frame flange, square in section, and to a depth equal to the asphaltic concrete base being placed but not less than 6 inches.

Payment for the PCC collar will be made under cubic yards of PCC Base with a minimum of 1/4 cubic yard of concrete allowed for each manhole.

### **311.04 RESET MANHOLE FRAMES/DROP INLET FRAMES**

When the Roadway is to be salvaged, Work consists of resetting sewer manhole frames, water valve casing frames and storm inlet grate frames by cutting and removing a rectangular section of existing paving to provide 9 inches width between frame flange edge and cut line;

adjusting frame to grade and soils for base if needed per 203.02; and furnishing and placing PCC base as a collar around adjusted frame to depth of existing base but not less than 6 inches depth. Work includes resetting private utility frames during emergencies. Units damaged due to the Contractor's operations shall be replaced at the Contractor's expense.

When traffic must be maintained, steel plating per 612.19 placed over the reset frame shall be used as directed as part of Work. Plates shall be maintained and removed when directed. They shall be of adequate size and positioned to provide bearing along each side of the plate of at least 6 inches between plate edge and cut edge. If the plate deflection under traffic alters the frame position, repair shall be at the Contractor's expense.

### **311.05 ADJUST STANDARD BASIN TOPS/ELONGATION TOPS**

Work consists of removing catch basin tops, cutting down basin and elongation walls not more than 8 inches as needed, mortaring and/or placing up to 3 full courses of brick, and reinstalling tops to meet approved line and grade, and to provide firm, even bearing for tops.

### **311.06 FURNISH INLET FRAME AND MANHOLE FRAME UNITS**

Work consists of furnishing storm inlet frame and grate units, basin tops of various size, and sewer-water manhole frame and cover units to replace units made unusable from conditions beyond the Contractor's control; Work also includes furnishing water valve casing frames and covers to replace obsolete conic water valve frames encountered.

Placement of furnished units will be included in applicable adjust and reset Pay Items.

### **311.07 MANHOLE ADAPTER RINGS**

Work consists of furnishing and placing cast iron adapter rings to bring manhole covers to approved grade. Rings shall be set just prior to placing asphalt pavement. Manhole cover seat of frame shall be cleaned just prior to setting ring.

Rings shall be either clamped or tack welded to the frame when improper seating is evident.

### **311.08 REBUILD SEWER-WATER MANHOLES AND STANDARD BASINS**

Where the grade differential is such that manholes and standard basins cannot be adjusted or reset as directed in 311.04 and 311.05, they shall be rebuilt as follows:

Work under (A), (B) and (C) includes excavation and disposal of excess materials, furnishing of brick, PCC, PCC rings, reinforcement, and backfill and compaction as appropriate per 207 and other incidental Work. Existing frames and covers shall be reused where practicable. Construction shall be in conformance with 302, 309 and 310.

- A. WATER VALVE CASINGS** - Where more than 2 precast rings are required, additional rings shall be added and payment limit will be the bottom of the lowest PCC ring set. Construction shall be per 302.
- B. SEWER MANHOLES** - Where more than 3 full courses of brick are required, or where a manhole is to be lowered, the manhole shall be removed to the bottom of the cone or tapered section, or lower if necessary. The manhole shall then be rebuilt to the new Elevation, providing a full 4 foot tapered section. Construction shall be in conformance with 309.
- C. STANDARD BASINS OR ELONGATIONS** - Where basin and elongation walls have to be cut down more than 8 inches, elongations shall be removed completely and replaced by double/triple basins, and existing basins shall be cut down and rebuilt with Class B concrete per 817 to new Elevations as shown on the Contract Drawings or as directed.

### **311.09 REPLACE BASINS**

Work consists of the complete removal of existing standard or elongated basins and the construction, in its entirety, of new double or triple basins at the same location. Work includes excavation and disposal of the existing basin and excess materials and construction of the new basin in accordance with 310 and backfilling.

When removing the existing basin, care shall be exercised to ensure that the connecting pipe entering the basin is not damaged. Pipe damaged due to the Contractor's operations and considered suitable for the final installation shall be replaced at his expense. Sections of connecting pipe deemed to be unsuitable for the final installation shall be replaced under the Basin Connect Pipe Pay Item per 310.

**311.10 MEASURE AND PAYMENT**

The unit of measure for items except Rebuild Sewer-Water Manholes and Rebuild Standard Basins and Elongations will be each. The unit of measure for Rebuild Sewer-Water Manhole will be the vertical linear foot, with measure taken from the lowest point of new construction to the top of the manhole frame. The unit of measure for Rebuild Standard Basin or Elongations will be the cubic yard with measure taken from the lowest point of new construction.

Payment for Adjust Manhole/Drop Inlet Frame, Reset Manhole/Drop Inlet Frame, Adjust Standard Basin Top/Elongation Top, Furnish Inlet Frame, Furnish Basin Top, Furnish Manhole Frame, and Manhole Adapter Ring, will be made at the respective Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for Rebuild Sewer-Water Manholes will be made at the Contract unit price per vertical linear foot. Payment for Rebuild Standard Basins or Elongations will be made at the Contract unit price per cubic yard which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for Replace Existing Basin with Double (or Triple) Basin and Replace Existing Basin with Double (or Triple) Type 'S' Basin will be made at the respective Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete the Work specified.

## 312 REPLACING SEWER/WATER MANHOLE FRAMES AND BASIN TOPS

### 312.01 DESCRIPTION

- A. REPLACE SEWER AND WATER MANHOLE FRAMES** - Work consists of replacing damaged or deteriorated sewer or water manhole frames and concrete rings.
- B. REPLACE OLD STYLE (CONICAL SHAPED) WATER VALVE CASTINGS** - Work consists of the replacing of the old style (conical shaped) water valve castings, encountered within the Project limits, with standard valve casing elements.
- C. REPLACE STANDARD BASIN TOPS** - Work consists of furnishing a new Standard Basin Top, when the existing top requires replacement due to damage not caused by the Contractor's negligence.

### 312.02 MATERIALS

Related Work specified elsewhere may include but is not limited to:

- 806.01 (A): Brick
- 806.05 (B) (4) and (5): Mortar
- 817: PCC, Class B
- 812.02: Reinforcing Steel, Grade 60
- 815.04: Manhole Frames and Covers
- 822.04: Precast PCC Risers and Cone Tops
- 802.04: Rapid Setting Emulsified Asphalt

### 312.03 CONSTRUCTION REQUIREMENTS

- A. REPLACE SEWER AND WATER MANHOLE FRAMES** - The method of construction shall be as specified in 311.

All new materials shall be furnished by the Contractor. Work includes replacing the cut out pavement with PCC base in accordance with 505.

- B. REPLACE OLD STYLE (CONICAL SHAPED) WATER VALVE CASTINGS** - Old style (conical shaped) water valve castings shall be removed and disposed of.
- C. REPLACE STANDARD BASIN TOPS** - Precast basin tops shall be constructed to the dimensions and details shown in the Contract Documents.

The method of construction shall be per 311.

### 312.04 MEASURE AND PAYMENT

- A. REPLACE SEWER AND WATER MANHOLE FRAMES** - The unit of measure for Replacing Sewer and Water Manhole Frames will be each.

Payment for frames furnished and placed will be made at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

- B. REPLACE CONICAL SHAPED WATER VALVE CASTINGS** - The unit of measure will be each.

Payment for Conical Shaped Water Valve Castings replaced will be made at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified. Payment includes replacement of pavement complete.

**C. REPLACE STANDARD BASIN TOPS OR ELONGATION TOPS** - The unit of measure will be each.

Payment for Basin Tops or Elongation Tops furnished and placed will be made at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

### **313 ABANDONING SEWER FACILITIES**

#### **313.01 DESCRIPTION**

Work consists of abandoning catch basins and storm inlets, and their connecting pipes, and sewer manholes either by removal, partial removal, bulkheading, or any combination thereof. Work includes excavation per 207, disposal of unusable materials, bulkheads, and backfill and compaction.

#### **313.02 MATERIALS**

Related Work specified elsewhere may include but is not limited to:

- 806.01 (A): Brick
- 817: PCC, Class B
- 806.05 (B) (4): Mortar

#### **313.03 CONSTRUCTION REQUIREMENTS**

Portions of catch basin connecting pipe, manholes, and storm inlets within 3 feet below approved Roadway Subgrade shall be totally removed. Catch basins outside the Roadway shall be totally removed to a level at least 8 inches below Subgrade; all trash and debris in the storm inlet chamber shall be removed; the basin bottom shall be broken to provide drainage as directed. Portions of sewer facilities lower than 3 feet below Subgrade shall be abandoned in place. Open ends of abandoned sewer pipes and connecting pipes shall be bulk headed at manholes, at catch basins, and at inlet chambers by either 9 inch thick masonry in 36-inch diameter and larger openings and 9 inch thick brick masonry or PCC of approved mix design per 817.01 in smaller size openings. Work includes backfill with Embankment fill and its compaction to Subgrade per 203. Abandoned manholes shall be backfilled with Embankment fill. Usable pre-cast basin tops, manhole frames and covers, basin seal castings, and precast sewer manhole units shall be removed from abandoned utilities with care and reused or delivered to a designated District Property Yard as directed. Unusable items shall be included in disposal.

#### **313.04 MEASURE AND PAYMENT**

The unit of measure for Abandoning Sewer Facilities will be each.

Payment for Abandon Basin Connecting Pipe, Abandon Sewer Manhole, and Abandon Storm Inlet will be made at the respective Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals needed to complete Work specified.



## **314 PIPE SEWER**

### **314.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 19 00.

Work consists of furnishing and placing reinforced PCC pipe and PVC pipe sewers, and all associated Work for a complete operable pipe system.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 309: Sewer Manholes
- 315: Pipe Sewer TV Inspection

Reference Codes and Specifications:

- AASHTO M 6: Fine Aggregate for Portland Cement Concrete
- AASHTO M 80: Coarse Aggregate for Portland Cement Concrete
- AASHTO M 170: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- AASHTO M 315: Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets
- ASTM D 3034: Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- ASTM D 3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- ASTM F 679: Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
- ASTM F 789: Specification for Type PS-46 Polyvinylchloride, (PVC) Plastic Gravity Flow Sewer Pipe and Fittings
- ASTM F 794: Poly (Vinyl Chloride) (PVC) Profiled Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
- ASTM C 76: Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
- ASTM C 443: Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets

Trench excavation and backfill are separate Pay Items from sewer pipe work, except for reinforced basin connections (see 310).

### **314.02 SUBMITTALS**

Shop drawings per 105.02 shall be submitted for pipe laying schedule, fittings, specials and bevel pipe.

### **314.03 MATERIALS**

- 808.01(B): PCC Pipe
- 808.02(A): PVC Pipe
- 806.05(B) (4): Joint Mortar
- 808.02(G): Pipe Bedding, Grading No. 57

### **314.04 CONSTRUCTION REQUIREMENTS**

Pipe Sewer construction shall conform to DC Water Standard Specifications Section 33 19 00, except that trench excavation and backfill shall be per 207. The Engineer shall retain all rights to inspect and approve all Contract Work. Where Work is noted in DC Water Standard Specifications Section 33 19 00 to be performed at no cost to DC Water, said Work shall be performed at no cost to the District.

**314.05 MEASURE AND PAYMENT**

The unit of measure for Pipe Sewer will be the linear foot, with measure taken along the top of the pipe complete in place, measured to inside face of sewer manhole. If profiles are included in the Contract Documents, they are approximate and any variation shall not be a basis of any claim for compensation above that provided by direct measure.

Payment for the various types, classes and sizes of Pipe Sewer will be made at the respective Contract unit price per linear foot complete in place, which payment will include furnishing and placing required pipe, bedding, jointing, maintaining sewer service, leakage tests, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## **315 PIPE SEWER TV INSPECTION**

### **315.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 01 30, 33 01 31 & 33 01 32.

Work consists of furnishing all materials, labor, supervision, and equipment for the television inspection of existing and new pipe sewers and building sewers. Pipe sewer refers to the following types: storm sewer, sanitary sewer, and water sewer.

Related Work specified elsewhere may include but is not limited to:

- 309: Sewer Manholes
- 314: Pipe Sewer

Quality Assurance:

- Experience – Television inspection work shall be performed by a Contractor who is regularly engaged in work of the character required.
- Equipment – All equipment, devices, and tools required for the Contract shall be owned (or leased) and operated by the TV inspection Contractor.

### **315.02 SUBMITTALS**

Before commencing Work, the Contractor shall submit to the District for approval: specific documentation, information, and references that the TV inspection contractor and the on-site supervisor for the Work have had successful experience in similar work under similar conditions.

Detailed written descriptions, including pertinent supplemental drawings, literature, tables, and other material, of equipment, methods, procedures, and scheduling proposed for the Work.

A television inspection log shall be maintained during the television inspection work. This log shall be on a printed form and shall include the following:

1. Job/work assignment number
2. Date of inspection
3. Location and identification of sewer section televised
4. Size and type of pipe
5. Length of sewer section televised
6. Locations of all service connections
7. Locations of all structural problems encountered such as cracked or broken pipe, offset or open joints, protruding service connections
8. Sags (including length and estimated depth)
9. Incidence of root intrusion
10. Areas where further cleaning is required
11. Recommendation of lining requirement
12. Locations of service connections shall be referenced by horizontal distance from identified manhole and circumferential position with respect to pipe axes.

A summary report shall be submitted to the Engineer within ten (10) days of the conclusion of TV inspection work including copies of all television inspection logs. The report shall be neatly bound in a protective cover.

Digital files shall be submitted to the Engineer within ten (10) days of the conclusion of field work.

**315.03 EQUIPMENT**

Television Inspection Equipment – Refer to DC Water Standard Specifications Sections 33 01 30, 33 01 31 & 33 01 32.

**315.04 EXECUTION**

- A. TV INSPECTION** - The interior of new pipe sewers and the interior of existing pipe sewers and building sewers shall be visually inspected, as directed by means of closed circuit television, in the presence of the Engineer.

Inspection for all sewers up through 36-inches diameter shall be performed by moving the camera through the line along the axis of the pipe in either direction at a uniform slow rate by remote means, stopping at each joint or defect to allow adequate evaluation by the Engineer. For sewers 42-inches diameter and larger, camera movement shall be on a “hand held” basis.

The Engineer shall have access to the television monitor and all other operations at all times. The Contractor shall provide space for 2 District personnel at the same time in the trailer.

Picture quality and definition shall be as approved by the Engineer. If unsatisfactory, the Contractor shall remove equipment, replace it with satisfactory equipment and repeat the inspection at no additional cost to the District.

The Contractor shall make visual (with audio) digital recordings of each sewer inspection. Date, station (distance from manhole) and manhole identification shall be visually displayed at all times.

All points of interest, including all obstructions, broken pipe, and other problems, shall be indicated via audio during inspection.

Throughout the television inspection activities, the District reserves the right to alter the speed at which the camera is moved through the sewer. Should the quality of the television picture fail to provide a clear view of the entire sewer, the Contractor shall make appropriate adjustments in his monitoring equipment or discontinue Work until the Engineer agrees that an acceptable picture has been obtained. Telephones or other suitable means of communication shall be set up between the 2 winches and the control monitor to coordinate the Work.

Should the camera become stuck in the sewer, the Contractor will be responsible for its removal at no additional cost to the District.

- B. SAFETY** - The Contractor is responsible for safety of personnel and the public during the Contract period. The Contractor shall provide all devices, material, and equipment necessary to assure the safety and health of personnel and the public.

**315.05 MEASURE AND PAYMENT**

The unit of measure will be lump sum, with no direct measure taken, or per linear foot as provided in the Schedule of Prices and the Contract.

Payment for Pipe Sewer TV Inspection will be made at the Contract lump sum price, or Contract unit price per linear foot, as specified, which payment will include preparation of logs for all sections inspected, television equipment, and a complete digital file of each section, and all labor, materials, tools, equipment, and incidentals needed to perform television inspection as specified.

## 316 BUILDING SEWER CONNECTIONS AND CLEANOUTS

### 316.01 DESCRIPTION

Work shall be per this Section, DC Water Standard Specifications Section 33 01 34, and the D.C. Plumbing Code and shall be performed by plumbers licensed in the District. In case of discrepancy between this Section and the D.C. Plumbing Code, this Section governs.

Where indicated in the Contract or directed, building sewers from abutting properties shall be replaced, extended, and/or reconnected to the public sewer to restore full permanent service. Work includes building sewer excavation, shoring, and backfill per 207, providing cleanouts, restoration of landscape features, furnishing and installing pipe, fittings, and incidental Work to restore full sewer service.

Related Work specified elsewhere may include, but is not limited to:

- 314: Pipe Sewer
- 315: Pipe Sewer TV Inspection
- 607.02: Sodding

Reference codes and specifications:

- AASHTO M 170-02: Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
- AASHTO M 315-03: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- ASTM A 74-98: Cast Iron Soil Pipe and Materials
- ASTM C 700-97: Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
- ASTM D 2564-96a: Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe System
- STM D 2665-98: Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- ASTM D 3311-94: Drain, Waste and Vent (DWV) Plastic Fittings Patterns
- D.C. Plumbing Code: BOCA Basic National Plumbing Code and DC Municipal Regulations.

Permits: The Contractor shall obtain a "Water or Sewer Excavation Permit" from the Department of Consumer and Regulatory Affairs for each address where excavation in public space is required for a building sewer connection and/or cleanout; District permits will be issued without charge to the Contractor.

### 316.02 SUBMITTALS

All PVC pipe and fittings shall be accompanied by a certification from the pipe supplier, per ASTM D 2665 and D 3311, which will be the basis of acceptance of PVC materials.

A similar certification shall accompany other pipe materials when requested.

### 316.03 MATERIALS

- 808.02 (C): Polyvinyl Chloride (PVC) Pipe
- 809.03: Cast iron Pipe
- Vitrified Clay Pipe – Vitrified clay pipe and fittings shall be used only as directed and shall meet requirements of ASTM C 700-97, Extra Strength
- 808.01(B): Reinforced PCC Pipe, Class III

**316.04 CONSTRUCTION REQUIREMENTS**

- A. GENERAL** - No taps of existing public sewers shall be made by the Contractor except under the supervision of the Chief Plumbing Inspector, his authorized assistant or the Engineer. Two (2) weeks prior to proposed scheduling of building sewer connection work, the Contractor shall give written notice to the Plumbing Inspector, with a copy to the Engineer, stating time of proposed work. All such connections shall be certified in writing by the Plumbing Inspector per D.C. Plumbing Code.

Joints must be made under dry conditions. If water is present, necessary steps shall be taken to dewater the trench.

Damaged pipe and joints will be rejected and shall be removed from the job Site by the Contractor.

The Contractor shall exercise care to avoid damage to water service piping which is normally located above and in proximity to building sewer piping. The Contractor shall repair water services that are damaged by their operations at no cost to the District.

- B. WORK ON PRIVATE PROPERTY** - In general, building sewer connection work is in public space. The Contractor shall locate all building sewer piping and may be required to conduct some minor Work on private property. The Contractor shall obtain written approval from property owners before disturbing any private property, and shall submit a copy of the approval to the Engineer. The Contractor shall make no claim for any time delay associated with obtaining permission to work on private property.

The District assumes no responsibility for any Work or trespass on private property.

- C. PRECONSTRUCTION PHOTOS** – A minimum of 2 preconstruction photographs shall be taken of each property where building sewer connections will be replaced or extended, or cleanouts constructed. These photographs are in addition to, and shall meet the same requirements of, 108.08. Views shall be taken as directed to show preconstruction, existing conditions at each property within the area associated with this Work.

- D. MAINTAINING SEWER SERVICE** - Existing building sewer service shall, in general, be kept in service for the maximum time practicable. Disconnection and reconnection of building sewer and/or cleanout shall be accomplished within the time limits specified herein.

Existing service in the street sewer shall be maintained at all times. The Contractor shall conduct his operations so as to maintain flow in the existing sewer. This will require proper coordination for construction of new wye for building sewer connection.

The Contractor shall have suitable hose and flow control equipment available to plug, block, bypass, and pump sewage around isolated building sewer and street sewer sections until permanent piping is complete and in service.

When necessary to pump sewage while installing wyes in existing sewers, or while replacing or extending building sewer connections, material pumped shall be carried by means of approved hose or other closed, watertight conveyors to the downstream sewer or manhole designated by the Engineer.

In no case shall bypass pumping be permitted other than during hours when the Contractor is present at the Site. Sewage diverted during these times shall be returned to the sanitary system and not discharged into storm sewers, streams, or the traveled way.

No more than 3 separate service disruptions will be permitted during phases of Work for any single building sewer connection, and the duration of each disruption shall not exceed two (2) hours, except in an emergency, when the Engineer will grant a time extension. The Contractor shall give written notice to the Engineer, stating time and duration of proposed disruption sufficiently in advance to provide for emergency sewer service. If proposed disruption time conflicts with essential consumer use, it shall be rescheduled to alleviate interference. The Engineer will determine action to be taken for essential consumer use requests.

Overtime, weekend, and holiday Work may be required at no additional District cost to promptly complete temporary and/or permanent sewer service.

- E. HANDLING PVC PIPE** - PVC pipe shall be handled per applicable requirements of 314.04(E).
- F. REPLACE BUILDING SEWER CONNECTION** - Work consists of replacing malfunctioning building sewer connections as well as those with service traps, and reconnecting to existing or new street sewers. Work includes excavation and shoring, backfill and compaction to grade per 207, removal and disposal of old building sewer pipe encountered, furnishing and installing new PVC pipe and fittings between property line and street sewer, making approved connections, restoration of surfaces, sodding per 607.02,

and incidental Work to restore sewer service. Work may include abandoning existing piping in place and constructing new piping in new trench.

Wye and cleanout will be paid under separate Pay Items.

Other piping materials shall be used only in special situations as directed.

Replacement building sewer piping shall be the same diameter as piping replaced unless otherwise shown on the Drawings. However, in no case shall the nominal pipe diameter be less than 4 inches. Replacement building sewer pipe shall be laid to a minimum 2 percent grade and approved by the Engineer prior to backfilling.

Routings for building sewer replacement shall comply with the D.C. Plumbing Code with respect to clearances from lot lines and separation from water service.

Each replacement building sewer shall have a cleanout installed as near to the property line as practicable per Standard Drawing 316.01.

Unless otherwise approved or directed by the Engineer, the buildings sewer shall be connected to a wye-branch installed in the street pipe sewer.

All building sewer replacements shall extend from the street sewer to the property line if there is no building projection (areaways, steps, porches) into public space. If a building projection exists onto public space, the building sewer replacement shall extend to the face of the projection.

- G. EXTEND/RECONNECT BUILDING SEWER CONNECTION** - Work consists of extending and connecting existing fully functional building sewer connections (no evidence of malfunction, no service traps, no cracks, breaks, sags in line, etc., as determined by the Engineer) to new street sewers. Work includes excavation and shoring, backfill and compaction to grade per 207; disconnecting building sewer pipe from old sewer, furnishing and installing extension pipe section, or removal of existing pipe to shorter length as applicable, using same type material for pipe as existing pipe, disposal of removed pipe and fittings, making approved connections, restoration of surfaces, sodding per 607.02, and incidental Work to restore sewer service.

Building sewer piping shall be the same diameter as existing piping unless otherwise shown on the Drawings. However, in no case shall the nominal pipe diameter be less than 4 inches. Building sewer pipe shall be laid to a minimum 2 percent grade and approved by the Engineer prior to backfilling.

Routings for building sewer piping shall comply with the D.C. Plumbing Code with respect to clearance from lot lines and separation from water service.

Unless otherwise approved or directed by the Engineer, the building sewer shall be connected to a wye-branch which has been installed in the street pipe sewer.

- H. ADD OR REPLACE STREET SEWER WYE** - When, in the course of replacing/extending/reconnecting a building sewer connection to a street sewer, it is found that a wye is not available at the location required in the street sewer for the new connection or existing wye is considered inadequate by the Engineer, the Contractor shall install a new wye.

The wye shall be of same material as the pipe sewer, and shall include the proper wye adapter. Concrete collars are not permitted on PVC pipe.

As an alternate to installation of a new wye and/or a wye of the same material as the pipe sewer, and when approved, a cast iron wye thimble may be used to connect building sewer connection pipe to vitrified clay pipe sewer. Such connection shall include cutting a neat hole to proper size in pipe sewer, attaching thimble over hole with suitable seal, and securing thimble with a Class B PCC collar to rigidly connect thimble to pipe.

Thimbles are prohibited for connection to PVC pipe sewers; only PVC wye shall be used. When approved, a cast iron straight thimble may be used to connect building sewer connection pipe to concrete pipe sewer. Such connection shall include cutting neat hole to proper size in pipe sewer, inserting thimble in hole with suitable seal, and securing thimble with a Class B PCC collar to rigidly connect thimble to pipe.

- I. ADD BUILDING SEWER CLEANOUT** - When existing building sewer connection is in satisfactory condition (no evidence of malfunction, no service traps, no cracks, breaks, sags in line, root intrusions, etc., as determined by the Engineer) but there is no cleanout, Work consists of adding a wye and cleanout near property line per Standard Detail 316.01.

The cleanout-to-building sewer connection pipe wye shall be of the same material as the building sewer connection pipe.

Work includes excavation and shoring, backfill and compaction to grade per 207; furnishing and installing cleanout, fittings, and screw plug, making approved connections, restoration of surfaces, sodding per 607.02, and incidental Work to restore sewer service.

- J. LEAKAGE TEST** - All equipment and materials required to perform leakage tests and all expenses in connection with such tests, except for District personnel engaged in the supervision of testing, shall be included as part of building sewer connection work.

Each replacement building sewer shall be plugged at point of connection with the street sewer and at property line, and filled with water and tested with not less than a 10 foot head of water. The water shall be kept in the system for at least fifteen (15) minutes before the leakage test starts.

Leakage shall not exceed a rate of 0.0316 gallon per hour per 10 feet of building sewer connection pipe.

Measurement by the Engineer will be made of the rate of leakage from the pipe by determining amount of water required to maintain the 10 foot head of water for a period not exceeding one (1) hour. The Contractor shall provide water for this test by making arrangements with the Engineer.

The pipe and cleanout shall be watertight within the foregoing leakage limit. Repairs to all defects responsible for leakage shall be by the Contractor at no additional cost to the District.

- K. RESTORATION** - Any items disturbed during construction including walls, fences, shrubs, etc., including decorative driveways, sidewalks and patios (brick, stone or decorative concrete), shall be restored by the Contractor upon completion of Work. Standard concrete and asphalt paved area shall be patched with asphalt per 407. Grassed areas shall be re-sodded per 607.02 as part of Work.

### 316.05 MEASURE AND PAYMENT

The unit of measure for Replace Building Sewer Connection, Extend/Reconnect Building Sewer Connection, and Add Building Sewer Cleanout will be the linear foot, with measurement made on actual length of new pipe in place complete excluding cleanout wye. Measurement will be made along vertical length of cleanout pipe to discharge end of cleanout wye.

The unit of measure for Add or Replace Street Sewer Wye or Thimble will be each.

Payment for Replace Building Sewer Connection will be made at the Contract unit price per linear foot, which payment will include excavation, shoring, backfill, compaction, restoration and sodding (excluding temporary asphalt patching, which will be paid separately), replacing or extending sewer connection pipe and jointing, leakage test, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for Extend/Reconnect Building Sewer Connection will be made at the Contract unit price per linear foot, which payment will include excavation, shoring, backfill, compaction, restoration (excluding temporary asphalt patching, which will be paid separately), extending sewer connection pipe and jointing or shortening existing pipe section and jointing, leakage test, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for Add or Replace Street Sewer Wye or Thimble will be made at the Contract unit price per each, which payment will include furnishing and installing wye or thimble, maintaining sewer service, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

Payment for Add Building Sewer Cleanout will be made at the Contract unit price per linear foot, which payment will include excavation, shoring, backfill, compaction, restoration and sodding (excluding temporary asphalt patching, which will be paid separately), installation of cleanout including wye and jointing, leakage test, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.



## 317 SEWER/WATER PCC FORMWORK CONSTRUCTION

### 317.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specifications Section 03 10 00.

Work includes furnishing all labor, materials, equipment, and incidentals required to provide formwork for all PCC structures as shown on Drawings and as specified herein.

Related Work specified elsewhere may include but is not limited to:

- 318: Reinforcing Steel – Sewer/Water Work
- 319: Sewer/Water PCC Accessories
- 320: Sewer/Water PCC Construction

Reference Codes and Specifications:

- ACI 347R: Guide to Formwork for Concrete
- ACI Special Publication Number SP-4: Formwork for Concrete
- ACI 117: Standard Specifications for Tolerances for Concrete Construction and Materials
- U.S. Commercial Standard CS-251
- U.S. Product Standard PS-1

General Design Criteria:

- Design formwork for vertical loads and lateral pressures per ACI 347R.
- Design a formwork system which is adequately braced and had adequate strength and stability to ensure finished concrete within specified tolerances.
- When necessary to maintain specified tolerances, design camber into formwork to compensate for anticipated deflection and creep due to weight and pressure of fresh concrete.
- Chamfer exposed external corners 3/4 –inch.
- Concrete formwork drawings and calculations shall be prepared by, or under the direction of, a Registered Professional Engineer (P.E.) and shall bear his/her P.E. Seal. Forms shall be designed in accordance with the criteria specified herein.

### 317.02 SUBMITTALS

Working drawings shall be prepared in accordance with 703.14(A) and (B) and submitted in accordance with 105.02.

### 317.03 MATERIALS

- 703.14: PCC Formwork
- 319: Sewer/Water PCC Accessories

### 317.04 CONSTRUCTION REQUIREMENTS

Formwork and falsework shall be placed in accordance with 703.14 and 703.16 and removed in accordance with 703.17.

### 317.05 MEASURE AND PAYMENT

PCC formwork will not be measured separately for payment; the cost thereof shall be included in the lump sum or unit price for PCC items of which it is a part.

## **318 REINFORCING STEEL – SEWER/WATER WORK**

### **318.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 03 20 00.

Work includes furnishing all labor, materials, equipment, and incidentals required and installing all reinforcing steel required for the reinforcement of PCC, as shown on the Drawings and as specified herein.

Related Work specified elsewhere may include but is not limited to:

- 320: Sewer/Water PCC Construction

Reference Codes and Specifications:

- American Concrete Institute: ACI 315: “Manual of Standard Practice for Detailing Reinforced Concrete Structures
- American Concrete Institute: ACI 318: “Building Code Requirements for Reinforced Concrete
- ASTM A 82: Specification for Cold-Drawn Steel Wire for Concrete Reinforcement
- ASTM A 185: Specification for Welded Steel Wire Fabric for Concrete Reinforcement
- ASTM A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- CRSI: Manual of Standard Practice for Reinforcing Concrete Construction

### **318.02 SUBMITTALS**

Shop drawings shall be submitted in accordance with 704.03.

### **318.03 MATERIALS**

- 812.02: Reinforcing Steel, Grade 60

### **318.04 CONSTRUCTION REQUIREMENTS**

Fabrication, protection, and placement of reinforcing steel shall be performed in accordance with requirements of 704.04 through 704.08.

### **318.05 MEASURE AND PAYMENT**

PCC reinforcement will not be measured separately for payment; the cost thereof shall be included in the lump sum or unit price for PCC items of which it is a part.

## 319 SEWER/WATER PCC ACCESSORIES

### 319.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specifications Section 03 25 00.

Work includes furnishing all materials, labor, tools, equipment, and incidentals required to make all joints tight in the concrete, as detailed in the Drawings and as specified herein.

Related Work specified elsewhere may include but is not limited to:

- 318: Reinforcing Steel – Sewer/Water Work
- 320: Sewer/Water PCC Construction

Referenced Standards:

- AASHTO M 282: Standard Specifications for Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete
- AASHTO M 153: Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- U.S. Army Corps of Engineers Specification CRDC572: Specification for PVC Water Stop

### 319.02 SUBMITTALS

Shop drawings (specification sheets) per 105.02 shall be submitted for products including names, sources, and descriptions.

Samples of materials being used shall be submitted when requested by the Engineer.

### 319.03 MATERIALS

- 807.05: Water Stops
- 807.01 (B):Preformed expansion joint filler
- 807.02 (A) (2): Joint sealant

### 319.04 CONSTRUCTION REQUIREMENTS

**A.** Footings, beams, and slabs shall have no horizontal joints.

**B.** Construction joints shall be placed and secured perpendicular to the face of the PCC section.

**C.** Defective joints and defective and improperly placed sealers and sealants shall be removed and reconstructed at Contractor expense.

#### **D. WATER STOPS**

1. Water stops for all joints, as indicated on the Drawings, shall be placed without bends but shall be continuous around all corners and intersections. Splices shall be made by welding per manufacturer's recommendations, subject to Engineer's approval.
2. Make provisions to support and protect water stops during the progress of the Work.
3. Fabricate field joints in water stops per manufacturer's printed instructions. Protect water stop material from damage where it protrudes from any joints.
4. A sufficient number of ties shall be placed, as directed, to insure that water stops will remain in the required position during PCC placement.

**E. PREFORMED EXPANSION JOINT FILLER**

1. Expansion joint filler shall be furnished as specified in 807.01(A). Laitance shall be removed and joint faces acceptably cleaned before placing preformed joint material.
2. Joint filler shall be fastened to the inside of the bulkhead form with non-corrodible fasteners to secure a mechanical bond with PCC placed on both sides of the filler. Material shall be so placed that exposed edge is within 1/8 inch for a 1/4 inch joint, in order that filler material edge can be lightly ground to provide uniform sealant depth.
3. Care shall be taken at all times to prevent any disturbance of or damage to the joint filler.
4. Field splices shall be made per manufacturer's recommendations for total contact fit.

**F. JOINT SEALANT**

1. Before sealing joint edges with sealant, all mortar, surface coatings, form coating, moisture, spalls, protrusions, dust, oil, grease, and frost shall be removed as approved by the Engineer by use of grinding, sandblasting, mechanical abrading, acid washing, or a combination of these methods to provide a clean, sound base for sealant adhesion. Heat shall be applied to dry out joints where required. Loose particles present or resulting from grinding, abrading or blast-cleaning shall be removed by blowing out joints with oil-free compressed air prior to application of primer or sealant. Where PCC has spalled or broken, an epoxy grout shall be used to repair the PCC to give a uniform width of joint. The epoxy shall be Engineer approved and shall be applied as directed by the manufacturer.
2. No sealant shall be placed until at least twenty-eight (28) days after the PCC is placed.
3. Polyethylene bond breaker tape of correct width and length shall be placed over the joint edge.
4. Sealant shall be applied by experienced applicators in strict accordance with manufacturer's recommendations. Joint sealer shall be applied when the ambient temperature is between 60 degrees and 80 degrees F.
5. All PCC joint faces to be sealed shall be primed with a primer recommended by the sealant manufacturer. The primer shall dry for the length of time recommended by the sealant manufacturer before applying the sealant. The sealant shall be placed before the primer has dried out, so that it will provide the proper bond. If the primer dries out, another prime coat shall be applied before placing the sealant.
6. Sealant shall be installed within the time limit specified. All material not used after this time shall be discarded.
7. The application, tooling, and finishing of the sealant shall be as recommended by the manufacturer. Sealant surfaces shall be smooth and even.
8. Adjacent surfaces shall be cleaned free of sealant or soiling as the Work progresses.
9. Use solvent or cleaning agent as recommended by the sealant manufacturer. All finish work shall be left in neat, clean condition.

**319.05 MEASURE AND PAYMENT**

PCC accessories will not be measured separately for payment; the cost thereof shall be included in the Contract Price for PCC items of which it is a part.

## 320 SEWER/WATER PCC CONSTRUCTION

### 320.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specification Section 03 30 00.

Work includes furnishing all labor, materials, tools, equipment and incidentals required to place Portland Cement Concrete (PCC), forms, joints including water stops, and miscellaneous related items including inserts, manhole steps and embedded items, and PCC finishing.

Related Work specified elsewhere may include but is not limited to:

- 317: Sewer/Water PCC Formwork Construction
- 318: Reinforcing Steel – Sewer/Water Work
- 319: Sewer/Water PCC Accessories

Portland Cement, fine aggregate, coarse aggregate, water, and admixtures as specified, shall be ready-mixed (transit-mixed) concrete produced per AASHTO M 157 and as specified herein. All constituents, including admixtures, shall be batched at a central Plant, except as further specified herein.

Reinforced concrete shall be per ACI 301 and as specified herein.

Samples of constituents and of concrete as placed shall be subject to laboratory tests. All materials incorporated in the Work shall conform to approved samples.

### 320.02 SUBMITTALS

- A. The Contractor shall submit, for approval by the Engineer, a report for each PCC mix design per 817.01.
- B. The Contractor and PCC supplier shall each submit certification that materials for the Contract are from the same source as trial mix tested materials.
- C. The Contractor shall submit, for approval by the Engineer, proposed methods for controlling PCC temperature.
- D. Ready mixed PCC production facilities shall meet requirements of AASHTO M 157 and shall be certified by the National Ready Mixed Concrete Association. A copy of the “Certificate of Conformance for Concrete Production Facilities” shall be submitted to the Engineer prior to batching any PCC materials. Equipment shall conform to the Standards of the Concrete Plant Manufacturer’s Bureau and shall have a rating plate attached.
- E. Truck mixers shall meet requirements of 905.02(A).

### 320.03 MATERIALS

- 801.01 (C): Portland Cement
- 801.05: Pozzolan
- 803.01: Fine Aggregate
- 803.02: Coarse Aggregate
- 822.01: Water
- 814.04 and .05: Admixtures
- 822.08 (B) (1): Epoxy Bonding Compound

### 320.04 MEASURING/MIXING

Materials for PCC shall be measured in accordance with 703.04. Mixing PCC shall be accomplished in accordance with 703.05.

**320.05 TESTING AND ACCEPTANCE**

Testing of PCC shall be in accordance with requirements of 703.06.

**320.06 CONSTRUCTION REQUIREMENTS****A. INSPECTION AND CONTROL**

1. The preparation of forms, placing of reinforcing steel, conduits, pipes and sleeves, batching, mixing, transportation, placing, and curing of concrete shall be at all times subject to the inspection of the Engineer.
2. Control of the mix shall be as specified in 817.01.

**B. FORMS** - Form work shall be as specified in 703.14.**C. PLACING AND CONSOLIDATING** - PCC shall be placed in accordance with requirements of 703.08 and consolidated in accordance with requirements of 703.09. Requirements of 703.07 apply for adverse weather conditions.**D. REMOVAL OF FORMS** - Forms shall be removed in accordance with requirements of 703.17.**E. CURING AND PROTECTION** - PCC shall be cured and protected in accordance with requirements of 703.19.**F. PATCHING REPAIRS** - Patching, if required, shall be done in accordance with requirements of 703.20.**G. EPOXY BONDING OF PCC** - Where indicated in the Contract Documents, epoxy bonding of new PCC to existing PCC shall be done in accordance with requirements of 703.25.**H. CONCRETE FINISHES** - Finishing of exposed surfaces of PCC structures shall be finished in accordance with requirements of 703.20.**320.07 MEASURE AND PAYMENT**

PCC work will not be measured separately for payment. The cost thereof, including incidental Work and materials, will be included in the payment for the applicable PCC work.

## **321 PCC VALVE/VENTURI VAULTS**

### **321.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 48 00.

Work consists of excavation, backfill and compaction beyond trench excavation limits, disposal of excess material, furnishing and constructing reinforced PCC vaults complete with gravel base, piers, joints, armored seats for top slabs, sumps, steps, water stops, anchor bolts, stack risers, valve box extension, lifting inserts, and manhole frames and covers at locations indicated in the Contract Documents and/or as directed.

Related Work specified elsewhere may include but is not limited to:

- 305: Pipe Water Main – Ductile Iron
- 308: Water Service Connections
- 319: Sewer/Water PCC Accessories
- 326: Moisture-proofing PCC Valve/Venturi Vaults

Reference Codes and Specifications:

- AASHTO M 105: Standard Specification for Gray Iron Castings
- AASHTO M 31: Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- AASHTO M 91: Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
- ASTM C 361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
- AASHTO M 315: Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- AASHTO M 199: Standard Specification for Precast Reinforced Concrete Manhole Sections
- ASTM D 1850: Standard Specification for Concrete Joint Sealer, Cold Application Type
- ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Sections
- ASTM C 32: Standard Specification for Seer and Manhole Brick (made from clay or shale)

### **321.02 SUBMITTALS**

Shop drawings shall be submitted per 105.02 for reinforcing steel layout, cast iron frames and covers, vault steps and anchor bolts for venturi vaults.

### **321.03 MATERIALS**

- 812.02: Reinforcing Steel, Grade 60
- 817: Cast-in-Place PCC, Class B
- 822.04: Precast Vaults
- Precast PCC Rings – Precast valve manhole rings and reducer rings shall be per 822.04. Precast manhole rings shall be cast with joint groove to receive compression seal.
- 807.06 (B): “O-ring” Seals
- 806.01 (A): Manhole Brick
- 822.07: Manhole Steps
- Manhole Frames, Covers and Sumps – Gray-iron castings for frames and covers shall be per 815.04. Castings for sumps shall be per AASHTO M 105, Class 35B.

**321.04 CONSTRUCTION REQUIREMENTS**

Precast rings may be used in lieu of brick stack risers; an adapter shall be provided in vault opening to receive precast unit.

Vaults shall be constructed per Contract Drawings.

Sumps shall be recessed to provide a flush surface between grate top and vault floor. Manhole steps shall be cast into walls as indicated.

The bottom flange of manhole frame shall have two 3/4 inch diameter holes drilled or cast therein, directly opposite each other. Corresponding holes shall be drilled, a minimum of 2 inches deep, into the precast concrete ring or brick masonry upon which the frame sits. Steel dowels shall be inserted through and into these holes to prevent lateral movement of frame and cover during backfill operations. Dowels shall be #5 rebars, 3 inches minimum length. Brick masonry, not exceeding 4 inches vertical depth, may be used to adjust frame and cover to approved grade when riser stack consists of precast rings.

Equipment for the installation or extrusion of sealant into joint spaces shall be a heavy-duty air-operated pump, capable of continuously feeding the compound under pressure, and capable of completely filling the joint space without discontinuities and without the formation of voids or entrapped air. Joints shall be dry, cleaned of scale, dirt, dust, curing compound and foreign matter prior to application. Cleaning shall be accomplished in a neat workmanlike manner with suitable tool(s) designed for cleaning concrete joints. The joint sidewalls shall be sandblasted and blown clean of loose sand prior to sealant application.

Suitable bond breaker shall be placed in joint recess. Bond breaker shall be compatible with the sealant, and shall not adhere to the sealant. Avoid overfilling the joint space. Joints shall be filled in a neat workmanlike manner from flush to 3/16 inch below the adjacent surface.

Vaults shall be moisture proofed as specified in 326.

After curing, remaining excavated area around vaults shall be backfilled per 207.

**321.05 MEASURE AND PAYMENT**

The unit of measure will be each.

Payment for PCC Valve/Venturi Vaults will be made at the Contract unit price per each, which payment will include excavation and backfill beyond trench excavation pay limits, moisture proofing, steps, sumps, and all labor, materials equipment, tools, and incidentals needed to complete Work specified.



## **322 PCC THRUST BLOCK**

### **322.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 11 20.

Work consists of excavation, backfill and compaction beyond trench excavation limits, disposal of excess material, furnishing all materials for construction and constructing reinforced PCC thrust blocks complete. Thrust blocks shall be constructed as shown in the Contract Documents to encompass H piles and water main so as to provide rigid anchorage.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 305: Pipe Water Main – Ductile Iron
- 317: Sewer/Water PCC formwork Construction

Reference Codes and Specifications: None this section

### **322.02 SUBMITTALS**

Shop drawings shall be submitted per 105.02 for reinforcing steel layout.

### **322.03 MATERIALS**

- 812: Reinforcing Steel, Grade 60
- 817: PCC, Class B

### **322.04 CONSTRUCTION REQUIREMENTS**

Thrust block shall be constructed as shown in the Contract Documents. PCC shall cure for a minimum of four (4) days prior to backfilling. Backfill shall be per 207.

### **322.05 MEASURE AND PAYMENT**

Thrust Blocks will not be paid for separately, but are to be included in the price of the details where they are shown.

## **323 REINFORCED PCC COLLAR**

### **323.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 11 21.

Work consists of excavation, backfill and compaction beyond trench excavation limits, disposal of excess material, furnishing all material for construction and constructing reinforced PCC collars complete. Concrete collars shall be constructed as detailed in the Contract Documents to encompass sewers so as to provide a rigid, watertight connection.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 314: Pipe Sewer

Reference Codes and Specifications: None this section.

### **323.02 SUBMITTALS**

Shop drawings shall be submitted per 105.02 for reinforcing steel layout.

### **323.03 MATERIALS**

- 812.02: Reinforcing Steel, Grade 60
- 817: PCC, Class B
- 320: Sewer/Water PCC Construction

### **323.04 CONSTRUCTION REQUIREMENTS**

PCC collar(s) shall be constructed per applicable requirements of 320.06, per Standard Drawing 323.01 and as shown in the Contract Documents. PCC shall cure for a minimum of four (4) days prior to backfilling. Backfill shall be per 207.

### **323.05 MEASURE AND PAYMENT**

The unit of measure will be each.

Payment for PCC Collar (Reinforced) will be made at the Contract unit price per each, which payment will include furnishing and forming Class B PCC, furnishing and placing reinforcing steel complete, backfilling, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## **324 PCC IN-LINE THRUST BLOCK**

### **324.01 DESCRIPTION**

Work shall conform to this Section and DC Water Standard Specifications Section 33 11 22.

Work consists of excavation, backfill, and compaction beyond trench excavation limits, disposal of excess material, furnishing all materials for and constructing reinforced in-line PCC thrust blocks complete. In-line thrust blocks for water mains 12-inch and larger shall be constructed as shown on the Contract Documents.

Related Work specified elsewhere may include but is not limited to:

- 207: Trench Excavation and Backfill
- 305: Pipe Water Main – Ductile Iron
- 317: Sewer/Water PCC formwork Construction

Reference Codes and Specifications: None this section

### **324.02 SUBMITTALS**

Shop drawings shall be submitted per 105.02 for reinforcing steel layout.

### **324.03 MATERIALS**

- 812.02: Reinforcing Steel, Grade 60
- 817: PCC, Class B
- 320: Sewer/Water PCC Construction

### **324.04 CONSTRUCTION REQUIREMENTS**

In-line thrust blocks shall be constructed as per applicable requirements of 320.06 and as shown in the Contract Documents. PCC shall cure a minimum of four (4) days prior to backfilling. Backfill shall be per 207.

### **324.05 MEASURE AND PAYMENT**

The unit measure will be each.

Payment for PCC In-Line Thrust Block will be made at the Contract unit price per each, which payment will include excavation beyond the trench excavation limits; forming, furnishing, and placing reinforcing steel, complete in place; furnishing and placing follower glands to anchor in-line thrust block; furnishing, placing, and curing PCC; backfilling, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified.

## 325 NON-SHRINK GROUTING

### 325.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specifications Section 03 60 00.

Work includes furnishing all labor and material, required to perform the grouting specified on the Drawings or in the Specifications.

Related Work specified elsewhere may include but is not limited to:

- 317: Sewer/Water PCC formwork Construction
- 318: Reinforcing Steel – Sewer/Water Work
- 319: Sewer/Water PCC Accessories
- 320: Sewer/Water PCC Construction

Acceptable Manufacturers:

- U.S. Grout Corporation
- Master Builders
- USM Corporation
- W.R. Meadows
- Sonneborn-Contech

Applicable Codes, Standards and Specifications:

- American Society for Testing and Materials (ASTM)
- U.S. Corps of Engineers (CRD)

### 325.02 SUBMITTALS

The Contractor shall furnish recent independent laboratory tests showing compliance with requirements specified. Certification or affidavits will not be acceptable.

The Contractor shall furnish manufacturer's literature describing product and instructions for use.

Applicable Shop Drawings showing grouting details shall be submitted per 105.02.

### 325.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

Grout shall be delivered in moisture proof bags with the manufacturer's name, product name, and general instructions for placement printed on the bag.

Product shall be stored on pallets and protected from damage.

### 325.04 MATERIALS

- 806.05 (E): Non-Shrink Grout

### 325.05 CONSTRUCTION REQUIREMENTS

**A. PREPARATION** - All contact surfaces shall be prepared in accordance with manufacturer's recommendations.

Grout contact surfaces shall be cleaned of all oil, grease, scale, and other foreign matter. Unsound concrete shall be removed, leaving surface level but rough.

Concrete contact area shall be saturated with water twelve to twenty-four (12-24) hours prior to grouting. Before placing grout, remove all excess or free standing water.

**B. MIXING** - Grout shall be mixed in strict accordance with the manufacturer's written instructions. Amount of water used should be a minimum quantity to provide the desired grout consistency. Mix only that quantity of grout that can be placed within thirty (30) minutes after mixing.

**C. GROUTING** - All Work shall be done in strict accordance with the manufacturer's recommendations, including special procedures for hot and cold weather grouting.

At the request of the Engineer, the manufacturer's representative shall be called to the job-Site for consultation regarding detailed use of the grout.

The grout shall be placed using the most practical method, completely filling the space to be grouted and shall be thoroughly compacted and free of air pockets.

Do not remove forms until after the grout has taken an initial set and will not slump. After removal, cut off excess grout and finish to a smooth surface.

Prevent rapid loss of water from the grout during first forty-eight (48) hours with the use of an approved membrane curing compound, or with the wetted burlap method.

### **325.06 MEASURE AND PAYMENT**

Non-shrink grout will not be measured separately for payment; the cost thereof shall be included in the lump-sum or unit price for PCC items of which it is a part.

## 326 MOISTURE-PROOFING – PCC VALVE/VENTURI VAULTS

### 326.01 DESCRIPTION

Work shall conform to this Section and DC Water Standard Specifications Section 07 10 00.

Work consists of furnishing and applying all materials required to provide a protective coating and moisture barrier for cast-in-place and precast PCC vaults as indicated on the Drawings and as specified herein.

Related Work specified elsewhere may include but is not limited to:

- 320: Sewer/Water PCC Construction
- 321: PCC Valve/Venturi Vaults

Quality Assurance:

Moisture proofing work shall be performed by a contractor who is regularly engaged in Work of the character required and in the application of materials specified herein.

Applicators of the materials specified shall be certified by the manufacturer.

### 326.02 SUBMITTALS

The following shall be submitted:

- Manufacturer's literature describing product and detailed instructions for use
- Manufacturer's certification of compliance
- Certification of applicators

### 326.03 MATERIALS

- 802.08: Emulsified Asphalt

### 326.04 CONSTRUCTION REQUIREMENTS

- A. DELIVERY/STORAGE** - Materials shall be delivered to the Work Site (either precast vault manufacturer's Site or job Site) in the original unbroken packages or containers bearing the manufacturer's brand or label. The kind of material and the purpose for which it is to be used shall be indicated on the label.

Materials shall be handled and stored at the Site in a place and in a manner so as to adequately protect the contents from damage, deterioration and contamination.

Storage space shall be kept clean at all times and every precaution shall be taken to avoid fire hazards.

All materials shall be stored at the temperatures recommended by the manufacturer.

- B. INSPECTION** - Prior to the application of any moisture proofing materials, the Contractor shall inspect surfaces to receive the moisture proofing specified and notify the Engineer in writing of any serious defects or conditions that will interfere with or prevent a satisfactory installation.

Moisture proofing shall not be applied until all concrete work to receive moisture proofing has cured.

- C. SURFACE PREPARATION** - All PCC vault exterior surfaces shall be smooth and free from projections or holes.

All PCC surfaces to be moisture proofed shall be thoroughly cleaned by water jet, light sand-blast, or combination thereof.

1. All surfaces shall be free from frost, dust, sand, laitance, mud, mortar, and other loose particles.

2. All grease spots or marks of oil shall be removed.

All voids, form tie holes, cracks, honeycomb, or other imperfections in surfaces which, in the opinion of the Engineer and/or the material manufacturer's representative, may cause leaks shall be routed out and patched prior to the installation of the moisture proofing system. Patching materials shall be as recommended by the vault manufacturer.

All joints in the PCC shall be prepared as recommended by the vault manufacturer.

- D. APPLICATION** - All materials shall be installed in strict accordance with the printed instructions of the manufacturer.

For cast-in-place vaults, apply to all exterior PCC surfaces of vault walls and top slab. For precast vaults, apply to all exterior surfaces.

Apply by brush or spray to give an even coat at rate of 2.5 gallons per 100 square feet, without rundown. Each joint area shall receive a second coat for a distance of 9 inches each side of joint.

- E. CURING AND BACKFILLING** - Moisture proofing shall cure properly before precast vaults are placed in the ground.

All areas that have been moisture proofed shall have cured properly before backfilling starts.

Backfill shall be placed in a manner that avoids damage to the moisture proofing system.

### **326.05 MEASURE AND PAYMENT**

Moisture proofing will not be measured separately for payment. The cost thereof shall be included in payment for PCC Valve/Venturi Vaults.

## 327 SIDEWALK INTERCEPTOR DRAINS, CONNECTIONS, GRATINGS, AND TRAPS

### 327.01 DESCRIPTION

- A. **SIDEWALK INTERCEPTOR DRAINS** - Work consists of the construction of sidewalk interceptor drains at the entrances to service stations, garages, or other similar places where it is necessary to relocate existing drains due to roadway construction. They shall be constructed to the dimensions and at the locations as shown in the Contract Documents, or as directed by the Engineer.
- B. **CAST IRON DRAIN CONNECTIONS** - Work consists of making the necessary connections for sidewalk intercept drains for service stations and/or garages to intercepting traps and/or existing or proposed storm sewers, and reconnecting rain leaders to the curb, where these connections or reconnections are due to roadway construction.
- C. **CAST IRON GRATING REPLACEMENTS** - Work consists of replacing cast iron gratings in garage and/or interceptor drains that are broken during construction operations. They shall conform in size and dimensions as closely as possible to the existing grating.
- D. **GARAGE INTERCEPTING TRAPS** - Work consists of constructing concrete garage intercepting traps to the dimensions and at the locations as shown on the Contract Drawings.

### 327.02 MATERIALS

- 815.01 (A): Steel/Angle Iron
- 815.05: Ductile Iron for Gratings
- 809.03: Cast Iron Soil Pipe
- 817: PCC, Class B
- 806.05 (B) (4): Mortar

### 327.03 CONSTRUCTION REQUIREMENTS

- A. **SIDEWALK INTERCEPTOR DRAINS** - Work shall be done in strict conformance with all provisions for PCC construction of these Specifications and the Plumbing Code of the District of Columbia with the following exceptions:

The bottom of the concrete drains shall be placed on the existing, undisturbed ground or the prepared, compacted fill neatly graded to the required Elevation and dimensions as shown on the Contract Drawings. Excavations shall be per 207 and kept dry for the placing of concrete. The drains shall be placed as soon as practicable after excavation is complete to grade.

All vertical faces of PCC shall be formed. Forms shall be mortar tight, securely braced, and tied to prevent movement and shall remain in place for at least twenty-four (24) hours after PCC is placed.

PCC shall be consolidated by continuous working with tools and/or spud vibrators meeting the requirements of 905.07(B) during and immediately after placement in the forms. The vibration shall be of sufficient duration to consolidate the PCC but shall not be continued so as to cause segregation.

The angle iron frame for the grating shall be inserted in the PCC to the desired Elevation when the PCC is still sufficiently plastic to do so without disturbing the forms or the top surface of the PCC drain.

The cast iron outlet pipe shall extend through the wall a sufficient distance to permit proper connections from the outside and cut flush with the inside wall. The area around the pipe shall be completely and neatly sealed with mortar.

The exposed sides of all angle irons shall be painted with 1 coat of primer paint and 2 coats of black paint prior to placement in the PCC. Painting shall be done as specified in 707.

- B. **CAST IRON DRAIN CONNECTIONS** - The intercept drain connections and the drain leader connections shall be constructed in accordance with the D.C. Plumbing Code.



**C. CAST IRON GRATING REPLACEMENTS** - Work shall be in accordance with the D.C. Plumbing Code.

**D. GARAGE INTERCEPTING TRAPS** - PCC garage intercepting traps shall be constructed on existing, undisturbed ground or on prepared, compacted fill, neatly graded to the required Elevation and dimensions as shown on the Contract Drawings. Excavation shall be per 207 and kept dry for the placing of concrete. The Work shall be done in accordance with the D.C. Plumbing Code.

All vertical faces of the walls shall be formed. Forms shall be mortar tight, securely braced and tied to prevent movement and shall remain in place for at least twenty-four (24) hours after PCC is placed.

Inlet and outlet pipes and fittings shall be inserted through the forms at the plan Elevations and securely anchored to prevent their being dislodged while concrete is being poured.

PCC shall be placed as per 320.

#### **327.04 MEASURE AND PAYMENT**

**A. SIDEWALK INTERCEPTOR DRAINS** - The unit of measure will be the linear foot.

Measurements will be made along the top surface of the drain out to the end walls. The actual number of linear feet of Sidewalk Interceptor Drain installed will be paid for at the Contract unit price per linear foot, which payment will include excavation, disposal of surplus material, backfilling, compacting, furnishing, hauling, and placing all materials, including angle iron frame with anchors welded to it, setting existing or new grates in place, forming, painting, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**B. CAST IRON DRAIN CONNECTIONS** - The unit of measure will be the linear foot.

The actual number of linear feet of Cast Iron Drain Connections of each size, measured complete in place, will be paid for at the Contract unit price per linear foot, which payment will include excavation, disposal of surplus material, backfilling, furnishing, hauling, and placing all materials including fittings, doing all jointing and connecting, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**C. CAST IRON GRATING REPLACEMENTS** - The unit of measure will be the linear foot.

The actual number of linear feet of Cast Iron Grating Replacements, measured complete in place, will be paid for at the Contract unit price per linear foot, which payment will include furnishing, hauling, and placing the grating, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**D. GARAGE INTERCEPTING TRAPS** - The unit of measure for Garage Intercepting Traps will be the cubic yard.

The actual number of cubic yards of PCC determined from plan dimensions, will be paid for at the Contract unit price per cubic yard, which payment will include 1 section of the inlet pipe and the necessary straight and 1/4 bend pipes to complete the goose-neck or water seal of the outlet pipe, all jointing and connecting, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

Deductions will not be made for the volume of inlet and outlet pipes.

## **328 CLEAN EXISTING STORM SEWER STRUCTURES AND CONNECTING PIPE**

### **328.01 DESCRIPTION**

Work consists of cleaning storm sewer structures and connecting pipe as designated in the Contract Documents.

### **328.02 CONSTRUCTION REQUIREMENTS**

Storm sewer structures shall be cleaned of all silt and deposits (leaves, trash, etc.) by either manual or mechanical means. Work shall also include removing debris to a distance of 2 feet into the attached connecting pipe.

If, during the sewer structure cleaning process, the Engineer determines that a connecting pipe is clogged or requires cleaning, he shall direct the Contractor to clean the connecting pipe.

The connecting pipe shall be cleaned, as designated in the Contract Documents or as directed, of all debris and thoroughly flushed by use of high-pressure hose. All Work to be performed must meet the requirements of DC Water.

Any material extracted from the storm water structure and connecting pipe during cleaning operations shall be removed from the Site by the end of the working day and properly disposed.

### **328.03 MEASURE AND PAYMENT**

The unit of measure for Clean Storm Sewer Structure will be each, and this measure shall include the elongated section, catchment chamber, and the connecting pipe as specified.

The unit of measure for Clean Storm Sewer Connecting Pipe will be linear foot and this measure shall be the horizontal distance, along the surface from the attached wall of the inlet to the center of the connecting sewer structure minus 2 feet.

Payment for Clean Storm Sewer Structure will be made at the Contract unit price per each, which payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

Payment for Clean Storm Sewer Connecting PCC Pipe will be made at the Contract unit price per linear foot, which payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

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**401 PLANT MIX PAVEMENTS – GENERAL**

**401.01 DESCRIPTION**

These Specifications include general requirements that are applicable to all types of bituminous pavements of the Plant mix type irrespective of gradation of aggregate, kind, and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.

This Work shall consist of furnishing, mixing, and placing materials for bituminous concrete pavements. Construction with bituminous mixtures shall meet these specification requirements and shall meet the requirements for the type of bituminous mixture as designated on the Plans or in the Special Provisions. Materials shall be placed to the depth, grade, and cross section shown in the Contract Documents and/or as directed by the Engineer.

**401.02 COMPOSITION OF MIXTURES**

The bituminous Plant mix shall be composed of a mixture of fine and coarse aggregate, mineral filler, bituminous material, anti-strip additive or hydrated lime, and other additives when required.

**TABLE 401.02 JOB MIX TOLERANCES FOR MIXTURE AND FINE AGGREGATES**

DESCRIPTION	MAXIMUM TOLERANCE (+ or -)
SIEVE SIZE, Percent Passing by Weight (inclusive), AASHTO T 30	
No. 4 and larger	7
No. 10 to No. 50	6
No. 80 to No. 100	4
No. 200	2
BITUMEN CONTENT, Percent by Weight	
AASHTO T 308	0.40
HYDRATED LIME	0.20
SOFTENING AGENT	0.20
LIQUID ANTI STRIP ADDITIVE	0.20

The job mix formula shall be submitted and approved in conformance with 818.01 prior to use.

The job mix formula shall remain in effect until a revised formula is submitted and approved or the formula is changed by the Engineer.

Results of single tests per 500 tons, or fraction thereof, of bituminous mixture for gradation and bitumen content shall meet the approved job mix formula, and shall not exceed the tolerances of Table 401.02, and shall be within the total job mix tolerances specified in 818.02. Tolerances for delivery temperature shall be ± 25 degrees Fahrenheit but shall not exceed the temperature limits specified in 818.02.

**401.03 MATERIALS**

Approval of the sources of supply and acceptance of the materials that are proposed for use shall be obtained prior to starting the construction, and in accordance with 106.

The materials for bituminous pavements shall be of the grade and type specified for the mixture designated and shall meet the following requirements:

- 802.02: Asphalt Cement
- 803.04: Coarse Aggregate
- 803.03: Fine Aggregate

- 803.05: Mineral Filler
- 802.03: Cut-back Asphalt
- 802.04: Emulsified Asphalt
- 822.03(A): Hydrated Lime
- 802.07: Liquid Anti Strip Additives
- 802.06: Softening Agent

#### 401.04 WEATHER AND SEASONAL RESTRICTIONS

Bituminous concrete mixes shall not be placed at certain ambient temperatures as indicated in Table 401.04, or when the surface temperature is below that in the table, or when weather conditions otherwise prevent the proper handling, placing, and compaction of the mixture.

Cold weather construction is defined as the period between November 1<sup>st</sup> and April 1<sup>st</sup>. During this period, asphalt mixes shall not be placed unless the surface temperature at the time of placement conforms to Table 401.04 for the type of mixes specified and provided that the ambient air temperature during the past twenty-four (24) hours was above 32 degrees Fahrenheit. At no time shall the asphalt be placed on frozen subgrade.

Deliver hot mix asphalt using asphalt trucks in sufficient quantities, and at such intervals, to allow continuous placement of the materials.

**TABLE 401.04 RESTRICTIONS ON PLACEMENT OF HOT BITUMINOUS MIXES**

(For PG Binders 64-22 and 70-22)

All Mixes	Minimum Surface Temperature (°F)	Minimum Delivery Temperature at the Project Site (°F)
Lift Thickness < 1.5"	50	305
Lift Thickness >1.5"	40	300
Base	35	290

Note: For PG Binder 76-22 the minimum surface temperature must be >50 degrees F and the minimum delivery temperature at the Project Site is 295 degrees F.

#### 401.05 EQUIPMENT

- 904.01: Bituminous Mixing Plants
- 904.03: Distributors
- 904.02: Trucks
- 904.04: Lay down Equipment
- 904.05: Rollers
- 904.06: Hand Tools
- 903.01: Milling Machine

#### 401.06 HAULING OF ASPHALTIC MATERIALS

Asphaltic paving mixtures shall be transported from the mixing Plant to the Project Site in trucks conforming to the requirements of 904.02.

Shipments found to contain an excess amount of liquid asphalt, moisture, lubricant, or other foreign material, or if delivered outside of the approved job mix temperature of the bituminous mixture, shall be rejected. No loads shall be dispatched at such time as will prevent completion of the spreading and compaction of the mixture during daylight, unless artificial light satisfactory to the Engineer is provided.

**401.07 PREPARATION OF BASE COURSE OR EXISTING SURFACE**

Before spreading materials, the surface upon which the mix is to be placed shall be cleaned as indicated herein. After cleaning and while surfaces are dry and free from all objectionable matter, tack coat, as specified, shall be applied to all areas in accordance with 403.

- A. ASPHALTIC BASE COURSE** - Base course shall generally be defined as asphalt base used for roadways with full depth asphalt pavement. Prior to laying base course, all manhole frames within the limits of the area to be paved shall be protected from debris entering the Structure during paving operations. The manhole shall be cleaned of all concrete, asphalt or other debris. Prior to placement of asphalt, poles, manholes or other structures projecting through the base course shall be given a heavy coating meeting the requirements of 802.03 or 802.04. At the limits of all base work, existing pavement shall be sawed full depth, cleaned to a vertical edge, all loose material removed, and tack coat applied. After base course has been laid, the manholes shall be re-set to the approved line and grade according to 311.04. Payment will be made according to 311.10 and shall include excavation and PCC base.
- B. BASE COURSE JOINTS** - In the event that the Roadway being constructed can only be done ½ at a time, prior to paving the second half of the Roadway, the longitudinal joint in the existing new base shall be trimmed back to a clean vertical edge of full depth asphalt using an air compressor or other approved method. In general, the required cut shall be from 3 to 6 inches from the edge of the cold joint, but in no case shall it be less than 3 inches.
- C. PCC BASE TO BE OVERLAYED WITH LEVELING OR SURFACE COURSE** - Before placing leveling or surface course over existing PCC base, the surface upon which the mix is to be placed shall be cleaned of all loose and spalling material. All joints or cracks in the existing PCC base, both longitudinal and transverse, and all spalled areas, shall be cleaned of all asphalt and unsound concrete using compressed air to the satisfaction of the Engineer. After the cleaning operation, the Contractor shall completely fill and thoroughly compact asphaltic concrete (Stone Filled Sheet Asphalt Patching) into the joints, cracks, spalled, and scaled areas, as directed by the Engineer. After cleaning, and while surfaces are dry and free from all objectionable materials, tack coat, as specified, shall be applied to all areas in accordance with 403. Joints and cracks smaller than ½ inch may be sealed with joint sealer meeting the requirements of 807.02 (A) (I), hot-poured type.

Particular care must be used to avoid discoloration or damage to the curb and gutter. Any Portland Cement Concrete pavement, curb, or gutter broken or damaged through carelessness on the Contractor's part shall be replaced by the Contractor without cost to the District.

When overlaying streetcar tracks, loose rust shall be removed from the tracks by sanding and by use of wire brushes to the satisfaction of the Engineer. Track rail grooves shall be swept clean. Hot mixed asphalt shall not be placed until the Engineer has inspected and approved the condition of the adjacent pavement.

All refuse material shall be hauled away and disposed of by the Contractor at his own expense.

**401.08 PREPARATION OF MATERIALS**

- A. ASPHALT** - Asphalt cement, as received at the mixing Plant, shall be such that it will remain within the specified limits throughout the entire period of its use. The asphalt cement, when delivered to the mixer, shall be at the temperature specified.
- B. AGGREGATES** - Aggregates shall be delivered, handled, and stored in a manner so as to prevent segregation, contamination, and mixing of material from other sources. Aggregate storage facilities and handling shall meet the requirements of 106.  
Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregates. Absorbed moisture in the aggregate shall be reduced to such a quantity that there is no flushing of asphalt resulting from escaping water vapor in the prepared mixture.
- C. HYDRATED LIME** - Hydrated lime shall be delivered, handled, and stored in a manner so as to prevent contamination and kept dry until mixed into a slurry.

**401.09 MIXING AND HOLDING**

Mineral aggregates, prepared as prescribed in 401.08, shall be combined in the proportionate amounts required to meet the approved job mix formula. The asphalt cement shall be weighed, measured, or gauged and introduced into the mixer in the amount required by the approved job mix formula for the bituminous mixture being produced.

Hydrated lime shall be weighed, measured, or metered and combined with the aggregates prior to drying or mixing in the maximum amount of 1.5 percent hydrated lime by weight of total mixture for the bituminous mixture being produced. The hydrated lime shall be distributed on the aggregates in the form of lime-water slurry. The lime-water slurry shall have the consistency to allow uniform distribution on the aggregate. Should the Contractor elect to use an alternate method, he shall submit his plan to the Engineer in writing for approval along with the job mix formula.

Liquid anti-strip additive shall be metered and combined with the asphalt cement prior to discharge into the mixing chamber. When batch Plants are used, prior to adding the asphalt cement, the combined mineral aggregates shall be thoroughly mixed dry for ten (10) seconds. Upon approval of the Engineer, dry mix times may be less than ten (10) seconds after it has been demonstrated to the Engineer that the requirements of 401.02 are met.

The asphalt cement shall be distributed over the mineral aggregates and the whole mass thoroughly wet mixed for a period of at least thirty (30) seconds to produce a homogenous and uniformly coated mixture. Upon approval of the Engineer, another wet mixing time may be established, based on a minimum of 95 percent coated particles as determined by AASHTO T 195. Mixtures with maximum size aggregate passing the No. 4 sieve will be visually examined by the Engineer to determine minimum wet mix times.

The dry mix time is defined as the interval of time between the opening of the weigh box gate and the application of asphalt cement. The wet mix time is the interval of time between the application of asphalt cement and the opening of the mixer gate.

For the continuous mix type Plants, the mixing time may be regulated by fixing a minimum gauge in the mixing unit and/or by other mixing unit adjustments that may be directed by the Engineer. All mixing Plants for the preparation of bituminous mixtures shall conform to the requirements of 904.01. The mineral constituents of the asphaltic mixture shall be so combined with the asphalt cement so that the resulting composite mixture will meet the grading, bitumen content, and temperature requirements of the approved job mix formula.

Storing or holding of bituminous materials will be permitted provided the characteristics of the mixture are substantially the same as those of the mixing Plant.

When allowed, the Contractor shall sample, in the presence of the Engineer, hot asphaltic paving mixtures stored for more than twenty-four (24) hours. 2 samples shall be obtained, 1 from the top and 1 from the bottom of the storage or surge bin. Test results obtained by the District for both samples shall conform to tolerances of the approved job mix formula. In the event the bitumen content, gradation or temperature of either sample is not within job mix tolerances, the material shall be removed from the Roadway at no cost to the District. The Contractor shall provide a sample of the mixture taken between the pug mill and storage or surge bin when requested.

#### 401.10 SPREADING AND FINISHING

- A. GENERAL** - Asphaltic paving mixtures shall be laid only on surfaces that are dry and when weather conditions are satisfactory. Spreading of asphaltic mixtures will not be permitted during rain. Mixture that gets rained on suddenly while being transported to the job Site may be placed provided the mixture is within the temperature limits specified and can be satisfactorily placed and rolled. Loads mixed and dispatched to the Site of Work after rain has commenced shall be rejected.

All asphaltic mixtures shall be spread and finished by a bituminous paver where practicable. Permission to spread and finish by hand must be secured from the Engineer. The placing of all asphaltic mixtures shall be as continuous as practicable and in a manner to eliminate joints. Asphaltic mixtures of the same type but from different Plants shall not be used alternately on the same section of a project. Contact surfaces of curbs, gutters, manholes and similar structures shall be painted with a thin uniform coating of hot asphalt cement or rapid setting emulsified asphalt, prior to placing the hot asphaltic mixture against them. Bituminous mixtures shall not be placed on a surface that is contaminated.

- B. PLACING AND FINISHING BY MACHINE** - All spreading and finishing machines shall meet the requirements of 904.04. The width placed by the machine shall be as approved by the Engineer, within the capabilities of the equipment. The Contractor is advised that the echelon method of spreading asphaltic mixtures shall be employed wherever, in the opinion of the Engineer, a roadway is of sufficient width and area to permit the use of 2 or more pavers or the location of the Project requires their use. Direction of the pavers shall not be changed by turning on newly placed bituminous pavements.

When placing asphaltic mixtures, joints shall be formed at the end of each day's work or when placing is discontinued for such period of time that the material cools below 140 degrees Fahrenheit. The joints shall be formed by laying and rolling against boards of the thickness of the compacted mixture or by such methods as may be approved by the Engineer.

- C. PLACING AND FINISHING BY HAND** - Tools for placing and finishing by hand shall conform to the requirements of 904.06. The Contractor shall provide means for keeping all small tools clean and free from accumulations of asphaltic materials. The mixture shall be distributed by means of hot shovels of approved size and shape and spread with hot rakes to the thickness specified. In



spreading, the loose material shall be thoroughly raked throughout its depth. Attention shall be paid to raking the loose material to its full thickness with the tines of the rake in order to eliminate voids. Boards of sufficient length and proper thickness shall be laid on the base course to check the thickness of the loose material and as a means of obtaining a uniform grade. The thickness of the boards shall be frequently checked for accuracy.

Immediately after placing and raking the mixture, and prior to initial rolling, the surface of the mixture shall be smoothed by the use of a lute which conforms to the requirements of 904.06(A).

#### 401.11 COMPACTION OF ASPHALTIC MIXTURES

A minimum of 2 rollers meeting requirements of 904.05 will be required, a 2-axle 10 to 12 ton tandem roller and a 2-axle roller of 5 ton to 8 ton capacity. No separate or additional compensation will be allowed. At the option of the Contractor and with the approval of the Engineer, intermediate rolling of asphaltic mixtures may be accomplished by the use of self-propelled pneumatic tired rollers meeting the requirements of 904.05. Initial and finish rolling, however, shall be done by steel-wheeled rollers. Each roller shall be operated by a competent, experienced operator, and while Work is underway, must be kept as nearly as practicable in continuous operation.

The motion of the roller shall at all times be slow enough to avoid displacement of the mixture and in no case shall the roller speed exceed 130 feet per minute. Any displacement of the mixture occurring as a result of reversing the direction of the roller or from any other cause, and any other surface irregularities developed by rolling, shall at once be corrected by the use of rakes, and fresh mixture applied when required. Straight edging and back patching shall be done immediately after initial compaction has been secured and while the material is still workable. To prevent adhesion of the mixture to the roller, the rolls shall be kept properly moistened, but excessive water will not be permitted.

For a radial distance of 8 inches around all Structures including manholes, along curbs, gutters and where it is impracticable to obtain proper compaction with rollers, compaction shall be effected with tampers, smoothing irons or mechanical tampers.

- A. BASE AND LEVELING COURSES** - Base and leveling courses shall be rolled starting longitudinally at the extreme sides and proceed toward the center of the pavement, overlapping on each successive trip by about 1/2 the width of the rear roll, but not less than 6 inches.

No traffic, except in connection with the delivery of asphaltic mixtures, shall be permitted on the newly laid pavement without the permission of the Engineer. All areas which become coated with any foreign material or that are loose shall be removed and replaced with new material.

After compaction, the base or leveling course shall not show an excess of asphalt cement and any material showing such excess shall be removed and replaced with new material. Any material broken up excessively during the process of spreading or rolling or which remains unbound after rolling shall be removed and replaced with new material. Rolling of base courses shall continue until all roller marks are eliminated.

- B. SURFACE COURSES** - Rolling of surface courses shall start longitudinally at the extreme sides and proceed toward the center of the pavement, overlapping on each successive trip at least 1/2 the width of rear roll. If required by the Engineer, the surface shall then be subjected to a diagonal rolling in 2 directions, the second diagonal crossing the lines of the first. Rolling of surface courses shall continue until all roller marks are eliminated and required compaction attained.

The surface course after compaction shall not show any excess of asphalt cement and any material showing such an excess shall be removed and replaced with new material. Any material broken up excessively during the process of spreading or rolling or which remains unbound after rolling shall be removed and replaced with new material.

- C. DENSITY REQUIREMENTS** - The Bituminous Concrete pavements shall be compacted to the densities indicated herein:
1. **Base and Leveling Courses** – not less than 94 percent of the bulk density of a standard specimen as prescribed in AASHTO T 166 for the job mix formula.
  2. **Surface Courses** – not less than 96 percent of the bulk density of a standard specimen as prescribed in AASHTO T 166 for the job mix formula.

When a reference mold density per AASHTO T 166 is not available, the specific gravity determined by AASHTO T 209 will be used with the following minimum requirements: Surface Course, 92 percent, and Base Course, 90 percent.

#### **401.12 SURFACE COURSE JOINTS**

In the event that surface course paving by the echelon method is not required or permitted, or the joint cools below 140 degrees Fahrenheit, or where the new asphalt is placed against an old pavement, surface course longitudinal joints shall be cut back on a vertical face by means of a power masonry saw, or alternative method approved by the Engineer, until a thoroughly compacted full thickness of section is exposed. In general, the required cut shall be from 3 to 6 inches from the edge of the cold joint, but in no case shall it be less than 3 inches. Disposal of materials removed from cut joint shall be included in Work. Traffic shall not be permitted to cross the cut edge prior to placing adjoining lane. Before placing fresh asphalt mix against cut joint, adjacent area of old pavement shall be thoroughly cleaned and the exposed cut edge shall be given a light coat of rapid set emulsified asphalt. The fresh mixture shall then be raked against the joint and thoroughly tamped with hot tampers and rolled.

The surface across all joints shall be tested with a 10 foot straightedge meeting the requirements of 903.03 and shall meet the requirements for smoothness of asphaltic surface of these Specifications.

#### **401.13 PAVEMENT SAMPLES**

The Contractor, when directed by the Engineer, shall cut 1 foot by 1 foot slab samples from the compacted pavement for testing by the Engineer. Samples of the mixture shall be taken for the full depth of the course at the locations directed by the Engineer.

#### **401.14 SURFACE TOLERANCES**

The Contractor shall have available at all times a 10 foot straightedge approved by the Engineer. Appendix I and II - the Department's Special Provision for Pavement Ride Quality and all other applicable sections in this Standard shall be applied on all the National Highway System (NHS) roads.

Immediately following second or intermediate rolling, the surface will be tested in the approximate center of each wheel lane with a 10 foot straightedge approved by the Engineer.

The surface of each asphalt pavement course shall be true to the established line and grade and shall be sufficiently smooth so that when tested with a 10 feet straightedge placed upon the surface parallel to the centerline, the surface shall not deviate by more than 1/8 inch. The surface of the transverse slope of the finished surface of each course when tested with a 10 feet straightedge placed perpendicular to the centerline, shall not deviate more than 3/16 inch. Any irregularities exceeding these tolerances must be corrected.

The entire affected area of any surface irregularity found shall be loosened promptly and sufficient material removed or new material placed to form a true and even surface. Its location will be marked and rechecked by the Engineer after final compaction is complete.

Any such irregularity, as determined by the Engineer, shall be removed to its full depth and new material laid to form a true and even surface, and the costs thereof shall be borne by the Contractor.

The surface within areas occurring on arcs of vertical and horizontal curves, within 25 feet of the P.C. or P.T., within 25 feet of an intersecting street, or within 25 feet of a change in grade, will not be considered in road rater tests. However, irregularities at these locations may be ascertained by accurate survey measurements with due consideration given to specified changes in grade.

#### **401.15 PROTECTION OF ASPHALTIC PAVEMENT**

After the asphaltic mixture has received its final rolling, no vehicular traffic shall be permitted on the pavement until the surface temperature is 140 degrees Fahrenheit or below.

#### **401.16 CLEANING**

Upon satisfying 401.15, the Contractor shall clean, haul away, and dispose of all surplus materials, dirt, and debris from the Work area. The area shall be cleaned to the satisfaction of the Engineer. The edges of the surface course adjacent to gutters, curbs, or shoulders shall be neatly trimmed.

**401.17 PAVEMENT CORES**

- A. GENERAL** - The Contractor shall provide the equipment and labor needed to obtain pavement cores for consolidation (compaction) and pavement thickness verification. A minimum of 3 cores per block per lane or 500 feet per lane of pavement shall be obtained by water cooled diamond bits for minimum disturbance of the finished pavement. The created holes shall be filled and compacted with the same type hot mix asphalt in layers not exceeding 2 inches in thickness. The total number and size of cores shall represent the minimum surface area or quantity as specified in AASHTO T 168, Sampling Bituminous Paving Mixtures. The location of the cores shall be as selected by the Engineer. The Contractor shall obtain pavement cores at the direction of the Engineer within twenty-four (24) hours of placement of asphalt. Cores shall be given to the Engineer at the Project Site.
- B. MEASURE AND PAYMENT** - No measure or payment will be made. Cost of Pavement Cores shall be reflected and distributed among Asphalt Pay Items.

**401.18 ADJUSTMENT OF PRICE FOR ASPHALT BINDER**

An adjustment will be made to the Contract unit price of Hot Mix Asphalt items if the price of asphalt fluctuates significantly from the prevailing prices set by the Department as base price or as quoted in the Contract Documents to the date of placement. The Contract unit price will be adjusted by the amount of fluctuation ± 10 percent for contracts scheduled to be paved within Contract duration or having an estimated mix quantity of 10,000 tons or more. Only the differential percent changes beyond the above noted ± 10 percent will be used.

For purposes of making these calculations, a monthly price index will be maintained by the Department. This index will be the average F.O.B. selling price of asphalt binder at the supplier’s terminal in the District of Columbia or closest to the District of Columbia.

The adjusted Contract unit price of Hot Mix Asphalt will be computed monthly by using the following formula:

$$F = \frac{(PP - PB)}{PB} \times 100$$

Where:

F = Percent price increase/decrease of asphalt binder

PP = Index price of asphalt binder per ton at placement date, and

PB = Prevailing index price of asphalt binder per ton as specified in the Invitation for Bids or as fixed by the Department

Adjusted Contract unit price due the Contractor when price of asphalt binder increases:

$$A = B + (D \times T \times PB)$$

Adjusted Contract unit price due the Department when price of asphalt binder decreases:

$$A = B - (D \times T \times PB)$$

Where:

A = Adjusted Contract unit price per ton of Hot Mix Asphalt

B = Contract unit price per ton of Hot Mix Asphalt

D = Differential percentage expressed as a decimal (F- 0.10 or F + 0.10 as defined above)

T = Design target asphalt content expressed as a decimal

PB = Prevailing index price of asphalt binder per ton as specified in the Contract or as fixed by the Department

Price adjustment will be shown as a separate entry on the monthly progress estimate; however, such adjustment will not be included in the total cost of the Work for progress determination or for extension of the Contract Time.

## 402 HOT MIX ASPHALT PAVEMENT (HMA)

### 402.01 DESCRIPTION

This Work shall consist of constructing 1 or more courses of bituminous pavement in accordance with the requirements of 401, these Specifications, and shall be in conformity with the lines, grades, thicknesses, and cross sections shown in the Contract Documents and as directed by the Engineer. The asphaltic mixture shall be either HMA 25.0 mm, HMA 19.0 mm, HMA 12.5 mm, HMA 9.5 mm, or HMA 4.75 mm as designated and composed of a mixture of asphalt cement, coarse aggregates, fine aggregates, and anti strip additive, or hydrated lime, as required by the approved job mix formula.

### 402.02 MATERIALS

Requirements of 401.03 apply except as modified herein.

- 803.04: Coarse aggregate
- 803.03: Fine aggregate
- 803.03(A): Stone screenings, No. 10 aggregate and shall be non- plastic.
- 822.03(A): Hydrated lime
- 802.07: Anti strip additive

### 402.03 CONSTRUCTION REQUIREMENTS

The construction requirements shall be as prescribed in 401. The Contractor shall have the option to use Plant mixed recycled bituminous concrete in place of virgin Plant mixed asphaltic concrete provided the recycled bituminous concrete meets the gradation requirements of 401.02.

- A. Recycled asphalt base course shall consist of asphalt milling or crushed bituminous pavement with maximum nominal size not to exceed 1 inch. There shall be no deleterious materials in the recycled concrete. The total amount of RAP in the mix shall not exceed 25 percent by weight of total mix.
- B. For surface course the Contractor may use RAP material from milling or crushed bituminous pavement. The RAP shall be free of deleterious materials and crushed to 3/8 inch maximum nominal size. The total amount of RAP in the mix shall not exceed 15 percent by weight of mix.
- C. HMA Pavement as base and surface course shall consist of recycled asphaltic concrete, coarse aggregate, fine aggregate, mineral filler, asphalt cement with or without RAP, modifying agent and hydrated lime, or anti strip additive as required by the approved job mix formula.
- D. Asphalt Cement shall conform to the requirements of 818 and AASHTO M 320. The delivery and certification requirements of 802.01 apply.
- E. Hot Asphaltic Concrete (HMA 25.0 mm, 19.0 mm base course or 9.50 mm leveling course) shall be compacted to not less than 94 percent of the bulk density of a standard specimen compacted as prescribed in AASHTO T 166 or not less than 90 percent of the maximum specific gravity determined in accordance with AASHTO T 209.
- F. Hot Asphaltic Concrete (HMA 12.5 mm and 9.5 surface course) shall be compacted to not less than 96 percent of the bulk density of a standard specimen compacted as prescribed in AASHTO T 166 or not less than 92 percent of the maximum specific gravity determined in accordance with AASHTO T 209.
- G. Hot Asphaltic Concrete pavement for base shall be placed in layers not to exceed 4 inches compacted thickness unless otherwise approved by the Engineer.

- H. Hot Asphaltic Concrete pavement for surface shall be placed in layers not to exceed 2 inches compacted thickness unless otherwise approved by the Engineer.

**402.04 MEASURE AND PAYMENT**

The unit of measure for HMA as base, leveling course, and surface course of the class specified will be the ton. The number of tons will be the actual number of tons complete in place as weighed on approved truck scales. The Engineer will deduct the weight of all material lost, wasted, damaged, rejected, or applied in excess of the Engineer's direction or contrary to these Specifications.

The number of tons of HMA as base or leveling course of the class specified, as measured, will be paid at the Contract unit price per ton, which payment will be full compensation for furnishing, hauling, and placing all materials and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work as specified herein.

## **403 TACK COAT**

### **403.01 DESCRIPTION**

Work shall consist of applying, where directed by the Engineer, a Tack Coat conforming to 802.04. The Tack Coat shall be pressure sprayed in the form of a spray mist onto clean roadway surfaces at a uniform rate of 0.01 to 0.05 gallon residual asphalt per square yard. Emulsions shall be diluted in the ratio of 3 parts emulsion to 1 part water by volume prior to use. Spraying equipment shall be approved in advance by the Engineer. When approved by the Engineer, trackless tack coat may be used in lieu of the tack coat specified in 802.04

### **403.02 CERTIFICATION**

Each delivery of tack coat from the refinery shall be accompanied by a copy of certified test results from testing completed not more than four (4) weeks prior to delivery of the material. Certification shall include a statement as to type, and amount of material contained in each carrier, and the identification of the storage tanks from which the material is delivered, with quantities determined from a certified gallon ticket for each location of Work. The certification shall be presented to the Engineer upon delivery.

### **403.03 CONSTRUCTION REQUIREMENTS**

Roadway surfaces shall be prepared and properly cleaned by power broom, compressed air, or other suitable means, and existing thermoplastic and/or pre-molded plastic markings removed prior to tack coat application. Tack coat shall be applied sufficiently in advance so that a tacky surface exists at time asphalt surface mix is placed. Extra tack coat shall not be applied except with the specific approval of the Engineer. The time interval between application of the tack coat and placement of the asphalt mix shall be sufficient to allow the tack coat to set (break). In no case shall the time interval between application of the tack coat and placement of the asphalt mix be less than ten (10) minutes. All necessary precautions shall be taken to prevent staining of curb and gutter surfaces. In the event such staining occurs, it shall be removed at the Contractor's expense.

### **403.04 MEASURE AND PAYMENT**

The unit of measure for Tack Coat will be the square yard.

Payment for Tack Coat will be made at the Contract unit price per square yard complete in place, which payment will include proper cleaning of roadway, removal of pavement marking, furnishing, and applying the tack coat, extra tack coat where authorized, and all labor, materials, tools, equipment, and incidentals needed to complete specified Work.

## 404 SLURRY SEAL

### 404.01 DESCRIPTION

Slurry Seal shall consist of mixing and placing a bituminous mixture on clean roadway surfaces in conformance with these Specifications, where shown on the Plans and/or where directed by the Engineer.

### 404.02 COMPOSITION

Slurry Seal shall consist of emulsified asphalt, mineral aggregate and water; and when required, may also consist of Portland Cement and/or an additive. Slurry Seal shall contain 2.5 to 3.0 gallons of asphalt emulsion for every 100 pounds of mineral aggregate, and the amount of water shall be regulated for proper consistency.

### 404.03 MATERIALS

- A. **ASPHALT EMULSION** - Asphalt emulsion shall conform to the requirements of 802.04.
  - 1. **Emulsified Asphalt** – AASHTO M 140, Grade SS-1 or 1h.
  - 2. **Cationic Emulsified Asphalt** – AASHTO M 208, Grade CSS-1 or 1h.
- B. **MINERAL AGGREGATE** - Mineral aggregate shall consist of clean aggregate and mineral filler, combined to meet the gradation of 803.08. For the portion passing the 200 sieve, Portland Cement may be used in an amount up to 2 percent by weight total aggregate mix to increase mixing time.
- C. **WATER** - Water shall conform to 822.01 and be free from foreign matter.
- D. **ADDITIVE** - An additive may be mixed with the water to extend the mixing time as temperatures increase.

### 404.04 CONSTRUCTION REQUIREMENTS

- A. **SURFACE PREPARATION** - Roadway surfaces shall be prepared and properly cleaned by power broom, compressed air, or other suitable means prior to Slurry Seal application. Prior to application of slurry seal, pavement surface and all crack faces shall be sprayed with water.
- B. **WEATHER AND TEMPERATURE** - Slurry seal shall be placed only when ambient air temperature is 60 degrees Fahrenheit or above. Slurry seal shall not be placed if rain is pending before the mix can properly set.
- C. **CONSTRUCTION METHODS** - A continuous feed-mix-flow spread slurry machine shall be used to produce and place creamy textured slurry that, when spread, will flow in a wave approximately 2 feet ahead of the strike-off squeegee to a minimum thickness of 1/4 inch, as well as flow into and fill pavement cracks, before the strike-off passes over. Where cracks exceed 1 inch in depth and 1/2 inch in width, they shall be first filled with the slurry mix prior to placing Slurry Seal over the entire surface.

The surface shall be damp, but no free water shall remain when slurry mix is applied. Slurry seal shall be applied sufficiently in advance of overlay so that the slurry mat may set. The time interval between application of the slurry seal and placement of the asphalt mix will be regulated by the Engineer.

Traffic shall be kept off the slurry seal until it has set sufficiently to prevent pick-up of the mix. Hand work with squeegees will be required as needed.

A pneumatic tired roller with smooth treads shall be used as directed by the Engineer.

### 404.05 MEASURE AND PAYMENT

The measure for Slurry Seal will be the square yard in place.

Payment will be made at the Contract unit price per square yard complete in place, which payment will include proper cleaning of roadway, furnishing, and applying the slurry mix, curing, and all labor, tools, materials, equipment, and incidentals needed to complete specified Work.

**405 TEMPORARY ASPHALT CONCRETE****405.01 DESCRIPTION**

Work shall consist of furnishing, hauling, and placing hot asphaltic concrete in areas shown on Contract Drawings or as directed by the Engineer, for temporary connections to existing roadways, sidewalks and detours, as shown on the Plans, as may be necessary to maintain pedestrian and vehicular traffic. Work shall include the removal and disposal of Temporary Asphalt Concrete when no longer required.

**405.02 MATERIALS**

Temporary Asphalt Concrete shall meet the requirements of 402.03 for Hot Asphaltic Concrete, HMA mixes, 12.5 mm or 9.5 mm..

**405.03 ALTERNATE**

In case the specified material is not readily obtainable, a cold asphalt mix may be substituted as an equivalent alternate, subject to prior approval of the Engineer, and shall meet the requirements of 819

**405.04 MEASURE AND PAYMENT**

Measure for furnishing, hauling, installation and maintenance of Temporary Asphalt Concrete shall be made in conformance with 402.04.

Payment will include removal and disposal of materials no longer needed.



## **406 STONE FILLED SHEET ASPHALT PATCHING**

### **406.01 DESCRIPTION**

This Work shall consist of constructing a thin surface repair or skin patch in areas of spalled pavement, deteriorated joints and streetcar track rail grooves, or as directed by the Engineer.

### **406.02 MATERIALS**

- 802.04: Tack Coat
- 818.02: Stone Filled Sheet Asphalt Surface

### **406.03 CONSTRUCTION REQUIREMENTS**

All defective material, asphalt and tar patch, spalled and cracked pavement, faulty joints and joint material, unsound concrete and asphalt shall be removed. The area shall be carefully cleaned to the satisfaction of the Engineer. Loose rust shall be removed from car tracks by sanding and by use of wire brushes to the satisfaction of the Engineer. Car track rail grooves shall be swept clean.

The perimeter of the repair shall be cut to a neat line as defined in 408.03 when the repair is to become part of the permanent Roadway surface. A neat line cut is not required where the repair is to be covered or resurfaced.

Dust and dirt shall be removed by compressed air or by careful brooming so as to leave surface dry and clean to sound concrete.

As soon as practicable after cleaning and while surfaces are free of all objectionable matter and dry, a tack coat shall be applied as specified in 403.

Sheet asphalt shall be carefully placed by hand in patch areas and in track rail grooves. The asphalt mix shall be compacted by hand methods and followed by mechanical compaction. Work shall be complete and open to traffic for at least three (3) days prior to placing asphalt cover courses. Minor depressions which develop under traffic may be filled as part of the first surface course.

### **406.04 MEASURE AND PAYMENT**

The unit of measure for Sheet Asphalt Patching will be the ton of sheet asphalt used for this purpose, complete in place.

Payment will be made at the Contract unit price per ton, which payment will include all removal and cleaning operations, disposal of excavated materials, repair of pavement damaged by Contractor, cutting to a neat line when required, tack coat, furnishing, placing and all compaction of the asphalt, curing and all labor, materials, tools, equipment, and incidentals necessary to complete specified Work.

## **407 ASPHALT PATCHING**

### **407.01 DESCRIPTION**

This Work shall consist of the removal of defective areas of asphalt and shallow depths of concrete pavements including joints and joint material and the replacement with bituminous materials in areas directed by the Engineer.

### **407.02 MATERIALS**

- 802.04: Tack Coat
- 402.03: Surface, 12.5mm or 9.5 mm
- 402.03: Leveling Course, 9.5 mm or 4.75 mm
- 402.03: Base Course, 19 mm or 25 mm

### **407.03 CONSTRUCTION REQUIREMENTS**

All defective areas shall be cut out and thoroughly cleaned of loose materials to a depth where the pavement appears to be sound. The Contractor may use the most economical method for the removal of this material with the approval of the Engineer.

The perimeter of the repair shall be cut to a neat line and repaired as specified in 408.03.C when the repair is to be part of the Roadway surface. A neat line is not required where the repair is to be covered or surfaced.

After the patch is complete, traffic is not to be placed on the patch for at least three (3) days prior to surfacing.

Minor depressions which develop may be filled and compacted as part of the first surface course.

### **407.04 MEASURE AND PAYMENT**

Unit of measure for Asphalt Patching will be the ton of asphalt mixture used for this purpose, complete in place.

Payment will be made at the Contract unit price per ton, which payment will include all removal and cleaning operations, disposal of excavated materials, tack coat, furnishing, placing, and all compaction of the asphalt, curing, and all labor, materials, tools, equipment, and incidentals needed to complete the specified Work.

## **408 REPAIR – REPLACE BITUMINOUS SURFACES AND BASE**

### **408.01 DESCRIPTION**

This Work shall consist of the covering of cuts in bituminous surfaces for underground installations, removing and replacing the binder and surface courses in defective areas, and miscellaneous minor construction; such repairs and construction to be executed as directed by the Engineer and to include all incidental Work necessary to complete the repair as ordered.

### **408.02 MATERIALS**

The materials for the repair work shall meet the requirements as specified for the type of pavement to be repaired. For each asphalt mix, the job mix formula shall conform to the requirements of 818.02.

### **408.03 CONSTRUCTION REQUIREMENTS**

The Contractor shall not make excavations or pavement openings to a greater extent than can be replaced and repaved during the same working day unless otherwise approved by the Engineer. Bituminous Surface and Base courses shall be replaced by new construction which closely conforms to the Specifications for the type of material which was removed with the following additions:

- A. CUTTING OUT DEFECTIVE AREAS** - All defective base and surface course material shall be cut out and the loose material removed and disposed of outside the area of Work at the Contractor's expense. This shall be accomplished as soon as possible and in no case shall the material be left on the Project overnight.
- B. REPAIR OF CUTS** - When the pavement base in the cut areas has been replaced, the existing asphalt must be sawn to a neat line, the base thoroughly cleaned, and a tack coat applied before new surface material is placed upon it.
- C. CUTTING TO A NEAT LINE** - The perimeter of all cuts and/or defective area repairs in asphalt roadways, alleys, sidewalks, gutters, and other miscellaneous pavements which become part of the permanent Roadway surface shall be cut to a neat line by means of a power saw. All surfaces will be sawn to a minimum depth of 1 inch.

The new material shall be placed, on the same day as the asphalt is removed, adjacent to the neat line. Should the Contractor fail to place the asphalt surface the same day, a new saw cut may be required.

A hand torch will be available to remove patching material from the existing Roadway. No separate payment shall be made for the use of the power saw.

- D. COMPACTION OF BITUMINOUS MATERIAL** - The bituminous mixture shall be compacted in accordance with the method specified for the type of pavement being repaired except that a 5-ton roller may be used where the area is less than 50 square yards. An approved vibrating roller may be used in areas where other rollers are not practicable.

Base and surface mixture adjacent to old pavement or structures shall be tamped as in the case of the surface mix.

When directed by the Engineer, on any repairs, the asphalt base course shall be omitted and replaced by Portland Cement Concrete base. This is intended for small repairs where it is impracticable to compact the binder course with a roller. The Elevation of the finished concrete bases shall be sufficiently below the pavement surface to allow for the placing and proper compaction of the specified thickness of surface mixture.

The surface of the repaired area shall be left smooth and even with the adjoining surface. No vehicular traffic of any kind shall be permitted on the bituminous surface until it has hardened sufficiently.

### **408.04 WASTED MATERIAL**

Deduction will be made for the actual quantity of materials wasted or not used after delivery as determined by the Department Field Inspector.

**408.05 MEASURE AND PAYMENT**

- A. ASPHALT SURFACE** - The unit of measure of Asphalt Surface of the type specified for covering cuts or street openings and for repairing asphalt pavements will be the ton.

The actual number of tons measured complete in place will be paid for at the Contract unit price per ton, which payment will include sawing, tacking, removing and disposing of existing materials, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

- B. ASPHALTIC CONCRETE BASE** - The unit of measure for Asphaltic Concrete Base, as used in sheet asphalt pavements, for covering cuts or street openings and for repairing sheet asphalt and asphalt block pavements, will be the ton.

The actual number of tons measured complete in place will be paid for at the Contract unit price per ton, which payment will include removal and disposal of existing materials and all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

**409 ASPHALT BIKE PATH****409.01 DESCRIPTION**

This Work shall consist of constructing a hot asphaltic concrete bike path on a prepared grade to the line, grade, and dimensions specified in the Contract Documents.

**409.02 MATERIALS**

- 402.03: Hot Asphaltic Concrete Surface-9.5 mm

**409.03 CONSTRUCTION REQUIREMENTS**

The pertinent provisions of 401 apply except that a 3 to 5-ton roller shall be used to obtain the required compaction. A 3-wheel roller will not be required. Hand work in certain areas may be approved when machine-laid asphalt would be impracticable.

**409.04 MEASURE AND PAYMENT**

The unit of measure for Asphalt Bike Path will be the ton. The actual number of tons of hot asphaltic concrete used will be paid for at the Contract unit price per ton, which payment will include furnishing all labor, equipment, materials, and other incidentals necessary to complete the Work as specified.

## **410 PAVEMENT PROFILING (MILLING)**

### **410.01 DESCRIPTION**

Work consists of profiling the existing asphaltic or PCC roadways to the depth specified in the Contract Documents or as directed by the Engineer.

Unless otherwise specified in the Contract Documents, all millings removed become the property of the Contractor and this material shall be removed and disposed of away from the Site.

### **410.02 EQUIPMENT AND CONSTRUCTION**

Equipment to be used for the milling process shall be inspected and approved prior to use and must pass all air quality regulations of the District. The milling machine must have the capability of milling a path a minimum of 40 inches wide and must have baffles attached to direct the milled material to the center point of the machine. It is desirable that the machine be equipped with a truck loading conveyor. If the areas adjacent to utility structures, corners, gutters, and all similar roadway projections are inaccessible to the milling machine, the Contractor shall place these areas on grade by other methods approved by the Engineer. The total completed process shall leave a finished surface which does not vary more than 1/4 inch from a 10 foot straightedge. All equipment shall comply with provisions of 903.01.

### **410.03 MEASURE AND PAYMENT**

The unit of measure for Pavement Profiling will be the square yard for a thickness up to 3.5 inches or to the surface of existing concrete base course, with no deductions for structures in the Roadway.

The number of square yards will be paid for at the Contract unit price per square yard, which payment will include the cost of furnishing all labor and equipment, including cutting to a neat line, jack hammering, hand milling, and the hauling and disposal of all milled material. Feathering of asphalt around manholes, gutters, ramping, filling of voids, and other measures necessary to assure a safe riding condition shall be included in Pavement Profiling. Feathering should be accomplished using hand tools and should result in an even transition between asphalt riding surface and manholes, gutters, etc. No additional payment for these measures will be made.

**411 FURNISHING BITUMINOUS MATERIALS****411.01 DESCRIPTION**

Work consists of furnishing and delivering to District trucks, at the Contractor's or Subcontractor's Plant within the District, bituminous mixtures of the type specified, in such quantities as may be directed by the Engineer and in accordance with provisions of these Specifications.

A twenty-four (24)-hour notice of a change in location of the furnishing Plant will be required except in case of extreme emergency, such as mechanical failure in the Plant.

**411.02 MEASURE AND PAYMENT**

The unit of measure for Furnishing Bituminous Mixtures will be the ton. The number of tons will be the actual number of tons placed in District trucks and weighed on approved scales at the Contractor's Plant. The scales shall be of sufficient size and dimensions to accommodate District hauling equipment. The net weight, as determined from the gross and tare weights, will be the weight on which payment is to be made. No payment will be made on individual batch weights.

The number of tons of Bituminous Mixtures will be paid for at the Contract unit price per ton, which payment will include coating truck beds, weighing trucks on approved scales, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

## **412 CUT PAVEMENT CHANNEL**

### **412.01 DESCRIPTION**

Work consists of cutting a tapering channel approximately 4 feet wide in existing concrete or asphalt surface where a proposed new surface meets the existing pavement and as directed by the Engineer.

The channel shall be formed by making a vertical neat line cut between 1 and 2 inches deep, approximately, as determined by the Engineer, and carefully removing existing surface by chipping, stripping, etc. as directed by the Engineer to form a gradual taper up to 4 feet wide and feathered to meet existing surface.

Where a new surface is to abut PCC pavement, the vertical cut line shall be made with a power saw designed for that purpose. Surfaces damaged from cutting procedures shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost to the District. Vertical cut line will not be necessary in PCC pavement at gutter outer edge or if the Engineer determines that a pavement joint may be used.

All tools used shall meet the approval of the Engineer. Disposal of removed materials shall be included as part of the Work.

### **412.02 MEASURE AND PAYMENT**

The unit of measure for Cut Pavement Channel will be the square yard of channel removed.

The actual number of square yards removed will be paid for at the Contract unit price per square yard, which payment will include all operations necessary for proper removal, repair of pavement damage due to removal operations, and all labor, tools, equipment, and incidentals necessary to complete the Work.



### 413 WARM MIX ASPHALT PAVEMENT (WMA)

#### 413.01 DESCRIPTION

Warm mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of 1 or more of several WMA technologies.

At no time shall WMA be placed on a frozen sub-grade.

The Contractor shall read and thoroughly understand the requirements of the QA/QC Specifications as defined in the Department Standard Specifications. It is the responsibility of the Contractor to determine all costs associated with meeting these requirements and to include them in the per ton bids for the various Superpave items.

#### 413.02 MATERIALS

WMA may be produced by 1 or a combination of several technologies involving Plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 215 degrees Fahrenheit to 275 degrees Fahrenheit.

- A. **ASPHALT BINDER** - The Performance Grade Asphalt Binder shall meet the requirements of AASHTO M320, Table 1 for PG 64-22, PG 70-22, or PG 76-22. Substitution of a higher temperature grade binder will require prior approval by the Engineer.
- B. **RECYCLED MATERIALS** - The percentage allowance of recycled materials shall be controlled by 406. The program can be used by the Contractor, to determine which materials and combinations of materials can be used to meet the specified material on the Contract.
- C. **SHINGLES** - Only shingles reclaimed from shingle manufacturers such as tabs, punch-outs, and damaged new shingles shall be allowed in the mixture. Post-consumer shingles or used shingles shall not be permitted in the mixture, and all shingles shall be free of all foreign material and moisture. Fiberglass-backed and organic felt-backed shingles shall be kept separately, and both materials shall not be used in the same mixture at the same time. The shingles shall be broken down in the mixing process with 100 percent passing the 1/2 inch (12.5 mm) sieve. Shipping, handling, and shredding costs are incidental to the price of WMA item. Shingles may be used only in base course and shall not exceed 5 percent by weight of total mix.
- D. **MINERAL AGGREGATE** - The mineral aggregate employed in the target gradation of the job mix formula shall conform to 803 and Table 413.02 (A). The criteria of Table 413.02 (A) apply to the combined aggregate blend.

**TABLE 413.02 (A) MINERAL AGGREGATE**

Design ESALs (Millions)	Coarse Aggregate Angularity <sup>a</sup> (% Min)		Fine Aggregate Angularity <sup>b</sup> (% Min)		Sand Content <sup>c</sup> (% - Min)	Flat and Elongated <sup>d</sup> (% - Max)
	# 100 mm	> 100 mm	# 100 mm	> 100 mm		
30	95/90	80/75	45	40	45	5:1 aspect ratio

- a Coarse Aggregate Angularity is tested according to ASTM D5821.
- b Fine Aggregate Angularity is tested according to AASHTO TP-33.
- c Sand Content is tested according to AASHTO T 176.
- d Flat and Elongated is tested according to ASTM 4791 with a 5:1 aspect ratio.

The source properties in Table 413.02 (B) apply to the individual aggregates in the aggregate blend for the proposed job mix formula.

TABLE 413.02 (B) TEST METHODS

Test Method	Specification Limits
LA Abrasion, AASHTO T 96 Percent Loss, Maximum	40
Soundness, AASHTO T 104 Percent Loss, Maximum for 5 cycles	15 for Course 20 for Fine
Deleterious Materials, AASHTO M 6, Percent, Maximum	Class A
Moisture Sensitivity, AASHTO T 283 Percent, Minimum	80

**E. MINERAL FILLER** - The mineral filler shall conform to AASHTO M 17.

### 413.03 MIX DESIGN REQUIREMENTS

**A. MIX DESIGN** - Develop and submit a job mix formula for each mixture according to AASHTO R35. Each mix design shall be capable of being produced, placed and compacted as specified. Apply all mix design requirements for Superpave to the development of the WMA mix design.

The Contractor shall submit a written mix design formula on the Department Standard Form for review and approval at least 30 Calendar Days before production. The following information shall be submitted:

1. WMA technology and/or additive information.
2. WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
3. Documentation of past WMA technology field application including points of contact.
4. Temperature range for mixing and compacting.
5. Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
6. Laboratory test data, samples and sources of all mix components, and asphalt binder viscosity-temperature relationships.

The Contractor shall follow the manufacturer's recommendation for incorporating additives and WMA technologies into the mix. The Contractor shall also comply with the manufacturer's recommendation regarding receiving, storage, and delivery of additives.

Ensure that a Technical Representative from the specified WMA additive or process manufacturer is present during production and placement of the initial WMA pavement section. During the initial production, the Contractor shall place no more than 500 tons or up to one (1) day's production as directed by the Engineer at an approved site, which may be the Project Site, so the Engineer can examine the process control of the mixing Plant, the Contractor's placement procedures, surface appearance of the mix, and compaction patterns of the Contractor's roller(s).

**B. GRADATION** - The FHWA Superpave 0.45 Power Chart with the recommended restricted zone shall be used to define permissible gradations for the specified mixture. Target values for percent passing each standard sieve for the design aggregate structure shall comply with the Superpave control points and should avoid the restricted zone. Percentages shall be based on the washed gradation of the aggregate according to AASHTO T11.

In addition to the results of the material requirements specified above, the following material properties shall be provided by the Contractor: bulk specific gravity  $G_{sb}$ , apparent specific gravity  $G_{sa}$ , and the absorption of the individual aggregate stockpiles to be used, tested according to AASHTO T 84 and AASHTO T 85 and reported to 3 decimal places along with the specific gravity of the mineral filler to be used, tested according to AASHTO T 100 and reported to 3 decimal places.

**C. SUPERPAVE GYRATORY COMPACTIVE (SGC) EFFORT** - The Superpave Gyratory Compaction effort employed throughout mixture design, field quality control, or field quality assurance shall be as indicated below. All mixture specimens tested

in the SGC shall be compacted to  $N_M$  Height data provided by the SGC shall be employed to calculate volumetric properties at  $N_i$ ,  $N_D$ , and  $N_M$

**D. SUPERPAVE GYRATORY COMPACTIVE (SGC) EFFORT**

Design Traffic Level (Million ESALs)	$N_{initial}$	$N_{design}$	$N_{maximum}$
3 -30	8	100	160
Required % $G_{mm}$	< 89.0%	96.0%	98.0%

**E. VOLUMETRIC DESIGN PARAMETERS** - The design aggregate structure and percent Binder targets shall satisfy the criteria below and, at  $N_{design}$ , the air voids ( $V_a$ ) shall be 4.0 percent.

**TABLE 413.03 (A) VOLUMETRIC DESIGN PARAMETERS (3.0 MILLION – 30 MILLION ESEALS)**

	Nominal Maximum Aggregate Size, mm				
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
(% VMA at $N_{design}$ ), Minimum	12.0	13.0	14.0	15.0	16.0
(% VFA at $N_{design}$ ), Range	65-75	65-75	65-75	73-76	66-77
Dust to Binder Ratio	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2	0.6 – 1.2	1.5 – 2.0

**F. AGGREGATE GRADATION CONTROL POINTS** - The combined aggregates shall conform to the gradation requirement specified in Table 413.03 (B) when tested in accordance with T-11 and T-27.

**TABLE 413.03 (B) AGGREGATE GRADATION CONTROL POINTS (% PASSING)**

Sieve Size	Superpave Mix Type (Size)					
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max
50.0 mm	100					
37.5 mm	90-100	100				
25.0 mm	Max. 90	90-100	100			
19.0 mm	--	Max. 90	90-100	100		
12.5 mm	--	--	Max. 90	90-100	100	100
9.5 mm	--	--	--	Max. 90	90-100	95-100
4.75 mm	--	--	--	--	Max. 90	90-100
2.36 mm	15-41	19-45	23-49	28-58	32-67	--
1.18 mm	--	--	--	--	--	30-55
0.075 mm	0-6	1-7	2-8	2-10	2-10	6-13

Note: The aggregates gradation for each sieve must fall within the minimum and maximum limits.

**G. GRADATION CLASSIFICATION** - The Primary Control Sieve (PCS) defines the break point between fine and coarse mixtures. The combined aggregate gradation shall be classified as “course graded” when the JMF target is less than the PCS for the given sieve and mix type. If the value is higher than the PCS, then the mix is considered “fine graded”. Use Table 413.03 (C) to determine the class of mix being considered.

**TABLE 413.03 (C) AGGREGATE GRADATION CONTROL POINTS FOR DIFFERENT MIX SIZES, (% PASSING)**

Mix Normal Max. Size	Superpave Mix Type (Size)			
	25.0 mm	19.0 mm	12.5 mm	9.5 mm
Primary Control Sieve	4.75 mm	4.75 mm	2.36 mm	2.36 mm
PCS Control Point	40%	47%	39%	47%

Note Control Point aggregate gradation passes beneath the PCS control point specified in the above table, the dust to binder ratio may be increased from 0.6 - 1.2 to 0.8-1.6

**H. DESIGN EVALUATION** - The Contractor shall furnish a Job Mix Formula (JMF) for review and approval. The Engineer will evaluate the proposed JMF and suitability of all materials. All materials requested by the Engineer shall be provided at the Contractor- 1.2 to 0.8-1.6 fined below. All other gradations shall be classified as fine graded. ng to AASHTO T 100 tractor shall provide sufficient material for each Mix Design as required

1. The proposed JMF shall include the following:

Plot of the design aggregate structure on the FHWA Superpave 0.45 power chart showing the maximum density line, Superpave control points, and recommended restricted zone.

Plot of the 3 trial asphalt binder contents at +/- 0.5 percent gyratory compaction curves where the percent of maximum specific gravity (percent of  $G_{mm}$ ) is plotted against the log base 10 of the number of gyrations ( $\log(N)$ ) showing the applicable criteria for  $N_i$ ,  $N_d$ , and  $N_m$ .

Plot of the percent asphalt binder by total weight of the mix ( $P_b$ ) versus the following:

percent of  $G_{mm}$  at  $N_d$ , VMA at  $N_d$ , VFA at  $N_d$ , Fines to effective asphalt binder ( $P_{be}$ ) ratio, and unit weight (kg/m<sup>5</sup>) at both  $N_d$  and  $N_m$ .

Summary of the consensus property standards test results for the design aggregate structure, summary of the source property standards test results for the individual aggregates in the design aggregate structure, target value of the asphalt binder content, and a table of  $G_{mm}$  of the asphalt mixture for the 4 trial asphalt binder contents determined according to AASHTO T 209.

The JMF shall also include the NCAT Ignition Oven calibration for the specific materials utilized for this mix.

#### 413.04 CONSTRUCTION

**A. PRODUCTION PLANTS** - The Contractor shall modify their production Plant as required by the manufacturer to introduce the WMA technology. Plant modifications may include additional Plant instrumentation, the installation of asphalt binder foaming systems and/or WMA technology delivery systems, tuning the Plant burner and adjusting the flights in order to operate at lower production temperatures and/or reduced tonnage.

**B. WEATHER LIMITATIONS** - Place WMA only on dry, unfrozen surfaces and only when weather conditions allow for proper production, placement, handling, and compacting. Asphalt shall not be placed if the surface temperature is below 35 degrees Fahrenheit and when the ambient air temperature during the past twenty-four (24) hours is below 23 degrees Fahrenheit.

**C. COMPACTION** - The asphalt Plant mixing temperature and the deliver temperature at the Project Site for compaction shall be included on the JMF.

**D. MEASURE AND PAYMENT** - The unit of measure for WMA as Base, Leveling and Surface Course of the class specified will be the ton. The number of tons will be the actual number of tons complete in place as weighed on approved truck scales. The Engineer will deduct the weight of all material lost, wasted, damaged, rejected or applied in excess of the Engineer and Surface Course of the class specified will be the ton.

WMA as Base, Leveling, or Surface Course of the class specified, as measured, will be paid at the Contract WMA Pay Item per ton. The payment will be full compensation for furnishing, hauling, and placing all materials and for furnishing all equipment, tools, labor and incidentals necessary to complete the Work as specified herein.

## **414 CRACK SEALING**

### **414.01 DEFINITION**

Crack sealing involves thorough preparation of cracks and the placement of sealing material into the cracks to reduce moisture and debris penetration and to slow down the rate of the crack deterioration.

### **414.02 DESCRIPTION**

Work consists of routing and pressure cleaning (air blowing) and removing all dirt and debris from cracks 1/4 inch wide or larger and then applying crack sealant. Pavement cracks shall be routed to a width at least 1/2 inch wide and 3/4 of an inch deep prior to cleaning. Cracks shall be thoroughly cleaned by pressure means and dried prior to placing the joint sealer material flush with the existing Roadway with an overlay of approximately 1/2 inch on either side of the crack. Alligator cracks and cracks wider than 1-3/4 inches wide are not included in this Work unless directed by the Engineer.

### **414.03 MATERIALS**

Materials for Crack Sealing shall comply with 807.02, and be sampled, tested, and approved prior to application. Mixing and placing instructions of the manufacturer shall be followed, 2 copies of which shall be delivered to the Engineer prior to sealing operations. Defective and improperly placed joint sealers, as determined by the Engineer, shall be removed and replaced at the Contractor's expense.

### **414.04 CONSTRUCTION METHODS**

Cracks shall be thoroughly cleaned by pressure means and dried prior to placing the sealing material upon determination by the Engineer if the cracks are ready to be sealed. All foreign material shall be removed from the pavement. Following the cleaning, the sealing material shall then be placed in the cracks by pumping directly from the sealing equipment. The sealing equipment shall consist of a melting kettle with a mechanically operated agitator, a pump, a thermostatic temperature control with temperature reading, and an applicator wand per the manufacturer's recommendations. The equipment shall be in good working conditions, with insulated hoses, connectors and applicator, as recommended by the manufacturer, and approved by the Engineer. Sealant shall only be applied when the ambient and pavement temperature is 45 degrees Fahrenheit and rising. After application, the material shall be struck off flush with a rubber squeegee with the material no more than 1/2 inch wide on either side of the crack. A fine layer of No. 10 stone, slag dust or neat cement will be placed in the hot poured crack sealer to prevent pickup by vehicle tires.

### **414.05 MEASURE AND PAYMENT**

The unit of measure for crack sealing will be the linear foot of cracks sealed.

Payment for crack sealing will be made at the Contract unit price per linear foot, which payment will include routing and cleaning pavement cracks, furnishing and filling with sealing material, striking off with rubber squeegee, placing No. 10 stone, slag or neat cement, collecting and disposal of excess material, and all labor, materials and tools, equipment and incidentals necessary to complete the Work as specified herein.

## 415 IN-PLACE RECYCLING OF HOT MIX ASPHALT PAVEMENT

### 415.01 DESCRIPTION

This Work shall consist of recycling the existing hot mix asphalt (HMA) surface in a continuous multi-step process of heating, milling, adding virgin HMA and emulsified recycling agent, then remixing, reshaping, and compacting the recycled mixture. All Work under this item shall be in accordance with this specification, Asphalt Construction (Division 400) of the Standard Specifications, and in substantial conformance with the Contract Plans and Special Provisions, and as directed by the Engineer. This process requires the use of Recycling Rejuvenator for Heater Scarification and Hot In-Place Recycling.

### 415.02 MATERIALS

The asphalt-rejuvenating agent shall be composed of petroleum resin oil base, meeting the requirements of 800 with a record of satisfactory service. Satisfactory service is based on the capability of the material to increase the ductility, penetration and durability of the asphalt binder in the recycled asphalt. A letter of compliance which certifies that material conforms to the manufacturer Specifications shall accompany each delivery to projects.

### 415.03 CONSTRUCTION REQUIREMENTS

**A. PAVEMENT PREPARATIONS** - The entire area to be resurfaced shall be cleaned of all deleterious material. If required, the Contractor shall broom clean the area prior to commencement of Work. The Contractor is required to provide traffic control.

**B. HEATING, SCARIFYING, LEVELING, AND REJUVENATING** - The existing asphaltic material shall be heated, scarified, and mixed to the specified depth. Under no circumstances shall the scarifying teeth penetrate into the existing base.

The heated polymer modified rejuvenator shall be applied immediately following the scarifying teeth. The polymer modified rejuvenator is specifically formulated for use with the hot in-place recycling, and therefore, shall not be substituted.

The hot scarified material shall then be milled / remixed immediately following the application of the recycling agent to eliminate premature compaction of the hot recycled asphalt resulting in final differential compaction and to the desired longitudinal and transverse section by the use of an attached, heated, augured screed. Directly behind the screed process shall be an 8 to 12 ton roller for compaction.

At all manholes, valve boxes, etc., the finished grade of the heater-scarifying process shall be transitioned to blend into the existing grade.

### 415.04 MEASURE AND PAYMENT

Asphalt recycling performed and application of rejuvenating agent shall be measured by the square yard. The measured quantity of hot-in place recycling including surface preparation, heating, rejuvenating, mixing and compacting shall be the actual number of square yards completed and accepted. The basis for mobilization shall be lump sum payment.

Payment shall include all labor, equipment, materials, fuels, supplies, rejuvenating agent, and heating, scarifying, and application of rejuvenating agent.

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## 501 PORTLAND CEMENT CONCRETE PAVEMENT

### 501.01 DESCRIPTION

Work consists of constructing a pavement composed of Portland Cement Concrete, with reinforcement, on a prepared base course in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and cross sections shown in the Contract Documents or as established by the Engineer.

### 501.02 MATERIALS

- 817: Portland Cement Concrete, Class E
- 812.01: Welded wire fabric
- 807.04: Tie rod assemblies and tie rods
- 807.03: Load transfer assemblies
- 807.01: Preformed expansion joint filler
- 807.02(A) or (B): Joint-sealing materials
- 822.14: Impervious sub-grade materials
- 814: Concrete curing materials and admixtures
- 801.05: Fly ash

### 501.03 PROPORTIONING

The Contractor shall submit a mix design conforming to 817.01 for the approval of the Engineer. The approved mix design shall not be changed except as provided below.

- A. ADJUSTMENT FOR VARIATION IN FINENESS MODULUS (FM)** - If the FM of the fine aggregate varies by more than 0.20 from the established value, the mix design shall be adjusted as provided in 817.01.
- B. ADJUSTMENT FOR VARIATION IN WORKABILITY** - If it is impossible to obtain PCC of the desired workability with proportions approved by the Engineer, the Contractor shall make such changes in aggregate weights as necessary, provided that in no case shall the cement content originally designated be changed except as provided below.
- C. ADJUSTMENT FOR VARIATION IN CONSISTENCY** - If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content shall be increased as directed by the Engineer so that the maximum allowable water-cement ratio will not be exceeded.
- D. ADJUSTMENT FOR VARIATION IN YIELD** - If cement content of the PCC determined by AASHTO T 121 varies more than plus or minus 2 percent from the approved design mix, the proportions shall be adjusted by the Contractor and approved by the Engineer to maintain a cement content within these limits. The water content shall not exceed the maximum approved.
- E. ADJUSTMENT FOR NEW MATERIALS** - Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.

Aggregates and Portland cement shall be proportioned by weight. Water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determinations performed by the Contractor as directed by the Engineer. These moisture determinations shall be made as frequently as deemed necessary by the Engineer.

Suitable means shall be provided for accurately determining the amount of moisture in the aggregates.

#### 501.04 EQUIPMENT

Equipment and tools necessary for handling materials and performing the Work shall conform to 905 and be subject to the approval of the Engineer.

- 905: PCC Equipment

#### 501.05 PREPARATION OF GRADE

After the roadbed, including the area that will support the paving equipment, has been graded and compacted, the grade shall be fine graded to correct elevation, extending the Work as necessary beyond each edge of the proposed concrete pavement.

Before or after side forms have been securely set to grade, the sub-grade or base course shall be brought to the proper cross section. The finished grade shall be maintained in a smooth and compacted condition until pavement is placed.

#### 501.06 SETTING FORMS

**A. BASE SUPPORT** - The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade that at the form line is found below established grade shall be filled to grade with base course material in lifts of 1/2 inch or less for a distance of 18 inches on each side of the base of the form and thoroughly compacted. Imperfections or variations above grade shall be corrected by re-tamping or by trimming as necessary.

**B. FORM SETTING** - Forms meeting the requirements of 905.03(A) shall be set at least 200 feet in advance of the point where concrete is being placed. Where local conditions make this requirement impractical, it may be waived. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically, or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than 3 pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. On curves having a radius of less than 250 feet, wood forms of dressed, well-seasoned lumber having a nominal thickness of not less than 2 inches and a width not less than the depth of the pavement to be placed against them may be used subject to the approval of the Engineer.

The forms shall not deviate from true line by more than 1/4 inch or from true grade by more than 1/8 inch at any point. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and coated with a form release agent or oiled prior to the placing of concrete.

**C. GRADE AND ALIGNMENT** - The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

#### 501.07 CONDITIONING OF BASE COURSE

After the forms have been finally set, the Elevation of the entire base course shall be tested by means of an approved template meeting the requirements of 905.04 held in a vertical position and moved backward and forward on the forms. Any excess material indicated by the template shall be removed and depressions shall be filled with approved material. After these adjustments have been made, the base course within the forms shall be compacted in accordance with 209.06. If construction methods are used that involve moving heavy equipment over the prepared base course resulting in heaving or rutting of the base course, the base course shall be protected by mats or boards. The prepared base course shall be maintained, compacted, and shaped to drain at all times.

When directed by the Engineer, the Contractor shall furnish and apply waterproofing materials in accordance with 605 upon the roofs and walls of all structures such as cellars, vaults, elevators, and coal chutes that may be encountered in any type of work. Materials shall be as specified in 802.05. Prior to waterproofing, all joints in the Structure shall be sealed in accordance with 501.19. Payment for waterproofing and sealing joints will be included under the PCC pavement item.

After the base course has been constructed and before the concrete is placed, the base course shall be entirely covered with a layer of impervious material meeting the requirements of 822.14.

Impervious material shall be lapped at least 12 inches at the ends and sides. After being placed on the base course, the impervious material shall be maintained reasonably intact and shall not be damaged.

Poles, manholes, or other structures projecting through the concrete shall be given a heavy coating of asphalt meeting the requirements of 802.04 or 802.05 prior to placing the concrete.

### **501.08 HANDLING, MEASURING AND BATCHING MATERIALS**

The supplier of the concrete shall have sufficient Plant capacity and transportation apparatus to provide delivery at the rate required to insure that the depositing of the concrete will be continuous.

Stockpiles of aggregate shall be constructed on areas that are hard, well drained, and denuded of vegetation. Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to cone down over the next lower layer. Aggregates from different sources and of different grading shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated or mixed with Earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least twelve (12) hours before being batched. Rail shipment requiring more than twelve (12) hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of twelve (12) hours may be required by the Engineer.

The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts conforming to the approved mix design. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Batching shall be so conducted as to result in weights of each material required within tolerances of 1 percent for cement and 2 percent for aggregates. The accuracy of measuring the water shall be within a range of error of not over 1 percent.

Unless otherwise permitted by the Contract, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type.

Methods and equipment for adding air-entraining agents or other admixtures to the batch shall be approved by the Engineer, when required. All admixtures shall be measured into the mixes within a tolerance of plus or minus 3 percent.

### **501.09 MIXING CONCRETE**

The method of mixing shall be approved by the Engineer prior to the start of concrete work.

- A. GENERAL** - The concrete may be mixed wholly or in part in paving mixers, stationary mixers located at a central Plant or at the Site. Ready-mixed concrete shall conform to the requirements of AASHTO M 157.

Concrete mixed under these Specifications shall be of uniform consistency and such that the mortar will cling to the coarse aggregate. It shall not be sufficiently wet to flow readily or segregate, nor shall it be of a mealy or too dry consistency.

The interval between batches shall be such that the concrete in place does not partially harden and in no case shall this interval exceed thirty (30) minutes. The time interval between admission of cement to the aggregate and final discharge of the concrete shall not exceed one and one-half (1 ½) hours. The time interval shall not exceed one (1) hour for hot weather (85 degrees Fahrenheit or above) construction.

Concrete that becomes non-plastic, unworkable, or outside the limits of the slump specified shall not be used. Concrete which has developed an initial set shall not be used. Re-tempering of partially set concrete by mixing with additional water is prohibited.

Delivery of concrete materials shall be controlled by tickets issued to the driver at the Plant. These tickets shall contain information as directed by the Engineer. Upon arrival at the job Site, the tickets shall be given to the Engineer.

- B. TRUCK MIXING** - Truck mixers shall meet the requirements of 905.02.

All wash water shall be dumped before reloading the truck with concrete or concrete materials. No truck shall be loaded which contains free water in the drum. In depositing aggregates into the mixer drum, and in fastening the charging gate, no free water in excess of that found in the moisture determinations shall be admitted into the mixer drum.

Mixing water and wash water for truck mixed PCC shall be stored in watertight tanks, separate from the mixing drum, and shall be equipped with an approved, operable, calibrated gauge on each tank. Water tanks shall be completely filled at Plant. If, on arrival at the job, inspection reveals a drop in the water level, the batch may be rejected. All mixing water, other than free moisture in the aggregates, shall be added to the mix in the presence of the Engineer. Prior to adding mixing water to the drum, the mixing water gauge valves shall be set to show the water level in the tank, and the gauge shall be read and recorded in the presence of the Engineer. No wash water shall be used until all concrete in the drum has been discharged.

The Contractor shall provide a level area for all truck mixing.

After all materials, including water, have been added to the mixing drum, mixing shall be in accordance with latest recommendations of the mixer manufacturer for a minimum of 70 and a maximum of 100 revolutions excluding revolutions at the agitation speed. The mixing speed shall not be less than 4 rpm and not more than 18 rpm.

If the slump is less than that desired, additional water may be added if permitted by the Engineer, provided w/c ratio does not exceed the approved mix design. After addition of the water, the mixing drum shall be rotated 20 to 30 revolutions at the mixing speed before the discharge of the concrete. After the addition of water the number of revolutions shall not exceed 100, except for concrete mixes containing coarse aggregates which do not wear more than 25 percent as determined in accordance with Resistance to Abrasion of Small Size Coarse Aggregate, AASHTO T 96, for which the number of revolutions shall not exceed 130.

The rate of discharge of concrete from the mixer drum shall be controlled by the speed of rotation in the discharge direction with the discharge gate fully open.

**C. TRANSIT MIXING** - Transit mixing shall be in accordance with 501.09(B) except:

Mixing water shall be accurately measured at the proportioning Plant and added to the mixing drum at the Plant. Mixing may be done at the Plant or at the job Site, at the option of the Contractor. In either case, the mixer drum shall be rotated at the agitation speed from the time the truck leaves the Plant until it arrives at the job Site.

**D. CENTRAL MIXING** - When central mixing is used, the proportioning and mixing Plant shall meet all the requirements governing the handling, proportioning and mixing of concrete materials in a stationary mixer in conformance with AASHTO M 157.

The mixed concrete shall be conveyed from the central mixing Plant to the Site of the Work in agitator trucks conforming to 905.02. The time from cement's addition to the mix until the concrete is deposited in place at the Site Work shall not exceed ninety (90) minutes when hauled in truck mixers or truck agitators, except that in hot weather (85 degrees Fahrenheit or above) the time interval shall not exceed one (1) hour.

**E. HAND MIXING** - Hand mixed batches of concrete may be allowed only in an emergency. The total quantity of such batches shall not exceed 1/2 cubic yard. Hand mixing shall be subject to the immediate direction and approval of the Engineer.

## 501.10 LIMITATIONS ON MIXING AND PLACING

**A. NIGHT WORK** - Concrete shall be placed during daylight hours unless otherwise permitted by the Engineer. If the placement of concrete is permitted at night, an adequate lighting system shall be provided for both placement operations and inspection testing. A minimum of 20 foot-candles illumination at the slab Elevation shall be provided at all areas within both the placement and testing Site. The Contractor shall provide a suitable light meter to the Engineer for approval. In addition, before any initial slab placement operation, a test run shall be made to insure that the specified illumination is provided. If a portable generator is used, an emergency backup generator shall be available at the job Site.

**B. TEMPERATURE AND WEATHER CONDITIONS** - The temperature of the mixed concrete shall not be lower than 50 degrees F and not more than 90 degrees F at the time of placement.

**1. Cold Weather** - Cold weather is defined as any time during the concrete placement or curing period that the ambient temperature, as given by The U.S. Weather Bureau for Washington DC drops below 35 degrees F, or the ambient temperature drops below 50 degrees F for a period of twenty-four (24) hours or more.

No concrete shall be placed on frozen sub-grade or base course nor shall frozen aggregates be used in the concrete.

When cold weather is reasonably expected or has occurred within seven (7) days of anticipated concrete placement, the Contractor shall submit a detailed plan for producing, transporting, placing, protecting, curing and temperature monitoring of the concrete during cold weather. Procedures for accommodating abrupt changes in weather conditions shall be included. Concrete placement shall not commence until approval is given by the Engineer.

All materials and equipment required for protection shall be available at the Work Site prior to cold weather concrete placement.

All snow, ice and frost shall be removed from the surfaces, including reinforcement and base course, against which fresh concrete is to be placed. The temperature of any surface that will come into contact with fresh concrete shall be at least 35 degrees F and shall be maintained at a temperature of 35 degrees F or above during the placement of concrete.

When the forecast indicates that the temperature is expected to drop below 35 degrees F or be less than 50 degrees F during the twenty-four (24) hour period following the placing of the concrete, the following conditions shall be met:

- a. A Type C accelerator meeting the requirements of 814.04(A) shall be incorporated in the concrete mix at the batching Plant. Calcium Chloride shall not be used.
- b. As soon as the concrete has hardened sufficiently to prevent marring, and after curing materials have been placed, all surfaces and edges shall be covered with an insulation blanket conforming to 814.01(E). Proper provisions shall be made to secure insulation in place for at least seventy-two (72) hours or until tests of field cured flexural strength beams indicate that the concrete has attained 450 psi flexural strength or 3000 psi compressive strength.

The Contractor shall furnish and place continuously recording surface temperature measuring devices that are accurate within  $\pm$  2 degrees Fahrenheit.

No direct payment will be made for incorporating an accelerator in the concrete or for the insulated curing required for cold weather construction. The cost of this Work will be included in the Contract unit price for the various Portland cement concrete Pay Items.

The Contractor will be held responsible for any defective work caused by frost or by freezing. Concrete damaged in any manner shall be removed and replaced at the Contractor's expense

2. **Hot Weather** - Hot weather is defined as any time during the concrete placement or curing period that the ambient temperature, as given by The U.S. Weather Bureau, for Washington DC is above 90 degrees Fahrenheit.

In hot weather, all surfaces that come into contact with fresh concrete shall be cooled to below 90 degrees Fahrenheit by covering with approved materials or by other approved methods

If the required consistency cannot be maintained, the mix shall be adjusted in accordance with 501.03. The temperature of cement at batching shall not exceed 160 degrees Fahrenheit.

During hot weather the Contractor shall maintain the specified concrete temperature by using shaved ice or chilled water and adjust the amount of mix water.

## 501.11 PLACING AND CONSOLIDATING CONCRETE

The concrete shall be deposited on the grade in such manner as to require as little re-handling as possible and to prevent segregating of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Spreading shall be accomplished with a mechanical spreader as specified in 905.05. Necessary hand spreading shall be done with square-faced shovels, not rakes or hoes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with Earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement and heavy equipment will be operated upon the existing lane of pavement, the concrete in that lane shall have attained a flexural strength of 550 psi or a compressive strength of 3500 psi. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days. Equipment that will damage the surface of the existing pavement will not be permitted. Concrete hauling units will not be allowed to operate over the base course when, in the opinion of the Engineer, they will damage or change the uniformity of the base course.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

All concrete shall be consolidated with spud vibrators meeting the requirements of 905.07. Concrete shall be thoroughly consolidated throughout the entire slab. The vibrator shall not come into contact with the joints, load transfer devices, side forms or the base course. In no case shall the vibrator be operated longer than five (5) seconds in any 1 location. When fabric or bar mat reinforcement is placed by mechanical equipment that uses vibration or a tamping action, other vibratory equipment may be eliminated except in areas adjacent to side forms. Any evidence of honeycombing or lack of consolidation shall be sufficient reason to require removal and replacement of the concrete at the Contractor's expense.

Concrete shall be deposited as near to the expansion joints as possible without touching them. It shall then be shoveled against both sides of the joint simultaneously, maintaining equal pressure on both sides. Care shall be taken that it is worked under the load transfer devices. The concrete shall not be dumped directly upon or against the joints, nor shall it be shoveled or dropped directly on top of the load transfer devices. In placing the concrete against expansion and contraction joints and in operating a vibrator adjacent to them, workmen shall avoid stepping upon or disturbing in any way the joints or load transfer devices, either before or after they are covered with concrete. Concrete shall be placed over and around dowels in a manner so that dowels are fully embedded without displacement. If any of the dowel bars are displaced, they shall be realigned before the finishing machine passes over them.

### **501.12 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT**

Following the placing of the concrete, it shall be struck off with a mechanical spreader meeting the requirements of 905.05 to conform to the cross section or typical section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be reasonably close to the Elevation shown on the Plans or as established by the Engineer. Reinforced concrete pavement shall be placed in 2 layers. The entire width of the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric conforming to 812.01 may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, screeded and consolidated. Any portion of the bottom layer of concrete that has been placed more than thirty (30) minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

Reinforcing steel shall be straight and its surface condition shall be free from dirt, oil, paint, grease, loose mill scale and loose or thick rust which could impair the bond of the steel with the concrete.

Unless otherwise shown on the Plans, wire fabric reinforcement conforming to approved standards and design requirements shall be used in PCC pavement 6 inches or greater in thickness.

The sheets of reinforcement shall be tied at the laps so as to be held in place and shall extend to within 2 inches of the ends of the slabs and to within 2 inches of the edges of the slab or through the cement concrete curbing to within 2 inches of the back of the curb when the curb is poured monolithically with the slab. Reinforcement shall not extend across expansion joints, contraction joints or planes of weakness. Wire fabric reinforcement shall be placed approximately 2 inches below the finished surface of the slab with the larger wires running in the longitudinal direction or as indicated in the Plans.

Additional reinforcement meeting the above Specifications shall be placed over utility cuts as directed by the Engineer. Additional wire fabric reinforcement, when used, shall be placed approximately 2 inches above the bottom of the slab. This Work shall be considered "Additional Wire Fabric Reinforcement."

### **501.13 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING**

**A. GENERAL** - The sequence of operations shall be the strike-off, consolidation, floating, removal of laitance, straight edging and final surface finishing. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing, straight edging and making corrections as hereinafter specified, shall be provided by the Contractor.

Finishing machines meeting the requirements of 905.06 shall be used to finish the pavement.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

**B. MACHINE FINISHING** - The concrete shall be distributed or spread as soon as placed, consolidated in conformance with 501.11 and 501.12 and struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper consolidation and leave a surface of uniform texture. Excessive operation

over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling or other variation affecting the precision finish.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

If a uniform and satisfactory density of concrete is not obtained at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and use methods that will produce pavement conforming to the requirements specified herein at his own expense.

- C. FINISHING AT JOINTS** - The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as specified.

After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated coarse aggregate shall be removed from both sides of and off the joint. The screed shall be lifted and brought across the joint. The forward motion of the finishing machine shall then be resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated coarse aggregate immediately between the screed or on top of the joint.

After the concrete has been placed on both sides of the joint and struck off, the installing bar or channel cap shall be slowly and carefully withdrawn, leaving the preformed filler in place. After the installing bar or channel cap is completely withdrawn, a tapered wooden strip shall be temporarily inserted in the joint, and freshly mixed concrete shall be worked into any depressions left by the removal of the installing bar. The installing bar shall be cleaned and oiled prior to each installation of a joint.

- D. HAND FINISHING** - Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs. Narrow widths, areas of irregular dimensions or areas where operation of mechanical equipment is impractical, may be finished by hand methods.
2. When finishing by hand is permitted, the concrete shall be placed to the full thickness required in successive batches for the entire width between construction joints shown on the Plans. The concrete shall be vibrated internally during placing as specified herein, and shall be screeded off with a steel shod screed weighing not less than 15 pounds per linear foot. The screed shall be constructed so that it can be set accurately to whatever roadway crown is required. It shall be operated by a sawing motion and moved forward on substantial screed supports set at proper elevations. The shape and construction of the screed shall meet the approval of the Engineer. The screeding shall be repeated, as required, accompanied by tamping, or other operations necessary to provide an even, approved surface ready for floating.

- E. FLOATING AND REMOVAL OF LAITANCE** - After screeding is completed, the surface shall be floated with a float meeting the requirements of 905.09(C). The float shall be operated transversely with a combined longitudinal and transverse motion and with a sufficient number of passes to smooth all ridges and fill all depressions. Excess water and soupy material shall be wasted over the forms at each pass.

- F. STRAIGHTEDGING AND SURFACE CORRECTION** - After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface shall be tested in accordance with 501.16. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, refinished and retested. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures, and the slab conforms to the required grade and cross section.

- G. FINAL SURFACE FINISH** - After the concrete has been floated and the surface corrected, it shall be finished by dragging the surface in a longitudinal direction with burlap meeting the requirements of 814.01. This drag shall be worked with a longitudinal motion, care being used not to permit the edges to dig into the surface of the concrete or to work the crown out of the pavement.

After the water sheen has practically disappeared, but previous to any initial set, the surface shall be given the final finish by brooming with a broom meeting the requirements of 905.09(D). The broom shall be moved from one side of the pavement to the other without interruption. The travel of the broom shall overlap a small amount. The brooming shall be perpendicular to the center line of the pavement and so executed that the corrugations thus produced will be of uniform character and width and not more than 1/8 inch in depth, with the resulting surface free from objectionable depressions or projections that might be formed by improper handling. The brooming must be completed before the edges of the pavement and joints are rounded.

The surface of the pavement adjacent to all curbs, i.e., in the flow line of the gutter, shall be troweled and finished with hair brooms or hair brushes conforming to 905.09(D) or (E).

- H. EDGING AT FORMS AND EXPANSION JOINTS** - All joints and edges shall be rounded to 1/4-inch radius.

#### 501.14 JOINTS

- A. GENERAL** - Longitudinal and transverse joints shall be located and constructed as shown on the Contract Documents. All joints shall be perpendicular to the pavement surface and perpendicular, radial, or parallel to the Roadway centerline or as directed.

The sequence of construction of various slabs shall be determined by the Contractor with the approval of the Engineer.

- B. LONGITUDINAL JOINTS** - Longitudinal joints shall be either formed or sawn. Joints between separately constructed roadway slabs and curb and gutter sections shall be formed. Longitudinal center joints shall be installed in a manner so that full contact is made at intersections with transverse joints. Longitudinal joints shall have tie rods or keyways and tie rod assemblies meeting the requirements of 807.04, constructed and spaced as shown in the Contract Documents. No tie device shall be placed closer than 18 inches to a transverse joint.

The initial installation of the tie rod assembly shall be firmly held in place by tap bolts and steel washers. Tap bolts shall be in place during the fine grading. The tap bolts shall then be removed and the remainder of the tie rod assembly installed.

The edges of the slab first constructed shall be given a heavy coating of bituminous material meeting the requirements of 802.04 or 802.05 prior to pouring the adjacent slab.

#### C. TRANSVERSE JOINTS

1. **General** - No transverse joint shall be formed within 10 feet of an existing pavement, bridge or approach slab. Expansion joints shall be placed 10 feet back from the end of the new pavement where it abuts an existing pavement.
2. **Transverse Expansion Joints** - Transverse expansion joints shall be composed of load transfer assemblies conforming to 807.03, and 3/4 inch thick preformed joint filler conforming to the requirements of 807.01. Transverse expansion joints shall be constructed and placed as shown in the Contract Documents.

Unless otherwise shown on the Plans, expansion joints shall be placed at each end of a block, at tangent points of curves and/or curb corners and at intervals of approximately 360 feet. The Engineer may require the spacing of joints to vary at intersections, islands, and circles or other similar locations.

Joints shall be constructed perpendicular to the centerline of the pavement so as to produce straight joints within an allowable variation of 1/4 inch in 10 feet and a discrepancy with the pavement surface of not more than 1/8 inch in 10 feet. The joint will be checked with a 10 foot straightedge.

The joint filler shall be securely held in place to insure against displacement during construction and the top edge of the filler shall be protected with a U-shaped metal cap while the concrete is being placed and finished. The joint filler shall be punched to admit dowel bars and to assure a tight fit.

The preformed expansion joint filler shall be continuous across the full width of the pavement and through the curb and gutter and shall extend from the base course to 1/2 inch below the finished pavement surface.



Where joint filler is joined to the joint filler of an adjacent, previously constructed slab, a perfect butt fit shall be accomplished or a U-piece of thin gage metal shall be placed to prevent the infiltration of cement mortar into the joint. Any section of expansion joint filler extending through any curb shall be so cut that the Elevation of the top of the joint filler shall be 1/2 inch below the finished surface of the curb. The filler so cut shall be in 1 piece except when the curb is superimposed, in which case that portion above the flow-line level of the gutter may be a separate piece securely aligned and constructed so that it will function properly as an expansion joint and that the top seal will be watertight. The expansion joint filler shall conform to the section of the pavement where thickened edges are used.

After the concrete is cured and as soon as the forms for longitudinal construction are removed, the ends of all expansion joint filler shall be cleaned of concrete and the full width of the filler exposed for the full depth of the slab. No concrete shall be placed adjacent to a previously poured slab until the ends of the filler have been cleaned. The ends of the joint filler in the next slab to be poured shall be placed neatly and firmly against previously placed joint filler.

3. **Transverse Contraction Joints** - Transverse contraction joints shall be constructed and located as shown in the Contract Documents or as directed by the Engineer.

Any section of the contraction joint extending through the curb shall be formed as specified in 606.01(C) (3).

4. **Transverse Construction Joints**- Transverse construction joints shall be formed where it is necessary to stop placing concrete for thirty (30) minutes or longer, by staking in place a timber bulkhead of the same depth as the thickness of the concrete at right angles to the slab and finishing the concrete to the bulkhead. Tie rod assemblies shall be placed in transverse construction joints as shown in the Contract Documents. Where the location of the construction joint coincides with that of the expansion joint, the expansion joint shall be constructed with load transfer devices. If, due to an emergency, concrete placement must be stopped within less than 10 feet of a previously formed transverse joint, the concrete shall be removed to the joint prior to continuing the pouring of the slab.

- D. **SAW JOINTS** - Longitudinal or transverse contraction joints may be sawn when permitted by the Engineer. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate to control cracking. The Contractor shall provide adequate artificial lighting facilities for night sawing. The grooves shall be cut to a minimum depth of 2 inches and the width shall be the minimum width possible with the type of saw being used, but in no case shall exceed 1/4 inch.

All joints shall be sawn before uncontrolled shrinkage cracking takes place and shall be regulated so that each joint is sawn four (4) to twenty-four (24) hours after placement of concrete. If necessary, the sawing operation shall be performed day and night, regardless of weather conditions. The concrete shall have hardened sufficiently to permit sawing without damage by blade action to the pavement surface or to concrete adjacent to the joint. Slight, though not excessive, raveling will be permissible along the joint edge. They shall be completed before placing concrete in the succeeding adjacent lane. The sawing of any joint shall be omitted if a crack occurs over load transfer devices prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints shall be sawn in sequence.

The slabs on either side of longitudinal joints shall be tied together by the installation of 1/2 inch tie rods 30 inches long placed across the longitudinal joint to a depth below the proposed saw cut and spaced in accordance with the Contract Documents. The tie rods shall be placed in a manner satisfactory to the Engineer. No tie rod shall be placed closer than 18 inches to a transverse joint.

- E. **LOAD TRANSFER ASSEMBLY** - All transverse expansion joints shall be provided with means for load transfer meeting the requirements of 807.03.

When dowel bars are used, they shall be of the sizes as shown on the Standard Drawings or Contract Documents, and shall conform to the requirements of 807.03(B). The dowels shall not be placed closer than 6 inches to a longitudinal joint. A dowel sleeve conforming to the requirements of 807.03 shall be placed on the greased end of each dowel.

The assembly shall be rigidly installed in a manner approved by the Engineer. The dowels shall be rigidly held in place parallel to the surface and center line of the pavement by supports that do not permit displacement by workmen or otherwise during construction. A tolerance of not more than 1/8 inch in 12 inches from correct alignment, either vertical or horizontal, will be permitted.

Special care shall be taken with the base course to establish the required cross section at the locations where assemblies are to be installed. If, for any reason, the base course is trimmed too low, or if there are any open spaces beneath the assembly, the assembly shall be removed, the base course backfilled, tamped firmly and the assembly reset.

**501.15 TESTING**

The consistency of the concrete will be checked by the slump test in conformance with AASHTO T 119. The determination will be made when and as often as deemed necessary by the Engineer to check the consistency of the concrete. The Contractor shall provide a slump cone, rod and a flat, non-absorbent surface in conformance with AASHTO T 119, for each project.

Test cylinders and beams will be made from each class of concrete, at the direction of the Engineer. 1 set of concrete test specimens shall be made for every 50 cubic yards of concrete placed. Concrete for such specimens shall be furnished by the Contractor as directed.

Concrete test specimens for both compression strength testing and for flexural strength testing shall be made and cured in accordance with AASHTO T 23. Unless otherwise specified, the minimum twenty-eight (28) day compressive strength shall be 3500 psi. Flexural strength shall be tested in conformance with AASHTO T 177. Flexural strength shall be as hereinafter specified. The Contractor shall provide cylinder curing facilities at the Project Site in conformance with AASHTO T 23. Immediately after molding and finishing, the concrete specimens shall be stored up to forty-eight (48) hours in a concrete curing box.

The Contractor shall transport PCC specimens along with the Department prescribed forms to the Department Materials Testing Facility in accordance with AASHTO T 23, Transportation of Specimens to Laboratory

Air content of plastic concrete shall be tested in conformance with AASHTO T 196 or AASHTO T 152 as determined by the Engineer. The entrained air shall be 5 to 8 percent by volume.

The Contractor shall furnish and maintain for the concrete phase of the Contract 2 pressure air type meters with necessary accessories meeting the requirements of AASHTO T 152, Type B. The air meter shall be properly calibrated by an independent laboratory with a certification furnished to the Engineer. The Contractor shall also furnish the Engineer with and maintain 2 concrete thermometers meeting the requirements of AASHTO T 309 and 2 slump cones calibrated by an independent laboratory and meeting the requirements of ASTM C 1431.

- A. ACCEPTANCE** - Concrete acceptance shall meet the requirements of 817.03 and final acceptance will be based on test results conducted by the Department materials testing Laboratory.

If concrete fails to yield the designated concrete strength, the Engineer shall make a determination of acceptance, rejection or acceptance at a reduced price. If the concrete is accepted at a reduced rate, the applicable rate will be calculated as per (B) Price Adjustment. Replacement of deficient concrete shall be at the Contractor's expense.

- B. PRICE ADJUSTMENT** - Payment for concrete that fails to meet minimum acceptance levels for strength will be adjusted according to the following formula:

$$\text{Pay Adjustment} = \frac{-2(f'_c - f_c)(\text{PAB})(Q)}{f'_c}$$

Where:

$f'_c$  = Specified minimum compressive strength measured in psi

$f_c$  = Compressive strength as determined by acceptance tests in psi

PAB\* = Price Adjustment Base

Q = Quantity of concrete represented by acceptance tests in cubic yards

\*PAB is the Contract unit price for the class of concrete involved. Where the Contract unit basis of payment is other than by unit price, PAB is \$800.00.

Payment will be made under:

**TABLE 501.15 PAY ITEMS AND UNITS**

<b>Pay Item</b>	<b>Pay Unit</b>
Class A Concrete	Cubic Yard
Class B Concrete	Cubic Yard
Class C Concrete	Cubic Yard
Class D Concrete	Each, per pre-stressed member
Class E Concrete	SY or CY as per Pay Item
Class F Concrete	SY or CY as per Pay Item
Class H Concrete	Cubic Yard
Class I Concrete	Cubic Yard
Class J Concrete	Square Yard

**501.16 SURFACE TESTING**

The finished surface of the pavement shall conform to the grade, alignment and cross- section specified. The surface shall be tested with a straightedge meeting the requirements of 903.03 laid parallel to the center line of the pavement. Any deviation of the pavement surface in excess of 1/8 inch in 10 feet shall be immediately corrected. Extreme care shall be exercised to see that there is no deviation at joints. The Contractor shall be held responsible for the trueness of the surface of the pavement and shall be required to correct any deviation from the alignment, grade and cross-section as specified. Dusting with cement or sprinkling with water will not be permitted.

**501.17 CURING**

The concrete shall be cured by 1 of the methods listed below.

- A. MEMBRANE CURING COMPOUND** - Membrane curing compound conforming to 814.02 shall be applied immediately after the final finishing of the surface by means of a mechanical sprayer conforming to 905.08. The curing compound shall be applied with an overlapping coverage that will give a 2 coat application at coverage of not more than 150 square feet per gallon for both coats. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be stirred continuously by effective mechanical means. Spraying pressure shall be sufficient to produce a fine spray and cover the surface thoroughly and completely with a uniform film. The application of curing compound by hand operated pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms, as authorized by the Engineer. When application is made by hand operated sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat.

The compound shall form a uniform, continuous, coherent film that shall not check, crack or peel and shall be free from pin holes and other imperfections. If pin holes or other discontinuities exist, an additional coat shall be applied within thirty (30) minutes to the affected areas. Concrete surfaces that are subject to heavy rainfall within three (3) hours after the curing compound has been applied shall be re-sprayed by the method and at the coverage specified above, at no additional cost to the District.

Necessary precautions shall be taken to insure that none of the curing compound enters joints that are to be sealed. Rope of moistened paper, fiber or other suitable material shall be used to seal the top of the joint opening, and the concrete in the region of the joint shall be sprayed with curing compound immediately after the rope seal is installed. Other methods of protecting the joints may be used when approved by the Engineer.

Approved standby facilities or approved alternate methods for curing concrete pavement shall be provided at a readily accessible location at the Site of the Work for use in event of mechanical failure of the spraying equipment or any other conditions which may prevent correct application of the membrane curing compound at the proper time. In the event of a failure of the regular spraying equipment, the paving operation shall be suspended and the standby or alternate curing method shall be used only on the remaining portion of the pavement already placed.

When the air temperature will reach 90 degrees Fahrenheit or above, 2 layers of water-saturated burlap shall be placed over the concrete after the application of the curing compound. The burlap shall be placed in accordance with the requirements for burlap curing and shall be kept wet for twenty-four (24) hours.

- B. BURLAP CURING** - Burlap meeting the requirements of 814.01A shall be placed as soon as it may be done without injury to the concrete. It shall be overlapped in half widths of strips so as to provide a double thickness throughout its coverage. It shall be saturated prior to placement and placed wet. It shall be kept wet continuously for a minimum of seventy-two (72) hours.

After the initial seventy-two (72) hour period, the burlap may be removed provided the concrete has developed a flexural strength of 450 psi as ascertained by testing in accordance with 501.15. If flexural strength tests are not made, or if the tests indicate strengths less than 450 psi, the concrete shall be burlap cured an additional four (4) days. The burlap shall be kept saturated during the entire seven (7) day period.

The burlap shall be free from holes, Earth or any substance that will interfere with its absorptive qualities or have a deleterious effect on the concrete. Any burlap that becomes contaminated with Earth or other deleterious substances shall be washed clean prior to use.

- C. POLYETHYLENE SHEETING OR WATERPROOF PAPER CURING** - As soon after finishing as practical without marring the surface, the pavement shall be covered with polyethylene sheeting conforming to 814.02(A) or waterproof paper conforming to 814.02 (B). The cover shall be of sufficient width to provide a complete cover for the surface of the pavement, including face and top of all curbs and the edges of the pavement or curb when the forms are removed. The cover shall be carefully placed as directed to completely seal the surface without marring it. The cover shall be secured along the sides and ends to maintain a reasonably airtight seal and adjoining covers shall overlap at least 12 inches. Any material that is torn or does not provide an acceptable airtight seal shall not be used.

The concrete shall be kept covered a minimum of seventy-two (72) hours. After the initial seventy-two (72) hour period, the covering may be removed provided that the concrete has attained a flexural strength of 450 psi as ascertained by testing in conformance with 501.15. Otherwise, the concrete shall be kept covered seven (7) days.

#### 501.18 REMOVING FORMS AND BACKFILLING

- A. REMOVAL OF FORMS** - Forms shall not be removed in any case in less than twelve (12) hours, and during periods of low temperatures (below 40 degrees F), they shall not be removed in less than forty-eight (48) hours. Forms shall be removed carefully to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured by 1 of the methods specified in 501.17. Honeycombed areas will be considered defective work and shall be removed and replaced as directed by the Engineer.
- B. BACKFILLING** - Where concrete pavements are constructed without curbs, backfilling shall be performed within twenty-four (24) hours after removal of the forms and shall consist of preparation of the Shoulder adjacent to the pavement. Where concrete pavements are constructed with curbs, backfilling shall be done in accordance with 606.01(E) (7).

#### 501.19 SEALING OF JOINTS

- A. TRANSVERSE JOINTS** - All transverse expansion, contraction and construction joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including the Contractor's equipment. The sealing material shall conform to 807.02(A) (1) or (2).

Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing, and the joint faces shall be clean and the surface dry when the seal is applied.

Cleaning shall be accomplished by the use of power tools approved by the Engineer. The use of any tools that result in damage to the pavement will not be permitted. Immediately prior to the actual sealing operation, the joints shall be thoroughly blown out with a jet of air having sufficient volume and pressure to remove any loose material left by the cleaning operation.

When hot poured-type joint sealing material is used, it shall be heated to the temperature recommended by the manufacturer, but not to exceed 450 degrees Fahrenheit at any stage during the melting or pouring operations, in an approved melting- applicator apparatus meeting the requirements of 903.02.

The sealing material shall be applied to each joint opening to conform to the details shown on the Plans or as directed by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. Any material heated beyond the recommended pouring temperature shall be rejected and removed from the apparatus, the apparatus thoroughly cleaned and new material heated to the proper temperature. Only sufficient material for the day's operations shall be heated at a time. When it is necessary to cut material into small chunks before putting it into the apparatus, the method used shall be approved by the Engineer.

The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

The joints shall be filled to within 1/4 inch of the finished pavement surface and the sealing material so placed that the resulting stripe will be straight and neat.

The use of sand or similar material as a cover for the seal will not be permitted. Poured joint sealing material shall not be placed when the air temperature in the shade is less than 50 degrees Fahrenheit, unless approved by the Engineer.

- B. LONGITUDINAL JOINTS** - When the edge of the first of separately constructed adjacent slabs is given a heavy coating of bituminous material as required in 501.14(B), it shall constitute the sealing of the longitudinal construction joint.

### **501.20 PROTECTION OF PAVEMENT**

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen and flaggers to direct traffic and the erection and maintenance of warning signs, lights, pavement Bridges or crossovers.

In order that the concrete may be properly protected against the effects of rain or other abrupt changes in weather conditions before it has attained final set, the Contractor shall have covering material available at the Work Site.

The Engineer will carefully consider any damage to the pavement occurring prior to final acceptance and may allow the Contractor to repair such damage or require the damaged pavement to be replaced.

### **501.21 OPENING TO TRAFFIC**

Vehicular traffic shall be excluded from pavement and pavement repairs for a minimum of seventy-two (72) hours after the placement of curing materials. After the initial seventy-two (72) hour period, if approved by the Engineer, the pavement may be opened to traffic providing that the concrete has developed a flexural strength of 550 psi or a compressive strength of 3500 psi as by testing in accordance with 501.15. If strength tests are not made, or if the required strengths are not attained, traffic shall be excluded for a minimum of seven (7) days after the concrete was placed.

The pavement shall be cleaned and all joints sealed prior to opening to traffic. The cost of steel plating, if needed, shall be paid for as specified in 612.19.

### **501.22 HIGH EARLY STRENGTH CONCRETE**

All Specifications for standard Portland Cement Concrete shall apply to high early strength concrete. High early strength concrete shall be produced by 1 of the following methods, or a combination thereof, as directed by the Engineer.

- A.** By the use of high early strength Portland Cement in lieu of the standard Portland cement specified and in the same amount.
- B.** By the use of additional standard Portland cement (the total amount of cement shall not exceed 1 bag over that required by the approved mix design).
- C.** By the use of a Type C accelerator meeting the requirements of 814.04 incorporated in the concrete mix.
- D.** By ready mix design approved by the District Department of Transportation Materials Division that shall be measured and paid in a similar method as Reinforced PCC Pavement.

Where the use of high early strength cement or additional standard cement is directed, the purpose being to produce a high early strength concrete to allow for earlier opening or completion of the Project, the Contractor will be required to proceed with diligent prosecution of all phases of the Work to insure the full benefit of the additional cost and an early opening.

Should the Contractor fail, refuse or neglect to complete the Work properly and diligently so as to render it ready for traffic, such failure, refusal or neglect shall be sufficient reason to withhold payment for high early strength cement or the additional standard cement.

### 501.23 TOLERANCE IN PAVEMENT THICKNESS

The thickness of the constructed pavement will be determined by average caliper measurement of cores measured in accordance with AASHTO T 148. At such points as the Engineer may select, in each 500 linear lane feet or fraction thereof of pavement, 2 or more cores will be taken and measured. These cores will be taken by the Contractor. The average thickness of each 500 feet of pavement will be determined from these cores. In calculating the average thickness of the pavement, measurements that are in excess of the thickness specified by more than 1/8 inch will be considered as the specified thickness plus 1/8 inch. Measurements that are less than the specified thickness by 1/2 inch or more shall not be included in the average. Disposition of pavement deficient by 1/2 inch or more in thickness will be as provided below.

For pavement slabs, the average thickness of which is 1/8 inch less than the thickness specified, the Contract unit price shall be used in the payment.

For pavement slabs, the average thickness of which is less than the thickness specified by more than 1/8 inch, but less than 1/2 inch, an adjusted unit price shall bear the same ratio to the Contract unit price as the square of the average thickness of the slab bears to the square of the thickness specified.

Additional payment over the Contract unit price will not be made for any pavement with an average thickness in excess of the thickness specified.

The adjusted unit price shall be calculated for each 500 feet or fraction thereof in which the deficient core lane measurements are included.

Payment will not be made for pavement that is deficient by 1/2 inch but less than 1 inch in thickness. Such pavement shall either be removed and replaced with pavement of specified thickness at the Contractor's expense, or may remain in place without payment to the Contractor. Pavement deficient by 1 inch or more in thickness shall be removed and replaced at the Contractor's expense.

Where the specified method of determining thickness reveals pavement deficient in thickness by 1/2 inch or more, additional cores shall be made at intervals of 25 feet parallel to the centerline to determine the extent of the deficiencies greater than 1/2 inch. Determination of the extent of the areas to be replaced and/or areas for which no payment will be made will be based on these additional thickness determinations.

If the Contractor believes that the cores and measurements taken are insufficient to indicate fairly the actual thickness of pavement, he may request additional cores and measurements. Such measurements shall be at intervals not less than 200 feet. The cost of additional cores and measurements shall be deducted from sums due the Contractor unless such measurements indicated that the pavement within the area in question is of specified thickness.

The Contractor shall fill test holes with the same type of concrete as in the pavement.

### 501.24 MEASURE AND PAYMENT

Payment for the various items of Work listed herein will include all costs for furnishing all materials, labor, tools, equipment and incidentals to complete the Work.

- A. REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT (SQUARE YARD METHOD)** - The unit of measurement for Reinforced PCC Pavement will be the square yard. The actual number of square yards of the specified depth measured complete in place will be paid for at the Contract unit price per square yard, or adjusted unit price per square yard if required under 501.23, which payment will include joints, waterproofing, load transfer devices, tie rods, impervious material, reinforcement, sealing of joints and curing.

The width for measurement will be the width from the intersection of the face of the curb or gutter with the surface of the pavement on one side to the intersection of the face of the curb or gutter with the surface of the pavement on the other side. Where there is no curb or gutter, the width for measurement will be from outside edge to outside edge of the pavement. The length will be the actual length measured along the center line of the riding surface.

- B. REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT (CUBIC YARD METHOD)** - The unit of measure for Reinforced PCC Pavement will be the cubic yard. The actual number of cubic yards complete in place will be paid for at the Contract unit price per cubic yard, or adjusted unit price per cubic yard if required under 501.23, which payment includes joints, waterproofing, load transfer devices, impervious material, reinforcement, sealing of joints and curing.

- C. PORTLAND CEMENT CONCRETE** - The unit of measure for PCC will be the cubic yard. The actual number of additional cubic yards furnished complete in place for extra depth of concrete over trenches, around manholes, thickened edges, or for other use, as directed by the Engineer, will be paid for at the Contract unit price per cubic yard.
- D. ADDITIONAL WIRE FABRIC REINFORCEMENT** - The unit of measure for Additional Wire Fabric Reinforcement will be the square yard. The actual number of square yards measured complete in place, with no allowance for overlap, will be paid for at the Contract unit price per square yard for the appropriate item listed in the Schedule of Prices.
- E. EXTRA PREFORMED EXPANSION JOINT** - No separate payment will be made for preformed expansion joint material; it will be included in the payment of the appropriate PCC items.
- F. HIGH EARLY STRENGTH PORTLAND CEMENT** - The unit of measure for High Early Strength Portland Cement will be the bag. The actual number of bags incorporated in the mix in lieu of standard Portland cement will be paid for at the Contract unit price per bag, which payment shall be for the additional cost of high early strength Portland cement over that of standard Portland cement.
- G. HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE PAVEMENT (CUBIC YARD METHOD)** - The unit of measure for High Early Strength PCC Pavement will be the cubic yard. The actual number of cubic yards complete in place will be paid for at the Contract unit price per cubic yard, or adjusted unit price per cubic yard if required under 501.23, which payment includes joints, waterproofing, load transfer devices, impervious material, reinforcement, sealing of joints and curing.
- H. ADDITIONAL STANDARD PORTLAND CEMENT** - The unit of measure for Additional Standard Portland Cement will be the bag. The actual number of bags of additional cement added to the mix at the direction of the Engineer for the purpose of producing high early strength concrete will be paid for at the Contract unit price per bag.

## 502 PORTLAND CEMENT CONCRETE BASE

### 502.01 DESCRIPTION

Work consists of constructing a base composed of Portland Cement Concrete, with or without wire fabric reinforcement, on the prepared base course in accordance with the Contract Documents. Except as herein stated, all requirements specified for 501 are applicable to this Specification.

Work also includes PCC for miscellaneous uses, thickened section of alley and drive entrances, bulkheads and various incidental repairs as determined by the Engineer.

### 502.02 CONSTRUCTION REQUIREMENTS

Construction methods shall conform to 501 with the following exceptions, changes or additions.

#### A. TRANSVERSE JOINTS

- 1. Transverse Expansion Joints** - When the temperature at the time of placing base concrete is 50 degrees Fahrenheit or higher, expansion joints shall be omitted. When the temperature at the time of placing base concrete is lower than 50 degrees Fahrenheit, preformed expansion joint filler 1/2 inch in thickness and meeting the requirements of 807.01 shall be installed in the concrete base at each end of the Project and at intervals of approximately 360 feet or at intersections as directed by the Engineer. Joints installed at the end of the Project shall be placed at least 10 feet from the end of the existing pavement. The expansion joint filler shall be placed flush with the surface of the finished base and shall extend the full width and depth of the slab. Expansion joints shall be provided with means for load transfer meeting the requirements of 807.03. It will be necessary to round the edges of the joint faces of Portland cement concrete base.
- 2. Transverse Contraction Joints** - Weakened plane transverse contraction joints in the concrete base to be covered with asphaltic material may be constructed in accordance with 501.14(C)(3); or after the concrete has been placed and floated, a groove shall be cut in the concrete to a depth of 2-1/2 inches, a fiber strip inserted into this groove and placed flush with the top of the concrete base, and the concrete finished over the newly formed joint. Joints need not be edged or sealed. These joints shall be placed approximately but not more than 20 feet apart. Load transfer devices will not be required.

**B. SEALING OF JOINTS** - Unless otherwise directed, sealing of joints in concrete base to be covered with asphaltic materials will not be required. Covering the base with asphaltic material shall constitute sealing.

**C. FINISHING** - In finishing Portland Cement Concrete base, any deviation of the base surface in excess of 1/4 inch from the straightedge shall be immediately corrected.

### 502.03 MEASURE AND PAYMENT

Payment for the various items of Work listed herein will include all costs for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the Work.

**A. SQUARE YARD METHOD** - The unit of measure for Portland Cement Concrete Base will be the square yard. The actual number of square yards of the specified depth measured complete in place will be paid for at the Contract unit price per square yard, or adjusted unit price per square yard if required under 501.23, which payment will include joints waterproofing, load transfer devices, impervious material, reinforcement and curing.

The width for measurement will be the width from the intersection of the face of the curb or gutter with the surface of the base on one side to the intersection of the face of the curb or gutter with the surface of the base on the other side. Where there is no curb or gutter, the width for measurement will be from outside edge to outside edge of the base. The length will be the actual length measured along the center line of the riding surface.

**B. CUBIC YARD METHOD** - The unit of measure for Portland Cement Concrete Base will be the cubic yard. The actual number of cubic yards complete in place will be paid for at the Contract unit price per cubic yard, or adjusted unit price per cubic yard if required under 501.23, which payment includes joints, waterproofing, load transfer devices, impervious material, reinforcement if specified and curing.



**503 REINFORCED PORTLAND CEMENT CONCRETE ALLEY****503.01 DESCRIPTION**

Work consists of constructing an alley composed of PCC with wire fabric reinforcement on a prepared base course in accordance with the Contract Documents. Except as herein stated, all requirements specified for 501 are applicable to this Specification.

**503.02 CONSTRUCTION REQUIREMENTS**

Construction methods shall conform to the requirements specified in 501 with the following exceptions, changes, or additions.

- A. DESIGN** - Reinforced Portland Cement Concrete Alley shall be constructed in 1 slab the full width of the Alley.
- B. PLACING CONCRETE** - A mechanical spreader will not be required in placing concrete.
- C. PLACING REINFORCEMENT** - Wire fabric reinforcement conforming to approved standards and design requirements shall be placed in Alleys 6 to 8 inch thick.
- D. FORMING JOINTS** - Transverse expansion joints shall be placed at approximately 40 foot intervals.  
  
Transverse contraction joints shall be placed at approximately 13 foot intervals between the transverse expansion joints. These contraction joints shall consist of a groove formed with a jointing tool with a blade projection not less than 1-1/2 inches. As an alternate method, saw joints will be permitted and shall be done in accordance with 501.14 (D).
- E. LOAD TRANSFER DEVICES** - Load transfer devices shall be 3/4 inch in diameter.
- F. FINISHING** - A finishing machine will not be required.

**503.03 MEASURE AND PAYMENT**

The unit of measure for Reinforced Portland Cement Concrete Alley will be the square yard. The width for measurement will be from outside edge to outside edge of the alley. The length will be the actual length measured along the center line of the riding surface.

The actual number of square yards of the specified depth, measured complete in place will be paid for at the Contract unit price per square yard, which payment will be full compensation for furnishing, hauling placing and finishing, all materials including joints, load transfer devices, reinforcement, impervious material, sealing of joints, curing and for furnishing all equipment, tools, labor and incidentals necessary to complete the Work as specified.

## 504 PCC DRIVEWAY AND ALLEY ENTRANCES

### 504.01 DESCRIPTION

Work consists of constructing driveway and alley entrances composed of Portland Cement Concrete with wire fabric reinforcement on prepared base courses in accordance with the Contract Documents. Except as herein stated, all requirements specified for 501 are applicable to this Specification.

### 504.02 CONSTRUCTION REQUIREMENTS

Construction methods shall conform to the requirements specified in 501 with the following exceptions, changes, or additions.

- A. **PLACING CONCRETE** - When the driveway and alley entrances abut other permanent structures such as Portland Cement Concrete pavement, bases, sidewalks, alleys, and driveways, 1/2-inch thick preformed expansion joint filler meeting requirements of 807.01 shall be installed between the driveway and alley entrance, and the permanent structure.
- B. **PLACING REINFORCEMENT** - Wire fabric reinforcement conforming to approved standards and design requirements shall be placed in driveways and alley entrances 6 inches in thickness or greater, in a manner conforming to the requirements specified in 501.12.
- C. **FORMING JOINTS** - Expansion and contraction joints shall be installed in driveways and alley entrances per 501.14

### 504.03 MEASURE AND PAYMENT

Payment for the various items of Work listed herein will include all costs for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the Work.

- A. **SQUARE YARD METHOD** - The unit of measure for PCC Driveway and Alley Entrances will be the square yard. The actual number of square yards of the depth specified, measured complete in place, will be paid for at the Contract unit price per square yard, which payment will include expansion joint filler, waterproofing, impervious material, wire fabric reinforcement and curing.
- B. **CUBIC YARD METHOD** - The unit of measure for PCC Driveway and Alley Entrances will be the cubic yard. The actual number of cubic yards, measured complete in place, will be paid for at the Contract unit price per cubic yard, which payment will include expansion joint filler, waterproofing, impervious material, wire fabric reinforcement and curing.

## 505 REPAIR PCC PAVEMENT BASE, ALLEY, DRIVEWAY AND ALLEY ENTRANCES

### 505.01 DESCRIPTION

Work consists of making repairs to PCC pavement, base, alley and driveway and alley entrances and includes the cutting, removal and disposal of the old material from cuts or openings for underground work to a depth equal to that of the surrounding concrete, or as directed by the Engineer. Unless otherwise mentioned in the Contract Documents, materials, construction requirements, and measure and payment shall meet the requirements of 505.02 through 505.06. Except where noted, provisions of Section 501 apply.

### 505.02 MATERIALS

- 817: Portland Cement Concrete, Class E
- 812.01: Welded wire fabric
- 807.04: Tie rod assemblies and tie rods
- 807.03: Load transfer assemblies
- 807.01: Preformed expansion joint filler
- 807.02(A) or (B): Joint-sealing materials
- 822.14: Impervious Subgrade materials
- 814.01: Concrete curing materials
- 801.05: Fly Ash

### 505.03 PROPORTIONING

The proportions of materials for concrete shall meet the requirements of 817. Adjustments may be made as provided in 501.13.

### 505.04 CONSTRUCTION REQUIREMENTS

The Contractor shall not make pavement excavation or openings to a greater extent than can be replaced and repaved during the same working day, unless otherwise approved by the Engineer.

PCC pavement repair shall conform to the requirements of the Specifications of new construction of a type similar to that on which the repairs are to be made, with the following exceptions, changes, or additions.

- A. PREPARATION FOR CONCRETE REPAIRS** – The areas to be repaired shall be prepared by removing all materials as directed by the Engineer. The area shall be graded to the depth necessary to construct the repair so that it will meet the requirements of the Specifications for new construction of a similar type. If unsuitable materials are discovered in the Base Course, it shall be removed and replaced with material conforming to 804.04 and measured and paid for under 202 (removal) and 209 (new material) respectively. The area of repair will be such as to provide on each side of the cut a minimum 6 inch shoulder on undisturbed base course.

The concrete adjoining the section to be replaced shall be left with reasonably straight edges. Repair sections shall be in accordance with the Standard Drawings. If it is necessary to make replacement closer than 2 feet to a joint or to an existing repair, the replacement shall be extended to the joint and/or the existing repair as directed by the Engineer.

All costs of cutting back, removal, and disposal of the excavated material to the depth of pavement which is to be placed shall be included in the Contract unit price for Repair PCC Pavement, base, alley, driveway and alley entrances.

When directed by the Engineer, the asphalt binder course shall be omitted from the repair area and replaced with base concrete. This is intended for small repairs where it is impractical to compact the binder course with a roller. The Elevation of the finished concrete base shall be sufficiently below the pavement surface to allow placing and proper compaction of the specified thickness of the asphalt surface course.

- B. CUTTING TO A NEAT LINE** – The perimeter of all repair areas that become part of the permanent Roadway surface shall be cut to a neat line by means of a power saw.

- C. PLACING CONCRETE** – The edges of the concrete adjoining the repair shall be thoroughly cleaned and wetted just prior to depositing fresh concrete against them. Wire fabric reinforcement meeting the requirements of 812.01 for the type of pavement being repaired shall be used in the repair of pavement, base and alley, if such pavement, base, or alley is reinforced or if directed by the Engineer. Any damaged expansion joint material in the area to be repaired shall be replaced with new material and shall conform in all respects as to type, quality, and method of installation to that of new construction. Sufficient carbon powder shall be used in the repair of pavement, alley and sidewalk so that the repaired area will closely match the color of the existing concrete. The cost of furnishing carbon powder for pavement and alley repair will be paid for at the Contract unit price per pound for carbon powder for PCC pavement and alley repair.

If sufficient concrete is not available to completely fill the repair section, bulkhead timber of the depth of the repair shall be placed to receive the concrete. Tie rods shall be placed in the concrete at approximately  $\frac{1}{2}$  the depth of the repair and shall be embedded  $\frac{1}{2}$  the length of the rod.

Tie rods for this purpose shall meet the requirements of 807.04 except that a length of only 20 inches will be required.

When truck-mixed concrete is used for repair, re-tempering the concrete and placing of concrete that has attained initial set will not be permitted. However, in lieu of the time interval requirements of 501.09, the interval between the admission of cement to the batch and final discharge shall not exceed two (2) hours.

It is important that all locations at which concrete is to be used are fully prepared prior to delivery of the concrete and that only sufficient concrete is ordered to permit its use within the time limit specified for hauling concrete. Due to the difficulty of placing concrete in irregular and small repairs, and the importance of attaining the best possible results, the Contractor shall proceed with the utmost diligence in the prosecution of all phases of Work.

- D. PROTECTION** – In lieu of the provisions specified in 501.20 and 501.21 the following shall apply: All classes of traffic shall be excluded from pavements by the erection and maintenance of suitable barricades for a period of twenty-four (24) hours after placing the concrete. This curing period will be increased to forty-eight (48) hours in the case of roadway and alley construction during the period classified as Cold Weather Construction.

On heavily traveled streets, a steel protection plate, as per 615.19, extending out onto the adjoining pavement at least 6 inches on all sides may be required over concrete base repair areas. The plates shall be securely anchored to prevent displacement under traffic. When steel protection plates are used, barricades will not be required.

The Contractor shall be responsible for the cuts and their condition from the initiation of excavation to the removal of barricades from completed repair.

- E. TREE SAFEGUARDS** – Tree safeguards shall conform to the requirements of 610.07 and 610.08.

### 505.05 CLEANING

The Contractor shall remove from the Roadway all excavated pavement, debris, and dirt as rapidly as the completion of the repair work permits, and in no case will it be permissible for this material to remain on the Project overnight.

### 505.06 MEASURE AND PAYMENT

- A. PORTLAND CEMENT CONCRETE PAVEMENT BASE, ALLEY, DRIVEWAY AND ALLEY ENTRANCES REPAIR** – The unit of measure for Portland Cement Concrete Pavement Base, Alley, Driveway and Alley entrances Repair will be the cubic yard. The actual number of cubic yards measured complete in place will be paid for at the Contract unit price per cubic yard, which payment will include sawing, removal and disposal of excavated materials, backfill, reinforcement, joint materials, load transfer devices, placement of dowels, tie rods and tie bars, curing, protection, joint sealing and all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.
- B. ADDITIONAL STANDARD PORTLAND CEMENT** – The unit of measure for Additional Standard Portland Cement will be the bag. The actual number of additional bags added to the mix, as directed by the Engineer per 501.22, will be paid for at the Contract unit price per bag, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.
- C. CARBON POWDER** – The unit of measure for Carbon Powder will be the pound. The actual number of pounds added to the mix will be paid for at the Contract unit price per pound, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

## 506 BUS STOP PADS, MEDIAN STRIPS, AND ISLANDS

### 506.01 DESCRIPTION

Work consists of PCC bus stops, median strips, directional islands for channelization of traffic, and pedestrian islands, constructed on bituminous pavement, PCC pavement, or on a prepared base course in conjunction with new construction. Except as herein stated, all requirements specified in Section 501 for “Reinforced Portland Cement Concrete Pavement” are applicable to this Specification.

### 506.02 MATERIALS

The materials shall meet the requirements specified in 501.02.

### 506.03 COMPOSITION

The proportions of materials for concrete shall meet the requirements of 817.01 (B), Class E.

### 506.04 TESTING

The concrete shall meet the requirements of 501.15.

### 506.05 CONSTRUCTION REQUIREMENTS

Construction shall conform to the requirements described in 501 with the following exceptions, changes, or additions:

- A. **PREPARING PAVEMENT FOR BUS STOP PADS** - Where bus stop pads are to be constructed on composite pavement, the bituminous surface course and binder course shall be removed and the area of the concrete base on which the islands are to be constructed shall be cleaned and roughened as directed by the Engineer.
- B. **PREPARING PAVEMENT OR BASE COURSE FOR MEDIAN STRIPS, OR DIRECTIONAL AND PEDESTRIAN ISLANDS** - Where the medians or islands are to be constructed on composite pavement, the bituminous surface course and binder course shall be removed and the area of the concrete base on which the medians or islands are to be constructed shall be cleaned and roughened as directed by the Engineer.

Where the medians or islands are to be constructed on PCC pavement, a groove 1 foot wide, 2 inches deep and approximately 6 feet in length shall be cut into the surface of the existing pavement at intervals of 6 feet for the full length of the island and shall be on the approximate center line of the proposed location of the island. The surface shall be thoroughly cleaned before placing concrete.

When islands are to be constructed on the base course or in conjunction with new construction, the Work shall be done in accordance with requirements for new reinforced PCC pavement or sidewalk construction, whichever, as determined by the Engineer, is applicable, except that the density of the base course shall not be less than 95 percent of maximum density.

#### C. REINFORCEMENT

- 1. **Bus Stop Pads** - When bus stop pads are constructed on a base course and extend for the full depth of the pavement, wire fabric reinforcement weighing 50 pounds per 100 square feet shall be used. When the bus stops are constructed upon concrete base previously placed, wire fabric reinforcement weighing 30 pounds per 100 square feet shall be used.
- 2. **Median Strips, Directional and Pedestrian Islands** - Wire fabric reinforcement weighing 30 pounds per 100 square feet shall be placed in the medians or islands approximately 2 inches below the surface and shall extend for the full width and length thereof.
- D. **PLACING ANCHOR SOCKETS** - Anchor sockets for reflector posts shall be installed in the directional and pedestrian islands or medians as shown on the Plans. They shall be placed in such a manner as to project above the surface for a distance of 2 inches. The cost of this Work shall be included in the Contract unit price per cubic yard for concrete for construction of bus stops, median strips, directional islands and pedestrian islands.

- E. FORMING JOINTS** - Where PCC bus stop pads, median strips, directional islands, or pedestrian islands are constructed upon PCC pavement or base, the joints in the bus stop pads, medians, or islands shall be placed at the same locations and be of the same type as the joints in the pavement or base. Where the bus stop pads, medians or islands are constructed upon base course, the joints shall be placed at the same locations, and be of the same type as the adjacent concrete against which the bus stops or islands are placed.
- F. SEALING JOINTS** - All joints in bus stop pads, median strips, directional islands, and pedestrian islands shall be sealed in conformance with 501.19.
- G. FINISHING** - Bus stops shall be finished in accordance with the requirements specified in 501.13. The surface of the islands shall be finished in accordance with 605.01(C) (6) except that the surface shall not be marked in 3 foot squares nor will transverse contraction joints be formed at 12 foot intervals. The faces of the islands and median strips shall be finished in accordance with the requirements specified in 606.01 (E) (9).

#### **506.06 MEASURE AND PAYMENT**

The unit of measure for PCC Bus Stop Pads, Median Strips, Directional Islands, and Pedestrian Islands will be the cubic yard. The number of cubic yards of concrete computed from field measurements will be paid for at the Contract unit price per cubic yard, which payment will include furnishing, hauling, and placing all materials, including joints, reinforcement, sealing of joints, and curing, and for furnishing all equipment, tools, labor and incidentals necessary to complete the Work.

**507 MINOR STRUCTURES****507.01 WALLS AND STEPS****A. DESCRIPTION**

1. **Concrete Footings** - This Work shall consist of excavating, forming, furnishing and placing concrete footings for concrete and stone masonry walls to the dimensions and at the locations as designated in the Contract Documents and/or as directed by the Engineer.
2. **Concrete Walls** - This Work shall consist of excavating, forming, furnishing and placing concrete on concrete footings, and backfilling of concrete walls, at the locations and to the dimensions as specified in the Contract Documents and/or as directed by the Engineer.
3. **Stone Masonry Walls** - This Work shall consist of excavating, furnishing and placing stone on the concrete footings, and backfilling of stone walls at the locations and to the dimensions as specified the Contract Documents and/or as directed by the Engineer.
4. **Concrete Steps** - The Work shall consist of excavating, forming, furnishing and placing concrete for steps at the locations and to the dimensions as specified in the Contract Documents and/or as directed by the Engineer.

**B. MATERIALS**

- 817: Concrete (Steps), Class F
- 817: Concrete (Footings and Walls), Class B
- 805.02: Pervious fill
- 804.04: Backfill

Facing Stone for the wall, if required, shall be sound and durable, subject to approval of the Engineer. It shall be gray granite, free from reeds, rifts, laminations and minerals which would cause discoloration or deterioration, and shall be 40 percent seam face and 60 percent split face of a light color.

Before proceeding with the Work, the Contractor shall submit for approval the name of the quarry and 2 samples of the stone proposed to be used in the Work. 1 sample shall show the lightest color and the other shall show the darkest color of the stone to be furnished. All stone in the Work shall be within the color range defined by the approved samples and of the same type of stone. The samples shall have a face size of at least 6 inches by 6 inches.

Stones for wall facing shall have a minimum depth of 6 inches. Stone shall range in rise from a minimum of 4 inches to a maximum of 12 inches, with an average rise of not less than 8 inches. Exposed surfaces shall have stones with a ratio of length to rise of not less than 1-1/2 to 1 and no more than 4 to 1, with the exception of closure stones. A minimum number of closures, not exceeding 5 percent of the exposed surface of the Work, may be placed. Closures shall be rectangular with the longest face laid horizontal.

Stone shall be 1 1/2 inch rock faced, i.e., the face shall be an irregular convex protecting surface without indications of tool marks, with no concave surfaces below the pitch line, and with no projections beyond the pitch line exceeding 1 1/2 inches.

Coping Stones shall be sound, durable, properly quarried gray granite free from reeds, rifts, seams, laminations and minerals, which by weathering would cause discoloration or deterioration. Before proceeding with the Work, the Contractor shall submit for approval the name of the quarry and 2 samples of the stone proposed for use in the Work. The samples, each having a face size of at least 2 inches by 6 inches, shall show the texture, color range, and finish of the stone to be furnished. All stone in the Work shall be of the same kind and color range as defined by the approved samples. All dimensions shall conform to those shown on the Plans unless otherwise ordered by the Engineer. The minimum length of coping stone shall be 3 feet.

The top and roadway sides of coping shall be sawn. All sawn surfaces shall be sandblasted after tooling and dressing. The backside of the coping shall be coarse pointed, with the point depressions approximately 1 to 1-1/4 inches apart with surface variations not to exceed 3/8 inch. Joint faces shall be vertical and at right angles with the exposed faces of the stone.

Backing Stones shall be sound, durable stone subject to approval of the Engineer.

- 806.05(B) (1) and (2): Mortar for stone masonry walls
- 812.02: Reinforcing steel for steps

### C. CONSTRUCTION REQUIREMENTS

1. **Concrete Footings** - Construction shall conform to the applicable provisions of 205, 206, and 703.
2. **Concrete Walls** - Construction shall conform to the applicable provisions of 205, 206, and 703.
3. **Stone Masonry Walls** - Construction shall conform to the applicable provisions of 205, 206, and 708 for Class B stone masonry except as herein noted. Beds and joints shall be pointed to produce a concave surface from stone to stone approximately 1/4 inch in depth.

The coping stone shall be set on the top of the stone masonry wall on a mortar bed 1/2 to 1 inch in thickness and shall be anchored to the top of the wall by wrought iron or galvanized iron dowels 3/4 inch diameter, 6 inches long, 1 at each end of each coping stone. Joints for coping shall be not less than 1/4 inch nor more than 1/2 inch with an average of 3/8 inch. The Contractor shall exercise care in the setting of the coping course so that the stones present smooth and uniform line and grade.

4. **Concrete Steps** - Construction shall conform to the applicable provisions of 205, 206, and 703 except as herein noted. Reinforcing steel, when specified in the Contract Documents, shall be placed in conformance with 704.

Where the steps are to be constructed on existing ground, the ground shall be neatly graded to required Elevation and dimensions as shown in the Contract Documents, and care shall be exercised to assure that the ground to receive the concrete is undisturbed and is kept dry. The concrete shall be poured as soon as practicable after excavation is complete and the forms erected. Forms shall remain in place for at least twenty-four (24) hours after the concrete is poured, unless permission for an earlier removal is granted by the Engineer.

The treads of the steps shall be broomed with a stiff brush to some uniform pattern to provide a roughened surface that will not be slippery when wet.

### D. MEASURE AND PAYMENT

1. **Concrete Footings** - The unit of measure for Concrete Footings will be the cubic yard. The actual number of cubic yards measured complete in place, or, if the footing is poured against side excavation computed based on plan dimensions, will be paid at the Contract unit price per cubic yard, which payment will include all excavation and disposal of surplus material and all labor, materials, tools, equipment and incidentals necessary to complete the Work.
2. **Concrete Walls** - The unit of measure for Concrete Walls will be the cubic yard. The actual number of cubic yards measured complete in place will be paid at the Contract unit price per cubic yard, which payment will include all excavation and disposal of surplus material, pervious fill and backfilling materials, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.
3. **Stone Masonry Walls** - The unit of measure for Stone Masonry Walls will be the cubic yard. The actual number of cubic yards of stone masonry complete in place, measured in the field will be paid at the Contract unit price per cubic yard, which payment will include all excavation and disposal of surplus materials, pervious fill and backfilling materials, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.
4. **Concrete Steps** - The unit of measure for Concrete Steps will be the cubic yard. The actual number of cubic yards of concrete measured complete in place, or, if the steps are poured against side excavation, computed based on plan dimensions, will be paid at the Contract unit price per cubic yard, which payment will include all excavation and disposal of surplus material, backfilling materials, reinforcing steel when specified and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.



**507.02 PORTLAND CEMENT CONCRETE COPINGS**

- A. DESCRIPTION** - This Work shall consist of the construction of standard and special copings to the dimensions and at the locations as indicated on the Contract Plans and/or as directed by the Engineer.
- B. MATERIALS** - The copings shall be constructed of concrete conforming to PCC Mix Design, Class F as per 817, with materials meeting the requirements of 501.02.
- C. CONSTRUCTION REQUIREMENTS** - Construction of copings shall conform to the requirements of 501 with the following exceptions, changes or additions.

- 1. Forms** - Forms for this Work shall meet the requirements of 905.03(B) with the following exceptions, changes or additions:
- a.** Backforms for both standard and special copings shall be of a depth equal to the depth of the coping.
  - b.** A front form will not be required for standard copings, but a method as approved by the Engineer shall be employed to achieve the end product of an 8 inch radius on the front face of the coping as shown on the Contract Plans.
  - c.** Front forms for special copings shall be required, shall be of a depth equal to the depth of the coping and shall be so equipped that the grooves and bevel are formed as shown on the Contract Plans.

- 2. Placing Concrete** - The concrete for standard copings shall be placed against the back form and thoroughly compacted by working with suitable tools. Care shall be exercised in depositing the concrete so that it reaches a position in the forms so that it can be finished to the required dimensions with a minimum of working. It shall be compacted to insure a smooth, even surface free from voids and honeycombs. The plastering of honeycombed areas will not be permitted.

Concrete for special copings shall be placed in accordance with the requirements specified in 606.01(E) (2).

- 3. Forming Joints** - Where the standard or special concrete coping is to be poured adjacent to a cement concrete sidewalk, the expansion joints and planes of weakness joints shall be formed at the same intervals and in line with the transverse joints in the sidewalk. Where the coping does not abut any sidewalk or any other concrete slab, the expansion joints shall be formed at 45 foot intervals with planes of weakness at intervals of 15 feet. Where shorter sections are necessary for closures, no section shall be less than 4 feet.

Where the copings terminate at alleys, driveways, or other permanent structures, expansion joint filler having a recovery of 90 percent or more shall be installed at the junction. Expansion joints shall be constructed with a single piece of joint filler meeting the requirements of 807.01(A), cut to the dimensions of the coping. Intermediate transverse joints shall be formed as specified in 605.01(C)(3)(a) when the coping is poured integrally with the sidewalk. When the coping does not abut the sidewalk or any other concrete slab, the plane of weakness joints shall be formed by a bar or plate which can be easily removed without damage to the coping.

- 4. Finishing** - The front face of the coping shall be shaped to the required dimensions as soon as possible after the concrete has been deposited and is workable. The front face of the coping shall be finished true to line, grade, and contour in a smooth, neat, and even manner. When the concrete has set sufficiently, the surface shall be brushed with a fine hair brush meeting the requirements of 905.09(E). The top surface of the coping shall be tested with a straightedge meeting the requirements of 903.03 laid along the surface in the longitudinal direction. Any deviation of the top surface of the coping in excess of 3/16 inch from the straightedge shall be immediately corrected. There shall be no variation in alignment of the coping exceeding 1/8 inch. All rejected coping shall be removed and replaced without additional compensation. Back forms shall remain in place for at least twelve (12) hours. Any irregular surface shall be corrected by rubbing with a carborundum stone. Special concrete coping shall be finished in accordance with applicable requirements of 606.01(E) (9).

- 5. Backfilling** - Backfilling of the coping shall be done to meet the applicable requirements of 606.01(E) (7).

- D. MEASURE AND PAYMENT** - The unit of measure for Standard Portland Cement Concrete Coping and of Special Portland Cement Concrete Coping will be the cubic yard. The actual number of cubic yards measured complete in place will be paid for at the respective Contract unit price per cubic yard, which payment will include excavation and disposal of material, furnishing, hauling, and placing all materials including joints, curing, backfilling, and all labor, materials, tools, equipment and incidentals necessary to complete the Work.

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## 601 UNDERDRAINS

### 601.01 DESCRIPTION

Work consists of trench excavation, dewatering, furnishing, and placing filler materials including fabric if required, under drain pipe, connecting pipe, pipe risers, and backfill. Work includes all pipe connections plus installation and maintenance of shoring as needed to provide the specified trench width. The Contractor shall make the requisite excavations for constructing the underdrain, appertaining structures, and connections and make provisions to maintain and protect fences, trees, underground installations, and other structures. He shall be responsible for the repair of all damage which may result from his operations.

The Contractor shall, after giving due notice to parties affected thereby, provide plank crossings, barricades or other means of maintaining and protecting travel on streets or roads in which trenches are excavated and shall maintain these in good and safe condition so long as may be necessary and shall then remove such temporary expedients and restore such ways to their proper condition.

Work shall include furnishing all materials, tools, labor, and equipment required to fully install and make operational the entire drainage system.

If the Engineer determines that sufficient and proper shoring is not provided, extra shoring shall be installed at the Contractor's expense.

### 601.02 MATERIALS

Materials shall meet the following requirements:

- 805.02: Pervious Fill
- 808.02 or 809.02: Underdrain Pipe
- 808.01(A) or 808.02(A) or (D): Connecting Pipe
- 806.05(B)4: Mortar
- 804: Backfill Material (as determined by the depth)
- 805.04: Blanket Soils
- 817: PCC for Collar, and Block
- 808.02(A): or 808.02(D): Class F Pipe Risers
- 822.16: Pipe Jointing Compound
- 808.02: Cleanouts – PVC Pipe meeting (they shall have an adjustable housing with a countersunk cleanout plug and a scoriated PVC cover)
- 805.03: Coarse Aggregate
- 822.09: Geotextile Fabric

### 601.03 CONSTRUCTION REQUIREMENTS

Trenches shall be excavated to the dimensions and grade as specified in the Contract Documents, Standard Drawings or as directed by the Engineer. The sides and bottom of trenches shall be smooth and uniform to prevent tearing of geotextile fabric during backfilling.

When specified in the Contract Documents, geotextile fabric shall be placed tightly against the trench to eliminate voids beneath the geotextile. The geotextile fabric shall be of sufficient width to completely enclose the underdrain trench including any specified overlaps. Wrinkles and folds in the geotextile fabric shall be avoided, except where trench changes direction. Geotextile joints and overlaps shall be a minimum of 24 inches and pinned securely to hold the fabric in place during backfilling. Damaged geotextile fabric shall be replaced or repaired as directed by the Engineer at the expense of the Contractor.

The slope of the underdrain pipe shall be so that positive drainage toward the underdrain outlet is maintained. Perforated pipes shall be placed with perforations facing down. Pipe shall be placed with the bell end up grade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe, except for combination underdrains, shall be plugged up grade as directed by the Engineer. When an underdrain connects with a manhole or catch basin, a suitable connection shall be made through the wall of the manhole or catch basin.

Underdrains shall be outletted into drainage structures wherever possible. Outlets that empty into a drainage structure shall be positioned a minimum of 6 inches above the normal flow level in the structure and shall be constructed of under drain pipe. A minimum of 18 inches of cover over the pipe shall be maintained. When outletted to a slope or ditch, the connector pipe shall slope a minimum of 3 percent unless otherwise directed by the Engineer. A sloped concrete headwall with removable rodent screen shall be constructed at the end of the connector pipe in conformance with the Contract Documents.

Pipe used for outlets shall be non-perforated rigid polyethylene or polyvinyl chloride. Flexible tube type pipe is prohibited. Geotextile fabric is prohibited for underdrain outlets. Longitudinal underdrains shall have outlets spaced at a maximum of 250 feet intervals, unless otherwise directed by the Chief Engineer, and at the lowest elevation on all vertical curves.

After pipe installation has been approved by the Chief Engineer, aggregate backfill shall be placed and compacted. Pipe and covering at open joints shall not be displaced during subsequent operations. The Contractor shall replace any geotextile, underdrain, or connector pipe damaged by excessive tamping at no additional cost to the District.

#### 601.04 MEASURE

**A. UNDERDRAINS AND CONNECTOR PIPES** - The unit of measure for Underdrains, and Connector Pipes will be the linear foot. The number of linear feet will be measured along the center line out of the top of the pipe, complete in place. Measure for underdrain will be made from the spigot end of the pipe where it enters the bell of the fitting for the connecting pipe. When cleanouts are being installed, the measurement will terminate at the riser; otherwise, it will terminate at the end of the pipe. For connector pipe, measure will be made from the outside face of the headwall, inlet wall or manhole to the bell end of the connecting pipe where it meets the underdrain pipes.

**B. ADDITIONAL EXCAVATION FOR UNDERDRAINS** - The unit of measure for Additional Excavation for Underdrains will be the cubic yard.

When directed by the Engineer, the additional excavation required for lowering the trench to an elevation lower than specified in the Contract Documents or the Standard Drawings will be measured and paid as Additional Excavation for Underdrains.

**C. UNDER DRAIN PIPE RISERS** - The unit of measure of Underdrain Pipe Riser will be the vertical linear foot. The number of vertical linear feet will be measured along the center line on the outside of the pipe.

Measure will be made from the bell end of the underdrain pipe where the elbow fits into the bell to the top of the cleanout plug.

#### 601.05 PAYMENT

**A. UNDERDRAINS & CONNECTOR PIPES** - The number of linear feet of Underdrains and Connector Pipes, as measured in 601.04(A), will be paid for at the Contract unit price per linear foot, which payment will include excavating to plan depth and width, or as specified herein. This payment will also include disposal of all excess and unsuitable excavated materials, the furnishing, hauling, and placing of all under drain pipe, connector pipe, and backfill and all labor, geotextile fabric, materials, tools, equipment, and incidentals necessary to complete the Work.

**B. ADDITIONAL EXCAVATION FOR UNDERDRAINS** - The number of cubic yards of Additional Excavation for Underdrains as measured in 601.04(B), will be paid for at the Contract Price per cubic yard, which payment will include the excavation and disposal of all excess excavated materials, the furnishing, hauling, and placing of all materials including additional pervious materials, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**C. UNDERDRAIN PIPE RISERS** - The number of linear feet of Underdrain Pipe Risers, as measured in 601.04(C), will be paid for at the Contract unit price per vertical linear foot, which payment will include excavation and disposal of excess and unsuitable materials, the furnishing, hauling, and placement of all materials, including the elbow fitting, the PCC blocks, the cleanout box, and all labor, tools, equipment, and incidentals necessary to complete the Work.

## 602 SLOPE AND FOUNDATION PROTECTION

### 602.01 DESCRIPTION

This Work consists of constructing a protective covering of grouted riprap or slope paving along embankment slopes, around culvert inlets or outlets, or placing a graded stone mass around foundations or at such locations as directed by the Engineer, in conformance with grades, dimensions, and details indicated in the Contract Documents.

Work also includes the necessary excavation, shaping and compacting the foundation, trimming, and cleanup.

### 602.02 MATERIALS

Materials shall meet the following requirements:

- 803.09: Stone for Grouted Riprap
- Stone for foundation protection shall be graded from coarse to fine and meet the same requirements for suitability as listed above for riprap stone
- 801.01: Portland Cement
- 803.06(C): Mortar Sand
- 822.01: Water

### 602.03 CONSTRUCTION REQUIREMENTS

- A. GENERAL** - Slopes and ground surfaces shall be excavated to lines and grades indicated in the Contract Documents, on Plans, or as directed by the Engineer.

After this excavation is complete, the area shall be compacted to a density of 93 percent of that determined by AASHTO T 180, Method D. Any poor material shall be removed and suitable fill material placed so that proper compaction can be achieved.

All outer edges and the top of grouted riprap or concrete slope paving, where construction terminates, shall be formed so that the surface of the Work will be embedded, and even with adjacent slope or ground.

At toe of slopes, the bottom of grouted riprap or concrete slope paving shall be placed at least 3 feet below the finished ground surface unless otherwise indicated.

Construction of all grouted riprap or concrete slope paving shall be started at bottom of slope, progressing upward.

No grouted riprap or concrete slope paving shall be placed during freezing weather nor while there is any ground frost. Cold weather construction shall conform to the requirements of 501.10(B).

Grouted riprap and concrete slope paving shall be covered with 2 layers of burlap, meeting the requirements of 814.01, and kept wet for three (3) days after placement.

- B. GROUTED RIPRAP** - All stones shall be hand placed substantially in a single layer, with a 12 inch dimension laid perpendicular to the exposed face. As stones are placed, grout shall be deposited to completely fill all voids between stones. Care shall be taken to secure maximum compaction and density.

Depth of riprap shall be as indicated on the Plans in the Contract Documents and shall not vary more than 2 inches plus or minus; average depth shall be not less than stipulated. Surface of the completed Work shall have a neat, rustic appearance, and no grout shall be used to cover surface of stone. Variance from the theoretical surface shall not exceed 2 inches in 10 feet and shall be made as smooth as practicable without cutting or breaking stones.

Grout shall be composed of 1 part Portland Cement, 3 parts mortar sand, measured by volume and thoroughly mixed dry, and a sufficient quantity of water added afterwards to make a paste of such consistency that it will flow and completely fill all voids.

- C. SLOPE PAVING** - Slope paving shall be constructed as a single layer, using a single pour between joints, in conformation with grades, dimensions, and details indicated on the Plans in the Contract Documents. Concrete shall meet requirements of 817, Class F and be mixed and placed in accordance with 501, except that volumetric batching may be used.

The concrete shall be finished with a wooden float; all edges shall be neat, using an approved edger.

- D. STONE FOUNDATION PROTECTION** - Stone for protection of foundations at abutments, walls, piers, etc., shall be carefully dumped around the foundation, as indicated on the Plans or as directed by the Engineer, in such a manner that segregation of the graded stone mass will be kept to a minimum and will produce a reasonably compact and properly sloped mass with minimum voids.

#### **602.04 MEASURE AND PAYMENT**

- A. GROUTED RIPRAP AND SLOPE PAVING** - The unit of measure for Grouted Riprap and Slope Paving will be the square yard. The actual number of square yards of the specified thickness, complete in place, measured on the exposed surface of the grouted riprap or slope paving will be paid for at the Contract unit price per square yard, which payment will include all necessary excavation and its proper disposal, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.
- B. STONE FOUNDATION PROTECTION** - The unit of measure for Stone Foundation Protection will be the ton. The actual number of tons complete in place determined by the certified scale weights will be paid for at the Contract unit price per ton, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**603 GUARDRAILS AND GUARDRAIL TERMINALS**

**603.01 GUARDRAIL**

- A. DESCRIPTION** - Work shall consist of the fabrication and erection of new guardrail installations or the reconstruction and re-setting to proper line and grade of existing guardrails, as indicated in the Contract Documents. The guardrails shall consist of steel and/or wood systems of either single face or double face configurations, installed to the dimensions and at locations shown in the Contract Documents or as directed by the Engineer.

The guardrail systems are designated as follows:

**TABLE 603.01 GUARDRAIL SYSTEM DESIGNATIONS**

Type I	W-beam (standard-block-out)
Type ID	W-beam (double faced)
Type II	W-beam (weak post)
Type III	Box beam
Type IV	Thrie beam (standard-block-out)
Type IVD	Thrie beam (double faced)
Type V	Corrosion Resistant (weathering steel W- beam)
SBT	Steel-backed Timber Guardrail/Timber Posts and Block-out

- B. MATERIALS** - Materials shall meet the following requirements:

- AASHTO M 180, Class A, Type I: W/Thrie Beam Rail Elements, Back-up Pieces, and Terminal Sections
- 815.01(A): Rail Posts, Offsets, Angles, Channels and Shims
- 815.01(B): Corrosion Resistant Steel (weathering steel)
- 815.01(A): Tie Rods
- 815.01(D): Splice Bolts, Nuts and Washers
- 815.01(H): Anchor Bolts and Nuts
- 815.01(A): Anchor Rods and Nuts
- 815.01(I): Anchorage Casting Plates
- 813.07: Timber Posts
- 813.05: Timber Rails
- 813.05: Wood Offset Blocks
- NCHRP 350: Composite Offset Blocks
- 822.13(C): Reflectors
- 815.12: Turnbuckles
- 817: PCC
- 822.08: Class F Epoxy
- 811.06: Galvanizing
- 812.02: Reinforcing Steel

### C. CONSTRUCTION REQUIREMENTS

1. **General** - Prior to erection, all parts shall be inspected for damage and for chipped or marred coatings. Pieces warped, deformed or with damage to galvanizing will be rejected and the Contractor will be required to replace any such damaged parts at his expense. Paint touch-up of marred or chipped galvanizing will not be permitted.
2. **Posts** - Posts shall be driven unless an alternative method is approved by the Engineer. The post driving method shall be such as to avoid battering or distorting the posts. Posts not driven shall be set in holes of sufficient diameter to permit tamping of the backfill. Post holes shall be backfilled with approved material placed in 6 inch layers and thoroughly compacted. When the posts are to be set in existing pavement, all loose material shall be removed and paving material replaced.

If rock is encountered while placing the posts, the hole shall be enlarged to provide not less than 6 inches clearance on all sides, and the hole shall be excavated to a minimum depth of 2.5 feet. The post shall be set in concrete to within 6 inches of the top of the hole. The hole shall be backfilled with approved material, properly placed and compacted.

Any post damaged from driving shall be withdrawn, not used, and another post placed at no additional cost to the District.

Posts may also be driven in existing sidewalk areas where there will be no interference with utilities, catch basins, sewers, etc. In these areas, the existing concrete shall be removed by cutting a square 8 inches by 8 inches to a depth of 1-1/2 inches below the bottom of the sidewalk with a power masonry saw. The remainder of the concrete may be removed by other methods. After the posts are driven, the concrete shall be replaced. Payment for concrete will be made under PCC for Post Anchorage.

3. **Anchor Bolt Alternative** - Where the existing concrete is of sufficient depth to accommodate the anchor bolts, installation shall be made in predrilled anchor holes.

- a. *Predrilled Anchor Holes* – Holes shall be drilled to diameters as specified in (c) below. Drilling templates shall be used for all drilling operations to insure properly aligned true anchorage holes. Where dry drilling is employed, the holes shall be vacuumed or blown out using oil-free compressed air. Where the drilling process requires the use of water, holes shall be carefully washed out after drilling to remove any drilling slurry residue that may remain. Holes shall then be permitted to dry thoroughly before placing bolts.

The Contractor is warned that reinforcing, utilities or other obstructions may be encountered during drilling of anchor holes in concrete. Diamond drilling or other special procedures necessary to construct anchorage shall be included as part of the Work. All cost involved in connection with drilled anchorages shall be included as part of Work. The Contractor shall assume the entire responsibility for all damage, and injury to electrical conduits, utilities and the Structure. Repair of any damage shall be included as part of the Work.

- b. Where existing concrete is of insufficient depth to accommodate the anchor bolts, the existing concrete shall be removed to a rectangle approximately 4 inches greater in each dimension than the base plate to be used. The concrete shall be cut to a neat line to a depth of 1-1/2 inches below the concrete surface with a masonry power saw. The rest of the concrete and soils may be removed by other methods.

- c. *Epoxy Installation of Anchor Bolts* – Bolts and bolt holes shall be clean, degreased with toluene and dry at the time of installation. Bolts may be installed by either of the following methods:

Holes shall be drilled in existing concrete to diameters not to exceed 1/4 inch greater than the diameter of the bolts or dowels being embedded or as recommended by the epoxy manufacturer. The bolts and dowels shall be fixed with an epoxy resin adhesive meeting the requirements of 822.08(B)(2).

Holes shall be drilled in existing concrete to diameters at least 1 inch greater than the diameter of the bolt or dowel being embedded. The bolts and dowels shall be fixed with an epoxy mortar meeting the requirements of 822.08(C).

When using either of the methods specified above, the locations of the holes to be drilled shall be accurately determined by means of templates. The templates shall also be used to hold the bolts in position until the epoxy resin or mortar has cured. The temperature of the concrete where bolts are being installed shall conform to the requirements of 501.10(B) at the time of installation.

- d. *Anchor Dowel Installation* – Where bolted anchorages are to be set on PCC mortar blocks, anchor dowels shall be carefully preset by template prior to placing the PCC sidewalk, median or anchor block.
- e. Base plates shall be set level by the use of steel shims or an epoxy mortar bed to insure plumb posts.

When steel shims are used, they shall be designed to provide full bearing between the full area of base plate and shims and no gaps shall appear between base plates and concrete.

If an epoxy mortar bed is used, it shall be applied to provide a level bed of mortar 1 inch greater in each horizontal direction than the base plate. It shall be a minimum of 1/4 inch thick on the high side and the complete area of the base plate shall be in contact with the mortar bed.

- 4. **Anchorage On Concrete Decks** - Where installation is to be made on an existing structure and the depth of the deck is less than the required depth for anchor bolts, the installation shall be made as follows:

- a. Holes shall be drilled through the concrete deck. The Contractor shall prevent broken concrete, other materials, and tools from falling onto any traveled roadway, sidewalk or other public space where the safety of the public may be endangered.
- b. The base plates, on neoprene pads, if required, shall then be anchored to the deck with bolts, anchor plates or any other method as shown on the Plans or as directed.

Prior to setting the rails or cables, the posts shall be properly aligned within a 1/4 inch tolerance of line and grade. Posts shall be plumb.

- 5. **Rail Elements** - Rail elements shall be erected to produce a smooth rail paralleling the set line and grade of the highway or as shown on the Plans.

All bolts, except expansion joint bolts and adjustment bolts, shall be drawn tight when the rails have been properly aligned and adjusted and approved by the Engineer. Bolts through expansion joints shall be drawn sufficiently tight to prevent the rail elements from slipping over longitudinally. Bolts shall be sufficiently long to extend at least 1/4 inch beyond the nuts. Except when required for adjustment, bolts shall not extend more than 1/2 inch beyond the nuts.

All splices shall be lapped in the direction of traffic. The trailing end of every installation shall be fitted with a rounded type terminal section and lapped on the face of the rail.

All metal shall be fabricated in the shop. Shop-bend all curved guardrail with radii of 150 feet or less. Burning, drilling, or welding may be performed in the field when indicated on the Plans. Field punching, cutting, and drilling may be permitted after the Contractor demonstrates that the process will not damage the metal surrounding the field adjustments, and the process has been approved by the Engineer.

Timber guardrail bolts shall be equally spaced along the front face of the timber rail to match the holes in the steel backing. Steel backing shall have the same vertical dimension as the timber rail. Align timber guardrail along the top and front edges of the rail. Field cut timber rails to produce a close fit at the joints. Field cuts shall be treated with wood preservative as per 811.08.

After final tightening of nuts, projecting threads on all bolts shall be burred to prevent removal.

- D. **MEASURE AND PAYMENT** - The unit of measure for Guardrail will be the linear foot.

The number of linear feet will be the actual length of guardrail measured, complete in place, along the face of the guardrail center to center of end posts for each installation.

For double-faced guardrail, measurement will be made along the centerline of posts, center to center of end posts.

Where types of installation change, measurement for each type will begin and/or end mid-way between the posts but will not include terminal sections.

The unit of measure for PCC for Post Anchorage will be the cubic yard, based on field measurement.

Payment will be made at the Contract unit price per linear foot, which payment will include all labor, equipment, tools, and

incidentals necessary to construct all components of the guardrail system complete in place.

Payment for PCC for Post Anchorage will be made at the Contract unit price per cubic yard. Payment will include furnishing and curing PCC, backfilling, and all other incidentals.

Payment for anchor bolts or bolt holes will be included in the Contract unit price for the appropriate Guardrail Pay Item.

Payment for additional excavation will be made under the appropriate excavation items.

## 603.02 GUARDRAIL TERMINAL SECTIONS

**A. DESCRIPTION** - Work consists of the construction of the guardrail terminal sections that are the end components of the guardrail systems. Terminal sections shall be constructed as shown in the Department Standard Drawings or as specified by the manufacturer of a particular type of end treatment. Terminal section construction also includes the proper termination and connection to vertical faces of abutments, piers, end walls, and safety shaped barriers. Materials, fabrication, and construction shall meet the requirements of 603.01(B) and (C).

**1. Guardrail Standard Trailing Terminal** – Work consists of the construction of Guardrail Standard Trailing Terminal at locations as shown on the Contract Documents or as directed by the Engineer. The unit shall consist of:

- 6 foot 3 inches Section of Rail
- Standard End Terminal Piece
- 1-1/2 inch Diameter Galvanized Rod, Turnbuckle, and Anchor Plate
- Miscellaneous Hardware
- PCC Anchor and W6-9 Steel Anchor Post and Plate

The anchor blocks shall not be constructed until anchor posts are in the proper place. Stay-in-place forms may be used, or concrete may be placed against plumb undisturbed Earth, if approved by the Engineer.

Tie rods shall be positioned prior to concrete placement so that the tie rod is oriented correctly, and loosely connected to the anchor at the post. After the anchor block has cured, the tie rod, and turnbuckle shall be securely tightened.

The area around the block shall be backfilled, and graded with Embankment material, meeting requirements of 204.

**2. Guardrail Approach Terminal** - Work consists of the construction of Guardrail Approach Terminal sections at locations shown in the Contract Documents or as directed by the Engineer. Approach Terminal sections shall consist of posts, railing, hardware, and the anchorage assembly necessary to construct the type of terminal section specified. Approach Terminal sections shall be installed according to the manufacturer's recommendations.

**3. Guardrail Exit Terminal** - Work consists of the construction of Guardrail Exit Terminal sections at locations shown in the Contract Documents, or as directed by the Engineer. Exit Terminal sections shall consist of posts, railing, hardware, and the anchorage assembly necessary to construct the type of terminal section specified. Exit Terminal sections shall be installed according to the manufacturer's recommendations.

**4. W-Beam/Thrie Beam Transition Panel** - The unit shall consist of 1 section, as detailed in the Contract Documents, for connecting W-beam guardrail to thrie beam guardrail, thrie beam impact attenuators or thrie beam guardrail to fixed objects, both approach and exit. Also included is the incidental hardware required for installation.

**B. MEASURE AND PAYMENT** - The unit of measure for Guardrail Terminal Sections will be each. The number will be the actual number of each type of Guardrail Terminal Sections installed complete in place, and accepted. Payment will be at the Contract unit price per each for the respective unit. Payment will include furnishing all components as specified for the particular Guardrail Terminal Sections, to include: all steel components, including galvanizing, PCC units, treated timber posts, cable assemblies, and anchors. Payment will also include Work performed for erection of Guardrail Terminal Sections complete, including excavation, backfilling, disposal of unsuitable materials, Shop Drawings, and all labor, material, tools, equipment and incidentals necessary to complete the Work.



**603.03 RUB RAIL**

- A. DESCRIPTION** - Work consists of adding a channel section, to be used as a rub rail, on existing or new guardrail installations at the locations as shown on the Contract Documents or as directed by the Engineer.
- B. CONSTRUCTION REQUIREMENTS** - 603.01(C) applies with the following additions:
1. New posts shall be pre-drilled at the fabricator.
  2. Existing posts shall be field drilled.
  3. Edges of field drilled holes shall be given 1 coat of zinc primer.
  4. Expansion splices shall be located as shown on the Plans, or as directed.
  5. Channels shall be of such a length as to accommodate the post spacing with a 50 foot maximum length.
  6. The Contractor shall make a field inspection of existing guardrail installations, so that required channel lengths can be accurately determined.
  7. On curves greater than 3 degrees, 15 minutes, the channel shall be fabricated to fit the required curvature.
- C. MEASURE AND PAYMENT** - The unit of measure for Rub Rail will be the linear foot, with measurements made along the top of the channel section. Payment shall be the Contract unit price per linear foot, which payment will include furnishing, fabricating, galvanizing, field drilling, touch-up painting, installation, tools, labor, equipment, and incidentals necessary to complete the Work.

**603.04 PCC TERMINAL BLOCK**

- A. DESCRIPTION** - Work consists of the construction of PCC Terminal Blocks of various dimensions and at locations as shown in the Contract Documents, or as directed by the Engineer. Work shall include excavation, forming, reinforcing steel, PCC, labor, tools, and equipment necessary to complete the item.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall perform the necessary excavation to construct the PCC Terminal Block. Whenever possible, the excavation shall be done in undisturbed Earth. Unsuitable excavated materials shall be disposed of by the Contractor. PCC work shall be done in conformance with applicable provisions of 501. After the PCC has cured, the area around the PCC Terminal shall be backfilled with embankment fill meeting the requirements of 204. Anchor bolts may be inserted in the plastic concrete or in expansion shields that may be installed in pre-drilled holes. The anchors shall be included as part of Guardrail Items.
- C. MEASURE AND PAYMENT** - The unit of measure for PCC Terminal Block will be the cubic yard, with measurement based on the plan dimensions. Payment will be made at the Contract Price per cubic yard, which payment will include excavation, backfill, disposal of excess and unsuitable excavated materials, forming, PCC, reinforcing steel, tools, labor, equipment, and incidentals necessary to complete the Work.

**603.05 REMOVE GUARDRAIL BURIED TERMINAL**

- A. DESCRIPTION** - All existing buried terminal sections shall be removed and replaced with modified eccentric loader terminal sections or various impact attenuator devices. Work consists of the complete removal of buried terminal sections including single and double rail, the PCC anchor block, anchorage shoe or shoes, 25 feet of twisted guardrail(s) plus the runout rail(s), and intervening posts, brackets and hardware. Work also includes necessary excavation and backfilling of holes from which anchor block and posts are removed and the disposal of all unusable guardrail elements including anchor blocks. Usable elements, if any, shall be saved for reuse.
- B. MEASURE AND PAYMENT** - The unit of measure for Remove Guardrail Buried Terminal will be each. The number will be the actual number of buried terminals, single or double rail, completely removed. Payment for Remove Guardrail Buried Terminal will be made at the Contract unit price per each, which payment will include complete removal of the buried terminal sections, including excavation and backfilling, disposal of all unsuitable elements, and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**603.06 REMOVE GUARDRAIL**

- A. DESCRIPTION** - Work consists of removing, dismantling, cleaning, touch-up painting, and storing of existing guardrail.

All guardrail elements shall be carefully removed from the posts and be carefully examined. Those elements meeting the Engineer's approval shall be stockpiled in an area acceptable to the Engineer. All rails and posts shall be cleaned and any marred or chipped areas in the galvanizing shall be painted with a zinc-rich paint. Elements determined by the Engineer to be unsuitable shall be disposed of properly.

All post holes shall be backfilled with applicable material and compacted. Anchor bolts in existing PCC shall be removed by burning off flush with the PCC, and the area shall be painted with zinc-rich paint.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Guardrail will be the linear foot of guardrail removed with measurement made along the front face of the guardrail, or along the posts for double-faced guardrail. Payment will be made at the Contract unit price per linear foot, which payment will include removal, dismantling, cleaning, touch-up painting, stockpiling, disposal of unusable elements, backfill and compaction of post holes, and all labor, tools, equipment, and incidentals necessary to complete the Work.

**603.07 RESET GUARDRAIL**

- A. DESCRIPTION** - Work consists of resetting usable guardrail, removed, and stored as per: 603.06, 603.01(B) and 603.01(C).

- B. CONSTRUCTION REQUIREMENTS** - 603.01(B) applies with the following additions:

Any materials damaged or missing prior to, during, or subsequent to removal due to the Contractor's negligence, shall be replaced at the Contractor's expense. Additional posts, offsets, back-up pieces, plate washers, bolts, nuts, reflectors, and other necessary equipment needed to provide 6 feet - 3 inches post spacing will be included as part of this item.

Additional rail-post bolt holes shall be drilled after the rail is reset. Edges of field drilled holes shall be given 1 coat of zinc-rich paint.

- C. MEASURE AND PAYMENT** - The unit of measure for Reset Guardrail will be the linear foot of guardrail reset, with measurement made along the front face of the guardrail. Payment will be made at the Contract unit price per linear foot, which payment will include furnishing all additional required materials, Shop Drawings, galvanizing, field drilling, touch-up painting, and all labor, tools, equipment, and incidentals necessary to complete the Work.

**603.08 EXTRA GUARDRAIL COMPONENTS**

- A. DESCRIPTION** - Work consists of furnishing and installing guardrail components that are in addition to the standard guardrail configuration. Transitions to rigid barriers as well as backup plates, posts, rails, offsets, and other materials used to stiffen sections as directed by the Contract Plans will be paid for under this item.

- B. MATERIALS** - Materials shall meet the requirements of 603.01(B).

- C. METHODS OF CONSTRUCTION** - Requirements of 603.01(C) apply.

- D. MEASURE AND PAYMENT** - The unit of measure for Extra Guardrail Components will be the pound. The weight shall be for the finished galvanized components, with galvanizing and allowable overrun percentage, in accordance with AASHTO M 111 and AASHTO M 160 respectively. No deduction will be made for bolt holes. No measure will be made for weight of weld metal, or for spike bolts, and nuts.

Weights of the hardware components will be computed from the weight determined by the Engineer, or from weights furnished by the manufacturer, and approved by the Engineer. Payment for Extra Guardrail Components will be made at the Contract unit price per pound, which payment will include furnishing and installing galvanized and reflectorized hardware, galvanizing, furnishing, storage, transportation, erection, drilling of bolt holes, and all labor, materials, tools, equipment, and incidentals needed to complete the Work specified.

**603.09 CABLE BARRIERS**

- A. DESCRIPTION** - Work shall consist of furnishing and installing high tension cable barrier systems in accordance with the requirements of the Contract Documents and the manufacturer's recommendations.

Barriers shall meet the NCHRP 350 Test Level 3 (TL-3) requirements as a minimum for roadside barriers. Unless otherwise specified, install high tension cable barrier of the 3 or 4 rope type, capable of roadside or median installation. Use only 1 manufacturer's cable barrier system for the entire Contract. At least ten (10) days prior to installation of the system, furnish the following information to the Engineer:

1. Manufacturer's product brochure, Specifications and requirements.
2. 4 sets of erection drawings that clearly depict the installation details for the proposed cable barrier system components, including terminals, terminal transitions, line posts, and cables.
3. Copy of the NCHRP 350 certification/acceptance letter for the proposed cable barrier system and end terminal.
4. Draft copy of the proposed cable Tension Log (blank sample).
5. Design calculations for the post and end terminal footings. The design of each end terminal footing is to be based on the following soil parameters:
  - a. Saturated unit weight of 112.4 pounds per cubic foot
  - b. Design water table at the ground surface
  - c. Effective unit weight of 50 pounds per cubic foot
  - d. Angle of internal friction of 30 degrees
  - e. Cohesion of zero
  - f. Factor of safety against overturning or pullout of 1.5

For soils meeting the above properties, use a design soil modulus value (k) of 7 pounds per cubic inch (psi/inch depth) when using Terzaghi's passive wedge-type failure method, and Brom's method, or 25 pounds per cubic inch when using the p-y method (COM 624, FB-Pier, L-pile, etc.) to evaluate the lateral loading response of the end anchor pile or shaft. For design of deadman type end terminals, use a passive Earth pressure analysis.

Designs of end terminal footings and cable connection to the footings shall be based on either: 1) If all cables are anchored in a single foundation, a minimum total equivalent horizontal static load of 50,000 pounds and the commensurate vertical component associated with the net cable angle from horizontal; or 2) If cables are anchored in multiple foundations, a minimum equivalent horizontal static load of 15,000 pounds per cable and the commensurate vertical component associated with this force and each cable's angle from horizontal.

**B. MATERIAL**

1. **Wire Rope** - Furnish galvanized wire rope that is 3/4 inch – 3x7, construction meeting the requirements of AASHTO M 30/ASTM A 741 Type 1 Class A coating, with a minimum breaking strength of 39,000 pounds. Furnish wire rope that has been factory pre-stretched to compress the cable fibers to minimize future strain relaxation of the cable. Provide a Certificate of Quality from the wire rope manufacturer with each cable spool specifying the breaking strength, modulus of elasticity and the amount of force used to stretch the wire rope.
2. **Threaded Terminals** - Furnish terminals, threaded 1 inch x 8 pitch, meeting the requirements of ANSI B1.1. The terminals may be of the swaged or wedge lock type. Ensure that the fully fitted ropes develop a minimum breaking strength of 36,800 pounds. Furnish terminals that have been galvanized after threading, meeting the requirements of ASTM A 153.
3. **Turnbuckles** - Furnish turnbuckles that meet the requirements of ANSI B1.1, 1 inch x 8 pitch of the size and shape specified by the manufacturer. The turnbuckles may be either the closed or open body type. Ensure that the screws allow for a minimum of 6 inches of penetration from each end. Ensure that the turnbuckles develop a minimum breaking strength of 36,800 pounds. Furnish turnbuckles that have been galvanized after threading, meeting the requirements of ASTM A 153.

4. **End Terminal Fittings** - Furnish anchor fittings at the termination of each cable barrier run. The fittings shall be of the same size and type used in connection to the turnbuckles. Ensure that the fittings develop a minimum breaking strength of the entire wire rope of 36,800 pounds.
5. **Line Posts and Post Accessories** - Furnish steel posts that meet the manufacturer's Specifications and consistent with the post sizes specified in the FHWA NCHRP 350 TL-3 acceptance letter. Furnish steel posts meeting the requirements of ASTM A 36, galvanized to ASTM A 123 requirements after fabrication. Furnish posts that have a means of holding the wire ropes at the design height. Furnish sockets (metal sleeves) conforming to the manufacturer's Specifications. These sockets will be set in concrete foundations for insertion of the posts at installation. Unless the fit between the post and socket is close enough to prevent debris from entering the socket, provide a low density polyethylene excluder profiled to fit tightly around the post for this purpose. On every fourth post or 50 feet, whichever is less, provide retroreflective sheeting. Meet the AASHTO M 268 Type 4 adhesive sheeting requirements. The minimum size of the retroreflective sheeting shall be 8 square inches. Use colorless (white) sheeting on posts installed to the right of approaching traffic and yellow sheeting on posts installed to the left of approaching traffic. Install sheeting only on one side of the posts unless otherwise specified in the Plans. For posts with flat surfaces facing approaching traffic, the reflective sheeting may be applied directly to the post. For posts without flat surfaces facing approaching traffic, provide a low density polyethylene post cap on which the reflective sheeting is mounted.
6. **Deadman Type Concrete End Terminals** - Furnish end terminals of the size and shape determined by the manufacturer and sufficient to prevent movement in the soil after tensioning the cables. Ensure that the terminal is consistent in shape with the terminal accepted by FHWA as meeting the requirements of NCHRP 350 TL-3 criteria.
7. **Gating End Terminals** - Furnish terminals which have been tested to NCHRP 350 TL-3 criteria and accepted by FHWA. Provide concrete foundations of the minimum dimensions recommended by the manufacturer and sufficient to prevent movement in the soil after tensioning the cables. Provide a minimum of 120 square inches of retroreflective sheeting meeting the requirements of AASHTO M 268 Type 4 adhesive sheeting on each of the gating end terminal posts. Use colorless (white) sheeting on posts installed to the right of approaching traffic and yellow sheeting on posts installed to the left of approaching traffic. Install sheeting only on one side of the posts unless otherwise specified in the Plans.
8. **Guardrail Attachment End Terminals** - Furnish terminals for attaching the cables to the guardrail panels that have been accepted by FHWA as meeting the requirements of NCHRP 350 TL-3 criteria. When required, furnish slotted panels necessary for passing the cables to the backside of the guardrail, and all necessary attachment hardware.
9. **Foundation Concrete and Reinforcing Steel** - Meet the requirements of Section 817 for Class IV, (Drilled Shaft) Portland Cement Concrete, except that slump loss testing will not be required. Meet the requirements of Section 812 for reinforcing steel.. Permit the concrete to cure a minimum of seven (7) days at ambient temperatures above 50 degrees Fahrenheit prior to setting the posts.

### C. METHOD OF CONSTRUCTION

1. **Training and Certification of Installation Forces** - Prior to installation of the cable barrier system, provide written certification from the manufacturer that the Work force to be used for installing the system has received the training and necessary aids to install the system elements. This includes installation of the posts, terminals, cable, and tensioning of the cables. Provide timely updates to the list for individuals trained and certified by the manufacturer during the Contract Time.
2. **Installation and Testing of the Cable Barrier System** - Install the cable barrier system at the locations shown in the Plans or as directed by the Engineer. Notify the Engineer of any existing utility conflicts prior to erection of the system.
3. **Layout and Preparation** - Mark the location of the cable barrier system between begin and end points for each run. Complete all grading to final grade requirements prior to installation of the cable barrier system.
4. **Constructing Foundations and Setting Posts and End Terminals** - Construct concrete foundations to the dimensions specified by the manufacturer and sufficient to prevent movement after tensioning of the cable barrier system. Excavate a properly sized hole for socketed post foundations, gating end terminals, and/or deadman type concrete terminals, dispose of the excavated material, and install reinforcing steel in accordance with the manufacturer's Specifications. Place the concrete and

install the sockets, ensuring the top of the foundation and socket is flush with the final grade. Place the sockets so that the posts will be plumb and in line to provide an aesthetically pleasing line of sight. Install gating end terminals and associated hardware. Furnish and install all guardrail end terminal components to w-beam approach transition in accordance with the manufacturer's Specifications.

Ensure that post spacing will provide the required deflection distance as specified in the Plans. When no deflection requirement is provided, ensure that the post spacing is installed such that the dynamic deflection is no more than a maximum of 8 feet. The maximum post spacing permitted is 16 feet, center of post to center of post.

5. **Cable Installation** - Install the cables in accordance with the manufacturer's Specifications. Position all turnbuckles so that there is no interference with posts or with one another. Establish initial tension in the cables and connect to the terminal end connections.
  6. **Tensioning** - Systematically tension the cables in accordance with the manufacturer's Specifications. Measure the temperature of the bottom cable, record and use to determine required tension values documented in the manufacturer's tension chart. Use certified, calibrated testing equipment specified by the manufacturer at the beginning of installation and throughout the Project duration. Results from only 1 model of tension testing device will be accepted. Provide a calibration certificate to the Engineer indicating calibration of the instrument no more than one (1) month prior to its first date of use. Furnish a copy of a letter from the manufacturer certifying the person testing is trained and authorized by the manufacturer to perform tension tests on the system.
  7. **Testing and Retensioning** - Test and retension, as necessary, each cable of each cable run to the manufacturer's Specifications, 14 - 21 days after initial tensioning. Retensioning will be required when the test reading is less than 90 percent of the manufacturer's recommended tension for the given material temperature. Repeat the testing and retensioning procedure immediately prior to final acceptance of the Project. Prepare a tension log for each tension test performed, showing as a minimum, the date, time, location and strand temperature of the bottom cable, tension before adjustment, tension after adjustment, any applicable notes and signature of the person conducting the test. Submit copies of the tension log to the Engineer.
- D. MEASURE AND PAYMENT** – The unit of measure for Cable Barrier will be linear foot. The number of linear feet will be the actual length of Cable Barrier measured, complete in place. Payment will be made at the Contract unit price per linear foot, which payment will include all labor, materials, components, equipment, tools, and incidentals necessary to construct all components of the Cable Barrier system complete in place.

## 604 MISCELLANEOUS FENCING

### 604.01 CHAIN LINK FENCE

- A. DESCRIPTION** - Work consists of furnishing, fabricating, assembling, and erecting chain link fencing along property line and/or adjacent to a roadway. The fence shall be erected to the lines, grades, and height as shown in the Contract Documents or as directed by the Engineer. Unless otherwise provided a top rail shall be used for a property fence and tension wire shall be used for the top of a fence adjacent to a roadway.

Work shall include clearing the fence line and disposing of resulting brush and debris, removal of high points in the existing ground between posts; connecting fences to other structures or existing fences, and other incidental work necessary to complete the specified Work.

### B. MATERIALS

Materials shall meet the following requirements:

- 801.01 and 817: Portland Cement Concrete Class F (for post footings)
- 813.01: Barbed Wire
- 813.03(A)(1): Chain Link Fence Fabric
- 813.03(A)(1) and 813.03(A)(3): Chain Link Fence Components
- 813.03(A)(4): Gates
- 822.12: Wood for Redwood Slats

The height and type of fence shall be as specified in the Contract Documents. When the type of chain link fence is not specified, one of the following types shall be used, meeting the requirements of 813.03 and AASHTO M 181, and shall include all chain link fence materials, including: fence fabric, posts, rails, ties, bands, bars, rods, hardware, and other fittings.

- Type I: Zinc-coated steel; fabric, posts, hardware, and fittings.
- Type II: Aluminum-coated steel: fabric and zinc coated posts, hardware, and fittings.
- Type III: Aluminum-alloy: fabric, posts, hardware, and fittings.
- Type IV: Polyvinyl Chloride (PVC)-coated: fabric.

Type I shall be used unless otherwise specified.

Chain link fence fabric shall be made of No. 9 gauge wire, woven in a 2 inch x 2 inch diamond mesh.

All pipe components shall be standard weight pipe of the following nominal diameters: Intermediate or line posts – 2 inches; End, corner and pull posts – 2-1/2 inches; Top rails and post braces – 1-1/4 inches; Tension bars and wires – No. 7 gauge.

Posts for swing gates shall be standard weight steel pipe for single swing gates or 1 leaf of double gates, and of the size indicated in the Department Standard Drawings or in the Contract Documents. Gates shall be complete with hinges, latches, stops, and other necessary fittings.

Barbed wire, when specified, shall be of the 4 point pattern, composed of 2 strands of No. 12-1/2 gauge line wires with No. 14 gauge barbs spaced on approximately 5 inch centers. Barbed wire shall conform to the requirements of AASHTO M 280.

- C. CONSTRUCTION REQUIREMENTS** - Installation shall be by skilled mechanics experienced in the erection of this type of fence. Details not specified herein shall meet the requirements of the Standard Drawings and the Contract Documents. Construction shall be as follows:

1. The Contractor's activities and operations shall be confined to the area immediately adjacent to the Right-of-Way lines, and within the Right-of-Way, except that permission may be granted by the Engineer for normal construction activities through lands owned by or under the control of the District.

In areas where any privately owned fence or other property is within the District's Right-of-Way, these items shall be removed by the property owner in advance of the District's Contractor commencing Work; however, in the event that the property owner has not removed these items, the Contractor shall remove these items and place them on the owner's property as directed by the Engineer. The Contractor shall be held responsible for any damage to privately owned items removed.

Fence lines specified in the Contract Documents serve as a guide only, and the exact location of the fence shall be determined in the field, as directed by the Engineer.

2. The posts shall be set plumb in concrete footings as shown on the Plans, spaced not more than 8 feet on centers. The minimum cross-section dimension of the footings shall not be less than 3 times the maximum cross-sectional dimension of the post, but in no case less than 9 inches for line posts, and no less than 12 inches for end or corner posts.
3. The top rails shall be provided with expansion shield couplings or other suitable devices approximately every 20 feet. The couplings are to be outside sleeve type at least 7 inches long. Expansion spring couplings are to be installed at 100 foot intervals on sections over 100 feet long. The top rail shall pass through the base of the line post tops and form a continuous brace from end to end, and shall be securely fastened to the end and/or corner posts with heavy pressed steel connections.
4. The wire fabric shall be fastened to the end and/or corner posts using a tension bar fastened to the posts with pressed steel bands. The bands are to be connected with carriage bolts and nuts. The fabric is to be stretched to proper tension and fastened to all line posts with wire clips and to the top rail with tie wires. The wire fabric is to be attached to a bottom tension wire with hog rings. The bottom of the fabric is to be held as uniformly as is practical to 2 inches above the finished grade.
5. Any excavation or backfill required to comply with the above clearance shall be as approved by the Engineer. Fence fabric shall be placed on the roadside of the posts. For storm water management ponds, the fabric shall be placed on the outside of the posts or the side farthest from the pond.
6. The fence shall be taut and true.
7. All end and/or corner posts shall be braced by a horizontal post brace. The post brace shall be securely attached to the end or corner post, to the posts adjacent to expansion couplings, and to the next adjacent line post midway between the top rail and the ground. This brace shall be truss-braced from the line post to the end, or corner post with a truss rod complete with tightening unit. Corner posts and line posts, at intervals of 500 feet, shall be trussed and braced in both directions.
8. All posts shall be plumbed and spaced as uniformly as practicable to the spacing specified in the Standard Drawings or the Contract Documents with a tolerance of 2 feet.

End or corner posts shall be installed at all terminals, abrupt changes in grade and at changes in horizontal alignment greater than 15 degrees. The maximum distance between end or corner posts shall be 500 feet.

Post lengths shall accommodate the fabricated width of the fence fabric without stretching or compressing the fabric and provide the required spacing below the bottom of the fabric.

Post caps are required at all line, end, and corner posts.

9. Gate frames shall be constructed of standard weight pipe with heavy malleable iron or pressed steel corner fittings securely riveted. Fabric to match the fence shall be installed in the frame by means of tension bars and hook bolts. Each frame shall be equipped with adjustable truss rods. Bottom hinges shall be ball and socket type designed to carry the weight of the gate on the post footing. Upper hinge shall be wraparound adjustable type. All gates shall be equipped with a positive type latching device with provisions for padlocking. All drive gates shall be provided with center plunger rod, catch, and semiautomatic outer catches to secure gates in opened position.
10. All posts shall be equipped with malleable, cast iron or pressed steel ornamental tops or extension arms for barbed wire as shown in the Standard Drawings or in the Contract Documents. Tubular post tops are to be so designed as to exclude moisture from the post. All intermediate post tops shall be designed to hold the top rails.

11. When barbed wire is specified, it shall be stretched to proper tension and securely fastened to the framework members by the use of heavy wire pins.
12. Where fencing crosses a drainage ditch, a line post shall be set on each side of the ditch so that the bottom of the fence is low enough to preclude the possibility of anyone climbing underneath. No post shall be set in a drainage ditch unless indicated in the Contract Documents. Posts shall be fitted with tops as shown on the Plans, or other approved tops so designed as to fit securely over the posts and carry the top tension cable.
13. When the fence crosses electrical transmission, distribution or secondary lines, a ground shall be installed at each crossing, in accordance with Section 9 of the National Electrical Code.

**D. MEASURE AND PAYMENT** - The unit of measure will be the linear foot. The number of linear feet will be the actual length of Chain Link Fence, complete in place, measured horizontally along the fence from center to center of end posts. Gates will be measured on the basis of the count or number of each type or size installed complete.

Payment will be made at the Contract unit price per linear foot, which payment will include the fabricating and furnishing of all materials, including barbed wire if used, labor, tools, equipment, and incidentals necessary to complete the Work.

Gates will be paid for at the Contract unit price per each type or size as counted, which payment will include the fabricating and furnishing of all materials, including barbed wire if used, labor, tools, equipment, and incidentals necessary to install the gate or gates complete in place.

#### **604.02 VINYL CLAD CHAIN LINK FENCE WITH REDWOOD SLATS**

- A. DESCRIPTION** - Work consists of the fabricating, furnishing, assembling, and erecting Vinyl Clad Chain Link Fence with Redwood Slats. The Vinyl Clad Chain Link Fence with Redwood Slats shall be constructed to the lines and grades shown in the Contract Documents.
- B. MATERIALS** - Materials shall meet the following requirements of 604.01(B) unless otherwise specified on the Standard Drawings and/or in the Contract Documents.
- C. CONSTRUCTION REQUIREMENTS** - Installation shall be by skilled mechanics experienced in the erection of this type fence. Details shall meet the requirements of the Standard Drawings and/or the Contract Documents.
- D. MEASURE AND PAYMENT** - The unit of measure will be the linear foot. The number of linear feet will be the actual length of Vinyl Clad Chain Link Fence with Redwood Slats, complete in place, measured horizontally along the fence from center to center of end posts. Gates will be measured on the basis of the count or number of each type or size installed complete.

Payment will be made at the Contract unit price per linear foot, which payment will include the fabricating and furnishing of all materials, labor, tools, equipment, and incidentals necessary to complete the Work.

#### **604.03 SAFETY FENCE SHIELDING**

- A. DESCRIPTION** - Work consists of the fabricating, furnishing, assembling, and erecting safety fence shielding on bridges and overpasses. The shield shall be constructed to the lines and grades and height shown in the Contract Documents.
- B. MATERIALS** - Materials shall meet the following requirements of 604.01(B), except as modified herein:
  - All posts shall be standard weight pipes, 2-1/2 inches I.D.
  - Top rails and post braces shall be standard weight pipe, 1-1/4 inches I.D.
  - Plates shall meet the requirements of ASTM A 36
  - Anchor bolts shall meet the requirements of ASTM A 307, Grade A



**C. CONSTRUCTION REQUIREMENTS** - Installation shall be by skilled mechanics experienced in the erection of this type fence. Details not specified herein shall meet the requirements of the Standard Drawings and/or the Contract Documents. Construction shall be as follows:

1. The Contractor's activities and operations shall be confined to the area immediately adjacent to the Right-of-Way lines and within the Right-of-Way except that permission may be granted by the Engineer for normal construction activities through lands owned by or under the control of the District.

Fence lines specified in the Contract Documents serve as a guide only and the exact location of the fence shall be determined in the field as directed by the Engineer.

2. The posts shall be set plumb and as shown in the Contract Documents.
3. The top rails shall be provided with expansion couplings at each expansion joint in the Structure.

The couplings are to be inside sleeve type at least 7 inches long and suitably welded to the rail. Expansion couplings shall be galvanized after welding.

4. The wire fabric shall be fastened to the end and/or corner posts using tension bar fastened to the posts with pressed steel bands. The bands are to be connected with carriage bolts and nuts. The fabric is to be stretched to proper tension and fastened to all line posts with wire clips and to the top rail with tie wires. The wire fabric is to be attached to a bottom tension wire with hog rings. The bottom of the fabric is to be held as uniformly as is practical to 2 inches above the finished grade.

5. All end and/or corner posts shall be braced by a horizontal brace. The post brace shall be securely attached to the end or corner post, to the posts adjacent to expansion couplings, and to the next adjacent line post midway between the top rail and the ground. This brace shall be truss-braced from the line post to the end or corner post with a truss rod complete with tightening unit. Corner posts and line posts, at intervals of 500 feet, shall be trussed and braced in both directions.

6. The fence shall be taut and true.

7. All posts shall be plumbed and spaced as uniformly as practicable to the spacing specified in the Standard Drawings and/or in the Contract Documents with a tolerance of 2 feet.

Post lengths shall accommodate the fabricated width of the fence fabric without stretching or compressing the fabric.

Post caps are required for all line, end, and corner posts.

8. Welding shall conform to the requirements of 706.18.

**D. MEASURE AND PAYMENT** - The unit of measure for Safety Fence Shielding will be the linear foot. The actual length of Safety Fence Shielding measured horizontally along the fence from center to center of end posts, will be paid for at the Contract unit price per linear foot, which payment will include the fabricating and furnishing of all materials, labor, tools, equipment, and incidentals necessary to complete the Work.

#### **604.04 CONSTRUCTION BOARD FENCE (SOLID WOOD FENCE)**

**A. DESCRIPTION** - Work includes furnishing, installing, maintaining, relocating, and removing 8 foot high board fencing around the construction area as shown on the Contract Plans and as directed by the Engineer. The board fence shall be painted (all sides) with a neutral shade of green color paint approved by the Engineer. Maintenance will include, but is not limited to, any repainting or repairing as directed for the duration of the Contract.

The fence shall be constructed with 1 x 6 inch boards and with 2 x 4 inch top and bottom horizontal brace members, and supported by 4 x 4 inch posts at a maximum spacing of 8 feet apart. Posts shall be set in augered holes or driven a minimum depth of 2 feet into the ground. Each post shall be braced by a 2 x 4 inch brace member meeting each post at a 45 degree angle and placed in the ground to a depth of approximately 2 feet. Lumber shall be Grade No. 2 common square cut. The Engineer shall approve the materials before and after installation.

Each tree not scheduled for removal but which may be damaged by construction activity on this Project shall, upon the direction of the Engineer, be protected by tree boxes of a minimum size of 6 feet square and 8 feet high. Trees enclosed by the Work area board fence may be protected as directed. Hand excavation shall be used beneath the low branches of trees where the use of mechanical equipment might be injurious to tree limbs.

- B. MEASURE AND PAYMENT** - The unit of measure will be the linear foot of fence installed, and measured along the top edge of the fence including gates and tree boxes as needed.

Payment for Construction Board Fence will include gates and tree boxes as needed and be made at the Contract unit price per linear foot installed, which payment will include all materials, erection, hardware, locks and keys, tree boxes, painting, repainting, maintenance, repair and removal, and all labor, tools, equipment, and incidentals needed to complete specified Work.

#### 604.05 TEMPORARY FENCE

- A. DESCRIPTION** - Work consists of the installation of temporary fence for work zone pedestrian and Site protection. The Contractor shall be required to protect the work area as shown on the Contract Plans or as directed by the Engineer. The Contractor shall furnish all materials. Work under this item includes furnishing, installing, relocating (if necessary), removal, and disposal of the fence.
- B. MATERIALS** - Fencing shall be of a type used for temporary protection and shall have a minimum height of 3 feet 6 inches. Posts shall be steel "U" channel posts, 3 pounds per foot, and either galvanized or painted.
- C. CONSTRUCTION METHODS** - Installation of the fence shall be performed prior to commencement of construction, or at a time required by the Engineer.

Where indicated in the Contract Documents, erosion and sediment control measures shall be installed as approved by the Engineer. Removal and disposal of the fence shall be done at a time during and/or after restoration of property, as required by the Engineer.

- D. MEASURE AND PAYMENT** - The unit of measure for Temporary Fence will be the linear foot. The number will be the actual number of linear feet of fence installed complete, as measured along the base of the fencing. Payment for Temporary Fence will be made at the Contract unit price per linear foot, which payment will include furnishing all materials such as fencing, posts, hardware, straw bales, installing, relocating if necessary, removal and disposal, and all labor, materials, tools, equipment, and incidentals needed to complete Work specified herein.

#### 604.06 ORNAMENTAL SAFETY FENCE

- A. DESCRIPTION** - Work consists of the fabrication, furnishing, assembling, and erection of ornamental safety fence on bridges and overpasses. The ornamental fence shall be constructed to the lines and grades and height as shown in the Contract Drawings.
- B. MATERIALS** - Materials shall meet the following requirements of AASHTO M 183.

Anchor bolts shall meet the requirements of ASTM A 307, Grade A.

The fence shall be designed to be free standing and to withstand all applicable wind, pedestrian, and bicycle loadings. If required in the Contract Documents, appropriate railings shall be designed and attached to the fence as per the most current ADA and bicycle requirements. Prior to fabrication, the Contractor shall submit for approval Shop Drawings, calculations, and material samples to the Engineer.

The fence panels shall be electro-forged steel fencing consisting of 31/32 inch x 1/8 inch main bar, 3/16 inch round cross bar and 2-7/16 inches x 5-3/16 inches mesh. Fence shall be galvanized as per ASTM 123 and/or powder polyester coated. The color shall be matte bronze.

- C. CONSTRUCTION REQUIREMENTS** - Installation shall be by skilled mechanics experienced in the erection of this type of fence.

Construction shall be as follows:

1. Posts shall be set plumb and as shown in the Contract Documents. For post heights up to 60 inches, the post size shall be 2-1/2 inches x 5/16 inch flat bar; for post heights greater than 60 inches and less than 96 inches, the post size shall be 3-1/2 inches x 5/16 inch flat bar; and for post heights greater than 96 inches, the post shall be 2 inch square tube.
  2. The rails shall be 2-1/2 inches x 2-1/2 inches x 3/16 inch. The base plates shall be 8 inches x 8 inches x 3/8 inch. The top rails shall be provided with expansion couplings at each expansion joint in the Structure.
  3. Welding shall be as per Section 706.18.
- D. MEASURE AND PAYMENT** - The unit of measure for Ornamental Safety Fence will be the linear foot. The actual length of fence measured horizontally along the fence from center to center of end posts will be paid for at the Contract unit price per linear foot, which payment will include the fabrication and furnishing of all materials, tools, equipment, and incidentals necessary to complete the Work.

## 605 SIDEWALK AND DRIVEWAY

### 605.01 PORTLAND CEMENT CONCRETE SIDEWALK AND DRIVEWAY

**A. DESCRIPTION** - Portland Cement Concrete sidewalk and driveway shall be composed of Portland Cement Concrete proportioned, mixed, and constructed on the prepared soils base in accordance with these Specifications, in 1 course, to a depth specified in the Contract Documents. Except as herein stated, all requirements specified in 501 are applicable to this specification.

**B. COMPOSITION** - The proportions of materials for concrete shall meet the requirements of 817 for Class F.

The concrete for sidewalks shall be darkened by incorporating in the mix at the batch Plant, a carbon powder, meeting requirements of 814.05(A), at the rate of 1/3 of a pound per sack of cement.

It may be necessary to vary the above amounts of carbon powder to match existing Portland Cement Concrete. Under no circumstances however, shall the quantities be increased such that the resulting reduction in strength exceeds 5 percent when tested in accordance with AASHTO T 106.

Care shall be taken to see that the Portland Cement Concrete is uniformly darkened and if necessary, additional mixing may be required.

#### C. CONSTRUCTION REQUIREMENTS

**1. Placing Concrete** - Concrete sidewalk and driveway shall be placed on a base course constructed as specified in Table 203.03. The concrete shall be placed for the full width of the sidewalk and driveway. It shall be thoroughly spaded along the edges and shall be tamped to eliminate voids and bring sufficient mortar to the top of the forms by use of metal shod templates.

When a concrete sidewalk abuts other structures, the area of the Structure against which the sidewalk concrete is placed shall be given a heavy coating of bituminous material meeting the requirements of 802.03 or 802.04. When a sidewalk is constructed between an adjoining permanent structure on one side and a curbing, either stone or concrete on the other, 1/2 inch thick expansion joint material having a recovery of 90 percent or more shall be installed adjacent to the curbing. When a concrete driveway abuts a concrete pavement and/or sidewalk the same type of expansion material shall be installed. No separate payment will be made for expansion joint material. It will be included in the payment of the appropriate PCC item.

Every effort shall be made to safeguard trees. If it becomes necessary to trim tree roots, the Contractor must notify the Engineer prior to trimming. The Contractor will then carry out his trimming operation under the supervision of the District's Urban Forestry Administration.

The nature and extent of tree root removal in connection with sidewalk construction will be determined prior to Work scheduling. Minor root removal and the forming and construction of tree boxes around existing and/or proposed tree locations shall be included in the Contract Price for PCC Sidewalk.

**2. Placing Reinforcement** - Wire fabric reinforcement will not be required in Portland Cement Concrete Sidewalk. However, wire fabric reinforcement of not smaller than No. 20 wire, spaced at 1 inch, shall be placed around manhole frames and other types of structures extending through the full depth of the Sidewalk. The material shall be cut approximately 6 feet square with a hole of the proper diameter cut in the center. The reinforcement shall be placed 1 inch below the surface of the Sidewalk. Wire fabric reinforcement weighing 50 pounds per 100 square feet shall be placed in driveways.

#### 3. Forming Joints

##### a. Transverse Joints

**i. Transverse Expansion Joints** – Transverse expansion joints shall be installed at intervals of approximately 48 feet and shall be provided with a means for load transfer. The expansion joint filler shall be of the preformed type, 1/2 inch in thickness and conform to the requirements of 807.01(A). The filler for this work shall have a recovery of not less than 90 percent and shall be installed flush with the finished surface of the Sidewalk.

Where sidewalks intersect, transverse expansion joints shall be placed in each sidewalk for its full width near the

intersections of the back lines of the Sidewalks or as directed by the Engineer. Where cement concrete leads abut the curb, expansion joint filler must be placed at the back of the curb.

- ii. **Transverse Contraction Joints** – Transverse contraction joints shall be constructed as weakened place joints at approximately 12 foot intervals as described in paragraph no. 6 below.

b. *Longitudinal Joints* - Longitudinal joints will not be required in this work.

- 4. **Load Transfer Assembly** - Transverse expansion joints shall be provided with means for transfer of load across the joint by use of dowels or other approved methods. The assembly shall meet the requirements of 807.03 except that the assembly shall be fabricated from 3/8 inch rods; the dowel bars shall be 1/2 inch in diameter and shall be spaced at approximately 2 foot intervals but not closer than 1 foot to the edge of the Sidewalk.

The assembly shall be installed in a manner conforming to the requirements of 501.14(E).

- 5. **Sealing Of Joints** - Joints with pre-formed joint filler shall be sealed with a sealant conforming to 807.02(A)(1). The preformed filler shall be removed to 1/2 inch below the top of sidewalk and this space sealed.
- 6. **Finishing** - After the surface has been struck off and screeded to the proper elevation, it shall be given a smooth finish, free from depressions or irregularities of any kind. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. The surface shall be marked into 3 foot squares, or as directed, by forming longitudinal and transverse grooves 1/2 inch in depth with a jointing tool having a blade projection of 1/2 inch and blade radius of 3/8 inch. At intervals of 12 feet, or as directed, the transverse groove shall be made 1/3 the depth of the Sidewalk to form a transverse contraction joint. When this groove is formed with a jointing tool, the blade projection shall be not less than 1/3 the depth of the Sidewalk; if a bar or plate is used, it shall be tapered from top to bottom so that it may be easily removed without damage to the Sidewalk.

After final finishing, the Sidewalk surface shall be lightly broomed with a hair broom meeting the requirements of 905.09(D)(2).

- D. **TREE SPACES** - That area, either continuous or interrupted, between the curb and the Sidewalk shall be defined as a Tree Space. The edges of the Sidewalk around these spaces shall present clear, vertical faces true to line. The spaces shall be filled to the level of the Sidewalk with topsoil meeting the requirements of 823.01. Payment for the topsoil will be made under a separate item. The minimum size of the Tree Space shall be 4 feet wide, measured from the front face of the curb, by 9 feet long unless otherwise directed by the Engineer.

- E. **EXPOSED AGGREGATE SIDEWALK** - Exposed aggregate sidewalk shall be constructed in 1 course to the thickness specified. Carbon powder will not be used in the mix and load transfer devices will not be required unless otherwise specified.

Concrete Materials:

- Portland Cement, Type I/II (ASTM C 150), no supplements such as Fly Ash or Granulated Blast Furnace Slug permitted.
- Aggregates
  - Coarse aggregates shall be gravel of normal weight and uniformly graded from a single source With nominal maximum size of 3/4 inch.
  - Fine aggregates must be free of materials with deleterious reactivity to alkali in cement.
- Air Entraining Admixture must meet ASTM C 94; percent entrained air shall be 5 to 8 percent by volume.
- Chemical Admixtures – Compatible with other admixtures and manufacturer certified and to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- Color pigment must be synthetic mineral oxide pigments conforming to ASTM C 979 and must be color stable, free of carbon black, non-fading and resistant to lime and other alkalis.

Aggregates for Seeding – Select aggregates for seeding shall be rounded (not crushed) gravel from 1 source; less than 1/2 inch in size; brown to yellow in color; washed, screened, and retained on 1/4 inch sieve.

- 1. The Contractor will construct a 4 foot by 4 foot horizontal sample test panel using the same material and methods that he intends to use in this construction. Work shall not proceed until the sample has been approved by the Engineer. The approved

sample panel shall be kept at the job Site until the Work is finished. Extreme care must be maintained by the Contractor to properly arrange his work and to employ only masons skilled in this class of work in order that the finished surface shall conform to the approved sample.

2. The PCC slab shall be constructed on the prepared soils base. Immediately after the slab has been placed, screeded, floated, or darbied, the unsegregated seeding aggregate shall be hand-scattered over the slab so that approximately 50 of the 1/2 inch to 1 inch stones occupy each square foot (smaller stones scattered are not counted). The seed aggregate shall be in a damp condition when placed on the surface of the slab. The aggregate shall be embedded initially by tapping with a wood float, a straight edge or a darby, and finally by using a bull float, or hand float until the appearance of the surface is similar to that of a normal slab after floating.

Care shall be taken not to overdo floating so as not to depress the aggregate too deeply.

3. Approximately 30 minutes after final troweling, the surface shall be uniformly sprayed with an approved retarder, covered with a plastic sheet and let set for 10 to 20 hours.
  4. Ten (10) to twenty (20) hours after the application of the retarder, scrub out cement with a coarse water spray and a fiber brush until the larger stones are well exposed. Care must be taken not to dislodge the aggregate as patching will not be permitted. The use of a steel brush will be permitted only in spots where surface shows excessive sand. When the brushing is completed the entire surface shall be carefully swept clean with fiber brushes to remove the excess mortar, which shall be removed from the Site of the Work.
  5. The surface shall be covered and cured for seven (7) days in accordance with 501.17.
  6. After curing, the surface shall be scrubbed with a 10 percent solution of muriatic acid and water. The entire surface shall then be washed thoroughly with water.
  7. The exposed aggregate concrete sidewalk shall be sealed with clear-water-based, epoxy modified solvent-free, breathable pavement sealer complying with ASTM E 514 for water penetration rate and ASTM D 1653 for water vapor transmission.
- F. COMPLETION OF WORK** - Before acceptance, the Work shall be cleaned up and all debris and unused material removed. Any defective sections shall be replaced or repaired immediately by the Contractor at his own expense. All Work hereunder must be completed within one (1) week after the construction of the Sidewalk is completed.

**G. MEASURE AND PAYMENT**

1. The unit of measure for Portland Cement Concrete Sidewalk, Exposed Aggregate Sidewalk and Exposed Aggregate Sidewalk Repair will be the square yard. The actual number of accepted square yards, 4 inches in depth, complete in place, measured along the Sidewalk surface will be paid for at the appropriate Contract unit price per square yard, which payment will be full compensation for furnishing, hauling, and placing all materials, including 4" graded aggregate base joints, load transfer devices, expansion joint materials, and reinforcement, for the removal and disposal of all existing sidewalk and curing; and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.
2. The unit of measure for Portland Cement Concrete Driveway will be the square yard. The actual number of square yards, of the depth specified, measured complete in place will be paid for at the Contract unit price per square yard, which payment will be full compensation for furnishing, hauling, and placing all materials including expansion joint filler, waterproofing, impervious materials, wire fabric reinforcement, curing, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.

**605.02 PORTLAND CEMENT CONCRETE SIDEWALK REPAIR AND MISCELLANEOUS CONSTRUCTION**

- A. DESCRIPTION** - Repairs to PCC sidewalk and miscellaneous construction shall consist of the cutting out, removal, and disposal of the old material from defective areas and replacing with Portland Cement Concrete to a depth equal to that of the surrounding concrete, or as directed by the Engineer. Materials and methods meeting, insofar as practicable, the requirements specified for new construction of similar type shall be used.

This work shall also include in a manner described above, the replacing of cuts or openings for underground work.

- B. MATERIALS** - The materials shall meet the requirements of 501.02.

- C. COMPOSITION** - The proportions of materials for concrete shall meet the requirements of 817 for Class F.
- D. CONSISTENCY** - The consistency of the concrete shall be as specified in 501.15.
- E. CONSTRUCTION REQUIREMENTS** - Portland Cement Concrete repair shall conform to the requirements of these Specifications for new construction of a type similar to that on which the repairs are to be made, with the following exceptions, changes, or additions:
- 1. Preparation For Concrete Repairs** - The defective areas to be repaired shall be prepared by removing all defective materials as directed by the Engineer. This area shall be graded to depth necessary to construct the repair so that it will meet the requirements of these Specifications for new construction. If unsuitable material is discovered in the soils base, it shall be removed and replaced with material conforming to 804.04 and measured and paid for as per 209.07.  
  
The concrete adjoining the section to be replaced shall be left with straight edges. Sidewalk replacement shall be extended to the scored joint and/or the existing repair as directed by the Engineer.  
  
All costs of cutting back, removal, and disposal of the excavated material to the depth of pavement which is to be placed shall be included in the Contract unit price for Repair of Portland Cement Concrete Pavement Sidewalk or Miscellaneous Repair. Material to be removed above or below the pavement will be paid for at the Contract unit price under 202.
  - 2. Placing Concrete** - The edges of the concrete adjoining the repair shall be thoroughly cleaned and wetted just prior to depositing fresh concrete against them. Any damaged expansion joint material in the area to be repaired shall be replaced with new material and shall conform in all respects as to type, quality, and method of installation to that of new construction. Sufficient carbon powder shall be used in the repair of sidewalk so that the repaired area will closely match the color of the existing concrete. The cost of furnishing carbon powder for sidewalk repair will be included in the Contract unit price per square yard for concrete sidewalk repair.  
  
If sufficient concrete is not available to completely fill the repair section, bulkhead timber of the depth of the repair shall be placed to receive the concrete.  
  
When truck-mixed concrete is used for repair, re-tempering the concrete and placing of concrete which has attained initial set will not be permitted. The interval between the admission of cement to the batch and final discharge shall not exceed two (2) hours.  
  
It is important that all locations at which concrete is to be used are fully prepared prior to delivery of the concrete and that only sufficient concrete is ordered to permit its use within the time limit specified for hauling concrete. Due to the difficulty of placing concrete in irregular and small repairs and the importance of attaining the best possible results, the Contractor shall proceed with the utmost diligence in the prosecution of all phases of work.
  - 3. Curing** - When wet burlap is used for curing, special care should be used to be sure it is thoroughly wet, that it is placed over the concrete surface as soon as the finishing is complete, and that the burlap is kept wet in conformance with these Specifications. Where it is not practicable to keep burlap, placed on concrete for curing, continually wet overnight following the placing of the concrete, a membrane cure meeting the requirements of 814.02 shall be applied to the surface as directed by the Engineer. Membrane cure shall not be used during the period classified as Cold Weather Construction.
  - 4. Protection** - All classes of traffic shall be excluded from pavements by the erection and maintenance of suitable barricades for a period of 24 hours after placing the concrete. This curing period will be increased to 48 hours in the case of roadway and alley construction during the period classified as Cold Weather Construction.  
  
The Contractor shall be responsible for the cuts and their condition from the initiation of excavation to the removal, upon approval, of barricades from completed repairs.
  - 5. Tree Safeguards** - Tree safeguards shall conform to the requirements of 606.01(E)3.
- F. MEASURE AND PAYMENT** - The unit of measure for Portland Cement Concrete Sidewalk Repair and for Miscellaneous Construction will be the square yard. The actual number of square yards measured completed in place will be paid for at the

Contract unit price per square yard, which payment will include the removal and disposal of old material from the defective area, expansion joint material and all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

### 605.03 ASPHALTIC CONCRETE WALK

- A. DESCRIPTION** - Asphaltic Concrete Walk shall consist of 2 inches of asphaltic concrete 9.5 mm, constructed in the areas shown in the Contract Documents and/or as directed by the Engineer. The pertinent provisions in 403 shall apply except that a 5 ton roller may be used for compaction of the asphalt.
- B. MEASURE AND PAYMENT** - The unit of measure for Asphaltic Concrete Walk will be the square yard. The number of square yards will be the actual number complete in place as measured in the field. Payment will be made at the Contract unit price per square yard, which payment will include furnishing, hauling and placing asphaltic concrete and all labor, tools, equipment, and incidentals necessary to complete the Work.

### 605.04 BRICK AND BLOCK SIDEWALK AND REPAIR

- A. DESCRIPTION** - Brick and Block Sidewalk shall be constructed and/or repaired in those areas indicated in the Contract Documents and/or as directed. The Sidewalk shall consist of brick or block in a mortar bed on PCC base or in a sand-cement bed on soils base as indicated in the Contract Documents and/or as directed. Joints shall be filled with a sand-cement mix. The exact pattern, brick size, color, and construction details shall be as indicated in the Contract Documents.

In sidewalk repair, available suitable old brick and block shall be used in addition to any new brick or block required to complete the Work. Delivery of brick or block from one site to another will be required and paid on per each basis.

- B. MATERIALS** - Materials shall meet the following requirements:

- 801.01: Portland Cement
- 801.02: Masonry Cement
- 822.08(C): Epoxy Mortar
- 803.06: Sand
- 822.01: Water
- 806.01(B): Brick
- 806.02: Pressed Concrete Block
- 807.01(A): Preformed Expansion Joint Material
- 807.02(B) (natural gray color): Cold-poured Sealant

- C. CONSTRUCTION REQUIREMENTS** - Premolded expansion joint material 1/2 inch shall be placed along the back of the curbs around structures in and abutting the Sidewalk. The pre-molded material shall be removed to 1/2 inch below the Sidewalk surface and this space sealed.

- 1. Brick Sidewalk On PCC Base** - shall meet the following requirements:

- a. Aggregate Base** – New Soils Base, if required, on existing soil, shall be brought to within 3/4 inch of proper grade. Soils base used shall meet the requirements of 804.04.
- b. PCC Base** – The PCC Base shall be constructed on soils base, prepared per 209. PCC base shall be per 502. Depth of the PCC base shall be 4 inches. Broom or machine finishing, scoring, carbon powder, and joint sealer shall not be required for PCC base.



- c. *Mortar Bed* – The mortar bed used when placing brick on PCC base shall consist of a mix of 2 parts by volume of well graded sand with 1 part by volume of masonry cement, mixed dry until the mass is uniform in color. Mixing may be done in an approved batch mixer or by hand on a clean tight surface. Enough water shall be added to the dry mix to make a comparatively stiff consistency. Mixing time shall be a minimum of four (4) minutes. Immediately prior to placing mortar bed, PCC base surface shall be dampened thoroughly.

The mortar bed shall be carefully shaped to a surface approximately parallel with surface of finished brick paving. The area of mortar bed placed and rolled in any workday shall be scheduled so that at the end of the day no bedding course remains without the brick course.

- d. *Laying Brick* – Upon prepared mortar bed the brick shall be laid in successive courses with the better face or wire- cut side upward.

Every course of brick shall be laid true and even and brought to grade by use of wooden mallets or similar tools, and except in special cases shall be laid parallel to the curb. No course shall deviate from a straight line more than 2 inches in 30 feet. Brick laying shall take place in a continuous sequence and shall follow the completion of the bedding within 50 feet.

Immediately after laying the brick, brick surfaces shall be swept and inspected. Any imperfect brick, as determined by the Engineer, shall be removed and replaced.

- e. *Tamping Brick* – Following inspection and replacement of defective bricks, the surface shall be swept free of spalls, covered with a board approximately 3 inches thick, 12 inches wide, and 6 feet long, and shall be tamped with an approved tamper. At no time shall tamper come in direct contact with bricks, and all work shall be done as soon as possible after laying so that tamping may be completed before the bed has begun to set.

- f. *Joint Filler* – When tamping is completed as described above, joints shall be thoroughly chocked with a dry mix of 2 parts sand and 1 part of cement by volume.

Filler shall be brought up flush with the surface of the bricks. After filling, the bricks shall be swept clean and carefully watered to saturate the joint filler, care being exercised not to displace filler from the joints. Any joints which do not remain flush with brick surfaces shall be re-chocked and watered. Particular attention shall be paid to soldier courses and those small sections of cut brick necessary to fit manholes, light poles, and obstructions within the paved area. Where directed by the Engineer, these shall be completely embedded in the 2:1 mix to prevent them from working loose.

- g. *Tree Safeguards* – Pertinent provision of 606.01(E)3 are applicable to this item of work.

**2. Brick Sidewalk On Sand-Cement Bed** - Requirements of 605.04(C)1 apply except as follows:

- a. Construction of PCC base shall not be required for this Work.
- b. Sand-cement bedding course and joint filler shall consist of sand and Portland Cement in the proportion of 1 part cement and 4 parts sand by weight mixed dry until the mass is of uniform color. Mixing may be done in an approved batch mixer or by hand on a clean tight surface.

The bedding course shall be placed and shaped upon the prepared soils base so that its finished depth shall be not less than 4 inches. The bedding shall be shaped to a true surface, parallel with the surface of the finished paving, by means of a template, and the bed shall be struck off until proper alignment is secured. The area of bedding course placed and rolled in any workday shall be scheduled so that no bedding course remains at end of day without the brick course.

If directed by the Engineer, in addition to shaping with a template, the bedding course shall be compacted with a hand roller. The bedding course shall be alternately struck off and rolled until uniform alignment is secured. The roller shall be not less than 36 inches in diameter and 24 inches in width, and shall weigh not less than 10 pounds per inch of width.

After final shaping, the bedding shall not be disturbed prior to laying the brick.

**3. Block Sidewalk On PCC Base Or On Sand/Cement Bed** - Requirements of paragraphs (1) and (2) above apply except as specified hereunder:

- a. *Sample* – Before Work shall start, the Contractor shall submit a sample to the QA/QC Division of the District Department of Transportation for approval.
- b. *Mock-Up* – The Contractor shall provide an in- place job mock-up of block paving work. Mock-up shall be representative of finished work in all respects, including poured concrete collars, joint fillers and sealants. Mock-up shall be used as a standard of acceptability for materials and workmanship. Accepted mock-ups will be allowed to remain as part of the completed work. Mock-up size shall be at least 10.5 feet by 10.0 feet.
- c. *Sand-Cement Bed* – Bedding course shall consist of 1 part cement and 2 parts sand, by volume, mixed dry until the mass is of uniform color. Mixing may be done in an approved batch mixer or by hand on a clean, tight surface. Once thoroughly mixed, the mass shall be lightly moistened with water.
- d. *Laying Paving Block* – Upon the bedding course as prepared, the pressed concrete pavers shall be laid with 1/4 inch joints, in successive, straight courses, starting perpendicular to the curb, with the better face, or non-slip finish up, and working toward the building line.

The surface edge of 1 paver shall be level with the next adjacent pavers so that no voids, rocking motions, or tripping hazards are encountered. Edge to edge rise shall not exceed 1/16 inch.

Unless otherwise specified in the Contract Documents or as directed, paving block shall be laid in a trisected running bond. Herringbone pattern shall be laid at corners.

After placement of paving block, the surface shall be covered by a board approximately 3 inches thick, 12 inches wide, and 6 feet long and shall be rolled with an approved roller. At no time shall roller come in direct contact with paving block. All Work shall be done as quickly as possible after laying.

The roller shall not be less than 36 inches in diameter and 24 inches in width, and shall weigh not less than 10 pounds per inch of width.

Before the pressed concrete paving blocks are installed in place, the backs of the blocks shall be moistened with water. Blocks shall be cut to fit around catch basins, wheelchair ramps, and around light standard bases. Where cutting is required, it shall be done with a high speed masonry saw producing clean, sharp edges.

At the option of the Engineer, square poured concrete collars of like color and treatment similar to the pressed concrete paving blocks shall be constructed around flagpole bases, manholes, and other small sidewalk interruptions.

For use in poured concrete areas, the Contractor shall procure from the paver supplier, bags of the same sand, cement, and aggregates used in the manufacture of the pressed concrete paving blocks. The poured concrete shall be scored to match the adjacent paver pattern.

Where irregularities of line and grade exist at the building line, a shoreline of smaller blocks, poured concrete or other treatment may be acceptable, upon approval by the Engineer. In no case will blocks less than 6 inches in length be used that can be easily dislodged.

Where indicated in the Contract Documents, the old removable-type steel vault covers will be removed and new pan vault covers furnished and installed by the respective utility company. On the new pan covers, the Contractor shall inlay pressed concrete paving block on an epoxy mortar bed. Level of blocks shall be flush with surrounding grade. Joints shall match that of the adjacent block sidewalk as much as practicable. Small blocks, less than 6 inches in length, will be allowed for use only in the paving of vault covers.

Where building vaults are encountered below grade, the pressed concrete block pavers shall be laid on sand-cement leveling bed installed in 2 lifts. The first lift shall be laid and compacted as a leveling course. The second lift shall be 3/4 inch depth and treated as a setting bed for pressed concrete block pavers.

Expansion joint material, 1/2 inch wide, shall extend from the vertical face to the underground vaults up through the sand-cement beds to within approximately 1/2 inch of the surface of the Pressed Concrete Block paving. Joint shall then be sealed with sealant.

The utility company shall be notified at least three (3) weeks in advance before paving work on the vault covers is scheduled to begin.

- e. *Joints* – Joints shall be 1/4 inch maximum between paving blocks. Edges of blocks shall be beveled to 3/16 inch maximum. Combined width across beveled joint shall be 5/8 inch maximum.

Immediately after installation of the paving block, the joints shall be filled, to bottom of bevel with joint filler. Any unsuitable blocks, so determined by the Engineer, shall be removed and replaced. Joints shall be thoroughly watered with a fine spray after filler is worked into the joints.

- f. *Tree Safeguards* – Pertinent provision of 606.01(E)(3) are applicable to this item of work.

- D. **MEASURE AND PAYMENT** - The unit of measure for the following items is the square yard. The number will be the actual number of square yards measured complete in place of any of the following items:

Brick/Block Sidewalk on PCC Base. Brick/Block Sidewalk Repair on PCC Base. Brick/Block Sidewalk on Sand-Cement Bed. Brick/Block Sidewalk Repair on Sand-Cement Bed.

Payment for the various items of sidewalk and sidewalk repair will be made at the respective Contract unit price per square yard, which payment will include compaction of existing soils base, furnishing and placing all materials including brick or block for new construction, PCC and mortar bed and filler or sand-cement bed and filler, preformed expansion joint material and joint sealer, epoxy mortar, water and all labor, tools, equipment, and incidentals necessary to complete the Work.

Payment for sidewalk repair shall also include removal and disposal of all unsuitable material and resetting existing brick or block. Any new bricks or blocks needed will be paid for on per each basis.

#### 605.05 INVERTED-U BIKE RACK

- A. **GENERAL** - The Contractor shall provide all labor, materials, and equipment necessary to install new bike rack as specified in the Contract Documents. All accessories including flange, bolts, bolt caps, nuts, washers and clips necessary for installation are included in the Work. All equipment that the Contractor receives shall be stored according to manufacturer recommendations.

The Contractor shall set the bike rack with care so as not to damage the finish. All damage to the finish will be repaired and/or replaced at no additional cost to the District. The Contractor shall maintain the bike rack properly until acceptance by the Department and replace any material damaged in kind at no additional cost to the District. All debris generated as part of the Work will be disposed of by the Contractor at no additional cost to the District.

- B. **MATERIALS** – The materials to be used shall be as follows:

1. 1.50 inches schedule 40 uncoated steel pipe (1.90 inches outside diameter).
2. Rack shall be 36 inches in height and 24 inches from the outside of each footing.
3. **Installation Methods** - In-ground mount shall be embedded into concrete base. Flange mount shall have two 2.5" x 6" x 0.25" steel base plate. Each base plate shall have four 3/8 inch diameter holes. Base plate shall be mounted using expansion anchor bolts. In-ground mount, foot mount, and rail mount models are available.
4. **Rail Racks** - Hoops are bolted to 2 parallel rails. Hoops can be left free standing or anchored to the ground. See Rail Racks section below. Rail material is AISI C3 x 4.1 steel channel.

- C. **FINISHES** – Finish shall be hot-dipped galvanized coated with black PVC.

- D. **PLACEMENT**

##### 1. **Setbacks**

- a. *Wall Setback* - For Hoops set parallel to the wall, a minimum of 24 inches should be left between the wall and the rack, the recommended setback is 36 inches. For Hoops installed perpendicular to the wall, a 28 inches setback is the minimum distance; however, 36 inches is recommended.
- b. *Distance between Racks* - 24 inches is the minimum distance between racks. 36 inches is recommended.
- c. *Street Setback* - 24 inches is the minimum distance between the street and the rack. 36 inches is recommended.
- d. The foot-mounted Inverted-U Rack has a 2.5" x 6" x 0.25" steel base plate which is installed onto a concrete base with 4 masonry anchors.

2. **Rail Racks** - Rail-mounted inverted-U is standard foot-mounted inverted-U racks attached with bolts to a rail in the configuration from 3 to 7 hoops.

E. **MEASURE AND PAYMENT** - The unit of measure for Install Bike Rack will be per each furnished and/or installed. Payment will be made at the Contract unit price per each Bike Rack. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

#### **605.06 REMOVE BIKE RACK**

A. **GENERAL** - The Contractor shall furnish all labor, material, and equipment to remove Bike Racks as shown in the Contract Documents. All Bike Racks that are to be reinstalled shall be carefully removed. All parts damaged by the Contractor will be replaced by the Contractor at no additional cost to the District. All Bike Racks shall be disassembled and inspected by the Contractor for parts that can be reused at a later time. The Contractor shall supply the District with an inventory of all parts that are removed and reusable. The Contractor will deliver the re-useable Bike Racks or parts to the District's warehouse. All debris, including broken parts, generated as part of this work, will be disposed of by the Contractor at no additional cost to the District.

The Contractor must secure exposed anchor bolts, backfill, and compact all holes created by removing existing Bike Racks. Backfill materials shall consist of suitable soils or granular material.

B. **MEASURE AND PAYMENT** - The unit of measure for Remove Bike Rack will be each. Payment will be made at the Contract unit price per each. The payment will include all labor, tools, materials, equipment, disassembly of bike rack parts, inventory of parts removed and reusable, delivery of parts, stacking in the warehouse, disposal of broken parts, debris, and all incidentals necessary to complete the Work specified herein.

## 606 CURBS, GUTTERS, DITCHES, AND PAVED FLUMES

### 606.01 PORTLAND CEMENT CONCRETE CURB, CURB AND GUTTER, AND GUTTER

- A. DESCRIPTION** - Portland Cement Concrete curb, curb and gutter, and gutter shall consist of Portland Cement Concrete proportioned, mixed, and constructed on the prepared base course in accordance with these Specifications to the grade and cross-section specified. Except as herein specified, the requirements of 501 are applicable to this specification. Repair-Replace items will include also removal and disposal of existing curb and/or gutter.
- B. MATERIALS** - Materials shall meet the following requirements specified in 501.02, except PCC shall be Class F.
- C. COMPOSITION** - The proportions of materials shall meet the requirements of 817, Class F.
- D. CONSISTENCY** - The consistency of the Portland Cement Concrete for this Work shall meet the requirements specified in 501.15.
- E. CONSTRUCTION REQUIREMENTS** - Construction of Portland Cement Concrete curb, curb and gutter, and gutter shall conform to the requirements of 501 with the following exceptions, changes, or additions.

1. **Forms** - Forms for this Work shall meet the requirements of 905.03(B) and shall be set in conformance with 501.06.
2. **Placing concrete** - The concrete shall be placed in the forms and thoroughly compacted by working with suitable tools and a mechanical vibrator. Care shall be exercised in compacting the concrete along the faces of the form in order to insure smooth, even surfaces free from voids and honeycomb. The plastering of honeycombed areas will not be permitted.
3. **Tree safeguards** - Every effort shall be made to safeguard trees. If it becomes necessary to trim tree roots, the Contractor must notify the Engineer prior to any trimming. The Contractor will then carry out his trimming operation under the supervision of the Department of Transportation's Urban Forestry Administration.

In areas where new curb abuts a tree, wood forms may be used and the aggregate base directly under proposed curb may be omitted at the discretion of the Engineer. Where new curb is placed directly against a tree's trunk or roots, the two shall be separated by strips of 1/2 inch preformed expansion joint. This Work shall be included in the Contract Price for applicable PCC curb and/or gutter items.

4. **Reinforcement** - Reinforcement will be required in circular Portland Cement Concrete curb, combination curb and gutter and gutter.
5. **Weep holes** - When directed by the Engineer, the Contractor shall install in the curb an approved type of 4 inch fiber duct for weep holes. The fiber duct shall be cut so that it is flush with both the curb face forms and curb back forms. The costs of furnishing and placing materials for weep holes shall be included in the Contract unit price per linear foot per 606.01(F)(1) or 606.01(F)(3) for Portland Cement Concrete Curb and PCC Curb and Gutter, or per cubic yard per 606.01(F)(2) for Portland Cement Concrete Curb, Gutter and/or Curb and Gutter (Variable Dimensions).
6. **Forming joints**

- a. *Straight Portland Cement Concrete Curb, Curb and Gutter, and Gutter* - Portland Cement Concrete curb, curb and gutter, and gutter, when constructed with flexible pavements, shall have expansion joints installed at intervals of 45 feet with control joints placed between them at intervals of 15 feet. Where shorter sections are necessary for closures, no section shall be less than 4 feet. All joints, both expansion and control in curb/or gutter shall be provided with two, 3/4 inch dowel bars meeting the requirements of 807.03(B). These dowels shall be spaced a minimum of 8 inches and not more than 12 inches apart. In the curb and gutter section, 1 of the dowels shall be placed 4 inches from the back of the curb. All expansion joints shall be constructed with a single piece of expansion joint material meeting the requirements of 807.01(A). The expansion joint material shall be 1/2 inch below the finished surface. The control joints shall be formed by means of 14 gauge metal sheets, or other approved materials, placed 1/2 inch from the finished surface and left in place.

Where concrete curb and gutter, or gutter is constructed integrally with Portland Cement Concrete pavement, base, or

alley, expansion joints and control joints shall be formed at the same intervals and in line with the transverse joints in the pavement or base. The expansion joints shall be of the same material and thickness as used in the pavement slab. At least 2 dowel bars meeting the requirements of 807.03(B) and of the same diameter as used in the pavement shall be placed across each expansion joint and control joint in curb and/or gutter and shall be spaced as specified above for separately constructed sections.

- b. Circular Portland Cement Concrete Curb, Curb and Gutter, and Gutter** – Portland Cement Concrete circular curb and gutter (for radii of 100 feet or less) shall be constructed as specified for straight curb and gutter with the following exceptions:

On radii of 100 feet or less, expansion joints shall be formed at equally spaced intervals of approximately 15 feet as is described in paragraph (a) above. On radii of less than 15 feet, 1 expansion joint will be required at the midpoint of the curve. The entire curve of the curb and gutter shall be reinforced by 1/2 inch deformed bars, 2 in the gutter section, and 1 approximately at the midpoint of the curb cross section above the plane of the gutter. Any lapping of the bars shall be a minimum of 10 inches.

- 7. Backfilling** - All backfilling behind curbs and combination curb and gutter sections shall be performed within 24 hours after removal of the rear curb forms.

Where the curb abuts a Portland Cement Concrete sidewalk the preparation of the Sidewalk foundation compacted to the density specified in Table 203.03 shall constitute backfilling. In all other cases, backfill material meeting the requirements of 804.04 shall be placed to within 4 inches of the top of the curb and compacted to 95 percent of maximum density. The top 4 inches shall be treated as indicated in the Contract Documents or as directed. Material limits for backfilling will be 2 feet in back of the face of the curb.

- 8. Sealing of joints** - All expansion joints in Portland Cement Concrete curb, curb and gutter, and gutter shall be sealed in accordance with 501.19(A).

- 9. Finishing** - Portland Cement Concrete curb, curb and gutter, and gutter shall be finished as follows:

The curb face forms shall be removed as soon as the concrete has set sufficiently to insure against injury by such removal. The curb back forms and the gutter face forms shall remain in place for at least 12 hours. Any irregular surface shall be corrected by rubbing with an approved carborundum brick. The top surface of the concrete shall be finished true to line and grade in a smooth, neat, and even manner by means of metal trowels. When the concrete has set sufficiently, the surface shall be brushed with a fine hair brush meeting the requirements of 905.09(E). The face edge of the curb shall be finished to a radius of 1 inch and the back edge to a radius of 1/4 inch. The edges of gutters shall be finished to a radius of 1/4 inch. The edging tools shall conform to the requirements of 905.09(B). The top surface of the curb shall be tested with a straightedge meeting the requirements of 903.03, laid along the surface in the longitudinal direction. Any deviation of the top surface of the curb in excess of 3/16 inch from the straightedge shall be immediately corrected. There shall be no variation in alignment of the curb exceeding 1/8 inch. All rejected curb, curb and gutter, and gutter shall be removed and replaced without additional compensation.

- 10. Superimposed curb** - Portland Cement Concrete superimposed curb shall be of the dimensions as shown on the Standard Drawings or the Contract Plans. It shall be constructed on the previously placed Portland Cement Concrete pavement slab and finished in accordance with 606.01(E)(9) above.

A control joint shall be cut midway between expansion joints to a depth of 1/3 that of the height, and shall be aligned as nearly as practicable with those of the existing PCC slab to prevent spalling. Superimposed curb shall be placed as soon as possible following placement of the pavement slab.

Measure and payment for superimposed curb will be as outlined in 606.01(F)(1) and 606.01(F)(2), and the depth of the curb shall include the depth of the concrete slab upon which it is superimposed.

- 11. Tree and curb** - In areas where new curb abuts a tree, wood forms may be used and the aggregate base directly under proposed curb may be omitted at the discretion of the Engineer. Where new curb is placed directly against a tree's trunk or roots the two shall be separated by strips of 1/2 inch preformed expansion joint. This Work shall be included in the Contract Price for applicable PCC or stone curb and/or gutter items.

- 12. Narrowed reinforced curb** - A narrowed reinforced curb section shall be installed as directed by the Engineer when full width curb is not practicable; reinforcement shall consist of 2 No. 4 deformed bars meeting requirements of 812.02. Bars shall be

equidistant from the face and back of curb, 1 bar 4 inches from the top, and 1 bar 4 inches from the bottom. Payment for narrowed curb and the reinforcing steel will be included under applicable PCC curb and/or gutter items.

#### F. MEASURE AND PAYMENT

1. **Portland Cement Concrete Curb, Curb and Gutter** - The unit of measure for straight Portland Cement Concrete Curb or Portland Cement Concrete Curb and Gutter will be the linear foot. The number of linear feet will be the actual number of linear feet for each type of curb or curb and gutter of the width and depth specified in the Contract Documents, measured complete in place. The number of linear feet of straight Portland Cement Concrete Curb or Portland Cement Concrete Curb and Gutter, will be paid for at the Contract unit price per linear foot, which payment will include furnishing, hauling, and placing all materials including joints, curing, and backfill, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.
2. **Portland Cement Concrete curb, curb and gutter, curb and/or gutter (variable dimensions)** - The unit of measure for Portland Cement Concrete Curb, Portland Cement Concrete Curb and Gutter or Portland Cement Concrete Curb and/or Gutter (Variable Dimensions) will be the cubic yard. The number of cubic yards will be the actual number of cubic yards of variable width and depth, measured complete in place. The number of cubic yards of Portland Cement Concrete Curb, Portland Cement Concrete Curb and Gutter or Portland Cement Concrete Curb and/or Gutter (Variable Dimensions), will be paid for at the Contract unit price per cubic yard, which payment will include furnishing, hauling, and placing all materials including joints, reinforcement for circular curb, curing, and backfill, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.
3. **Circular Portland Cement Concrete curb, curb and gutter** - The unit of measure for Circular Portland Cement Concrete Curb or Circular Portland Cement Concrete Curb and Gutter will be the linear foot. The number of linear feet will be the actual number of linear feet for each type of curb or curb and gutter of the width and depth specified in the Contract Documents, measured complete in place. The number of linear feet of Circular Portland Cement Concrete Curb or Circular Portland Cement Concrete Curb and Gutter, will be paid for at the Contract unit price per linear foot, which payment will include furnishing, hauling, and placing all materials including joints, reinforcement, curing, and backfill, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.
4. **Portland Cement Concrete gutter** - The unit of measure for Portland Cement Concrete Gutter will be the square yard. The number of square yards will be the actual number of square yards for each width and/or depth of gutter specified in the Contract Documents, measured complete in place. The number of square yards of Portland Cement Concrete Gutter will be paid for at the Contract unit price per square yard, which payment will include furnishing, hauling, and placing all materials including joints, curing, and backfill, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.
5. **Circular Portland Cement Concrete curb for alley and driveway entrances** - The unit of measure for Circular Portland Cement Concrete Curb for Alley and Driveway Entrances will be the linear foot. The number of linear feet will be the actual number of linear feet for each type of curb of the width and depth specified in the Contract Documents, measured complete in place. The number of linear feet of Circular Portland Cement Concrete Curb for Alley and Driveway Entrances will be paid for at the Contract unit price per linear foot, which payment will include furnishing, hauling, and placing all materials including joints, reinforcements, curing, and backfill, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the Work.

#### 606.02 STONE CURB

- A. **DESCRIPTION** - Work shall consist of furnishing and setting new stone curbing, resetting or adjusting existing stone curbing, both straight and circular, at locations and of dimensions as shown in the Contract Documents or as directed. Work shall include PCC foundation, backfilling, and other incidentals necessary for complete curb installation.

## B. MATERIALS

1. **Stone curb** - All new curbstones shall be first quality granite, hard and durable, of a uniformly light color from 1 deposit or quarry, free from seams, cracks, or other imperfections, and have a smooth splitting character.

It shall also be clean, and show no evidence of any iron rust or iron particles.

- a. *Dimensions* - Straight granite curbstone shall have a nominal width of either 5 inches or 8 inches plus or minus 1/8 inch at the top surface, a minimum width of 4 inches at the bottom surface for at least 2/3 of each curb piece or as shown in the Contract Documents or as directed. The front surface shall be between 12 inches and 14 inches in height. . The front surface shall be between 12 and 14 inches in height. Curbs 8 x 8 inches and 8 x 9 inches shall have a front surface of 8 inches and 9 inches respectively.

Straight curbing may be of random lengths, but no piece shall be less than 3 feet in length.

Unless otherwise shown in the Contract Documents, or directed, the front face shall have a batter of 1 inch in 12 inches.

Circular curb up to and including 100 feet radius shall have the same cross-section dimensions as straight curb, and shall be cut exactly true to the radius ordered. Circular curb with a 3, 6 or 15 feet radius shall have an arc length of 4.71 feet. All others shall have an arc length of 5.25 feet.

Circular curb greater than 100 feet through 200 feet radius shall consist of straight sections not exceeding 5 feet in length with ends cut to form radial joints.

- b. *Finish* - The top surface of curbstone shall be finished with 4-cut or 550-shot finish, or a wire cut finish to an approximately true plane, free from drill holes, and shall have no projection or depression greater than 1/8 inch.

The front face shall be at right angles to the horizontal plane of the top surface and shall be free from drill holes, except as specified in 606.02(C)(5). The front face shall have either a smooth or rough surface as indicated in the Contract Documents or as directed.

The smooth front face shall be finished the full height for the 8 inch and 9 inch deep curb and 2 inches greater than the height of curb reveal for the 12 inch deep curb. The smooth face shall have no projection or depression greater than 1/8 inch. Remaining depth of front face may be rough cut with depression or projections not exceeding 1-1/2 inches. The arris line between the top surface and front face shall have a 1/4 inch bullnose. A sawn finish will be an acceptable alternate.

The rough front face shall be smooth quarry split and shall have no projection greater than 3/4 inch or depressions greater than 1/2 inch as measured from the vertical plane of the face through the top arris line, for a distance down from the top of 8 inches. The remaining depth shall have no projection or depression greater than 1 inch measured in the same manner.

Front and back arris lines shall be straight and true with no variation from a straight line greater than 1/8 inch.

Bottom surfaces shall have no projection or depression greater than 1-1/2 inches and drill holes will be permitted.

Back surfaces shall be sawn or split approximately at right angles to the plane of the top surface. No projection or depression greater than 1/4 inch will be allowed for a distance of 4 inches down from the top. The remaining distance shall have no projection or depression greater than 1-1/2 inches. Drill holes will be permitted in the back surface but shall not show in the top arris line.

Ends of stone shall be square with the plane of top surfaces; except for curbs greater than a 100-200 foot radius where joints are cut radial, ends of the stone shall be square with the planes of the face and so finished that when set, no space more than 1/2 inch shall show in the joint for the full width of the top or down the face for 8 inches.

The remainder of the end may break back not over 8 inches from the plane of the joint (not over 2 inches from the plane of the joint for Bridge Curb).

2. **PCC foundation** - The PCC foundation shall be of a dry consistency, and composed of materials conforming to 817.03. Proportions shall be as specified in (C)(3)(b) below. The time interval for placing and compacting the dry-mix shall not exceed two (2) hours.



### C. CONSTRUCTION REQUIREMENTS

1. **Excavation for stone curb** - Excavation for setting of stone curb or resetting to a new line shall be as shown in the Contract Documents. The cost of this excavation will be paid for at the Contract unit price per cubic yard for the type of excavation encountered. Where stone curb is reset on approximately the same line, no payment will be made for excavation as this cost will be included in the Contract unit price per linear foot for the type of curb reset.

The bottom of the excavation shall be thoroughly compacted to grade. Any unsuitable material encountered shall be removed and replaced with base material meeting the requirements of 804.04. This excavation shall be paid for under the appropriate excavation item.

2. **Lines and grades** - Before setting, resetting, or adjusting any curb, the Contractor shall check all lines and grades furnished him, by the use of string line and tees. Upon the discovery of any error in line and grade furnished, the Contractor shall immediately notify the Engineer before proceeding with the Work. Any curb set to an improper grade shall be removed and reset at the Contractor's expense.

3. **Setting and resetting curb**

- a. *General* - In the setting of stone curb, the joint space between the sections of curb shall be 1/4 inch with 1/4 inch preformed expansion joint filler meeting the requirements of 807.01(A) placed therein. Before any concrete for pavement is placed against the curb, that portion of the curb against which concrete is to be placed shall be treated with a coating meeting the requirements of 802.03.

- b. *Setting curb* - A bed of dry-mix consisting of 5 bags Portland cement, 1300 pounds of fine aggregate (sand) and 1800 pounds of No. 67 aggregate shall be placed to a minimum depth of 7 inches. Immediately after the mix has been properly compacted, the curb shall be placed upon it and set to a firm bearing by ramming with crowbars. The face of the curb must be plumb and true to line, and the top set to grade. Care must be exercised in ramming the curb to grade to prevent marring or breaking the stone. A wood shield or board shall be placed on top of the curb to prevent such damage.

After the curb has been set to line and grade, the area behind the curb shall be filled with the specified mix to within 4 inches of the top of the curb and to a width of 6 inches. That part of the bed used in setting the curb which projects into the PCC or brick gutter, base, or pavement shall be removed. Removal shall not be done until the bed has sufficiently set to prevent any damage to the portion under the curb.

- c. *Resetting curb* - Resetting of curb shall be performed as described for setting new curb, except that no hauling will be necessary other than the disposition of the curb within the Project limits. It will be necessary to entirely remove the curb and old concrete foundations. Any curb broken due to the Contractor's negligence shall be replaced at his expense. Any curb deemed unsuitable for re-use by the Engineer shall be removed and new curb, furnished either by the District or by the Contractor as determined by the Engineer, shall be set by the Contractor. Payment for removal and disposal of unsuitable curb will be made under the appropriate excavation item.

4. **Adjusting curb** - The Work to be performed under this item shall consist of slight adjustment to line and grade of sections of curb which do not require complete resetting. Under this item, the removal of the curb, excavation, or replacement of concrete is not required. Adjustment shall be made by maneuvering the curb into position and ramming a dry mix under the curb to provide a firm foundation to maintain the curb in proper vertical and horizontal alignment. The cost of this mix shall be included in the Contract unit price per linear foot for adjusting curb.

5. **Drill weep hole in stone curb** - The Work to be performed under this item consists of core drilling weep holes, with a neat finish, in stone curbs for the purpose of connecting existing drain pipe (roof drains, etc.) to gutter. The diameter of the weep hole shall not exceed 4 inches.

6. **Backfilling** - After the curb and backing are in place the remaining area shall be backfilled to within 4 inches of the top of the curb with materials meeting the requirements of 804.02 and compacted to 93 percent of standard density.

In backfilling, including replacement of unsuitable material, suitable materials excavated from the Project shall be used insofar

as possible. When sufficient suitable material from the Site is not available, embankment or aggregate base, as directed, shall be used. Care shall be taken in this operation so that the curb will not be forced out of line. The Contractor will be required to refill any depressions that may occur after sufficient time has elapsed for settlement of the backfill. The lateral limits of this backfill shall be 2 feet from the face of curb.

7. **Salvage of stone curb** - The Work consists of the loading and hauling of existing stone curb to such locations off the Project as may be designated by the Engineer.
8. **Tree safeguards** - Tree safeguards shall conform to the requirements of 107.12 and 606.01(E)(3).

#### D. MEASURE AND PAYMENT

1. **Furnishing and setting, resetting, adjusting, and salvaging stone curb** - The unit of measure for Furnishing and Setting, Resetting, Adjusting, and Salvaging Stone Curb will be the linear foot. The number of linear feet will be the actual number of linear feet set, reset, adjusted, or salvaged as measured complete in place. All stone curb for payment under this item shall be furnished by the Contractor.
2. **Drill weep hole in stone curb** - The unit of measure for Drill Weep Hole in Stone Curb will be each. The quantity will be the actual number of weep holes drilled complete.
3. **Excavation, aggregate base and embankment** - These items will be measured under the appropriate items of Division 200.
4. **Furnishing and setting 8 inches x 12 inches straight and/or circular stone curb** - The number of linear feet of Furnishing and Setting 8 inches x 12 inches Straight and/or Circular Stone Curb, as measured above, will be paid for at the Contract unit price per linear foot. This payment will include furnishing, hauling, and placing all materials. Payment will include joining, dressing up and rounding off ends at driveways, backfilling trench bottom and back of curb and all labor, materials, tools, equipment and incidentals necessary to complete the Work.
5. **Payment for straight and circular curb sections with ends cut to form radial joints** shall be made at the respective Contract unit price per linear foot. Circular curb greater than 100 feet shall be paid as straight curb. Measure and payment shall include all provisions outlined herein.
  - a. **Resetting straight and/or circular stone curb** - Payment for Reset Stone Curb will be made at the Contract unit price per linear foot for all sizes both straight and circular, which payment will include excavation, hauling existing curb sections from one location to another on the job Site and from one job Site to another, as well as loading and hauling old and new stone curb as required from the District property yard; all other material, placement, joining, dressing, rounding off ends at drives, backfilling, all labor, tools, equipment, and incidentals needed to complete the Work. Where broken curb sections are encountered as determined by the Engineer, removal and disposal of broken curb shall be included as part of the Work; the District will furnish replacement curb sections to the Contractor at the District property yard at no cost.
  - b. **Adjusting straight and/or circular curb** - Payment for Adjusting Stone Curb will be made at the Contract unit price per linear foot for all sizes, both straight and circular, which payment will include excavation if necessary, all other materials, adjustment, joining, dressing, backfilling, all labor, tools, equipment, and incidentals needed to complete the Work.
  - c. **Drill weep hole in stone curb** - Payment for Drill Weep Hole in Stone Curb will be made at the Contract unit price each, which payment will include drilling, all labor, tools, equipment, incidentals needed to complete the Work.

Payment for adjusting drain pipes and extending drain pipes to back of curb will be made under other appropriate Pay Items.

- d. **Salvaging stone curb** - Payment for Salvaging Stone Curb will be made at the Contract unit price per linear foot, which payment will include removal, loading, and hauling to locations off the Project Site and all labor, tools, equipment, and incidentals needed to complete the Work.

**606.03 ASPHALTIC CONCRETE CURB**

- A. DESCRIPTION** - This Work shall consist of the construction of an asphaltic concrete curb, on a prepared surface course, of the dimensions and at the locations as shown on the Contract Documents, and/or as directed by the Engineer.
- B. MATERIALS** - The class of hot asphaltic concrete for curb will be stone-filled sheet asphalt or hot asphaltic concrete pavement, 9.5mm, as directed by the Engineer.
- 401.03: Plant Mix Pavements shall also be applicable.
- C. CONSTRUCTION REQUIREMENTS**
- 1. Preparation of curb foundation** - Asphalt curbs shall be placed on a newly laid asphalt pavement immediately following compaction of the asphalt surface. If this is impossible, as in the case of existing pavements, extra care must be taken to see that dust or any other foreign material is removed prior to laying the asphalt curb.
  - 2. Placing curbs**
    - a. General** - Placing temperature shall be the temperature specified for the type of asphalt being used. Adjustment of temperatures within the specified range shall be made in the initial stages of construction to achieve the best placement temperature. The cross-section of the curb shall be as designated in the Contract Documents.
    - b. Machine placing** - Machine-laid work usually requires no additional compaction. In areas where it is evident that compaction is inadequate, measures shall be taken to provide adequate compaction. No forms are needed for machine-placed curbs.
    - c. Hand placing** - Hand placing will be permitted only in areas where it is necessary to construct a transition curb section. Material placed by hand shall be tamped into place and screeded to a smooth finish in a workmanlike manner. Forms may be removed as soon as the material has cooled to air temperature.
    - d. Tree safeguards** - Tree safeguards shall conform to the requirements of 107.12.
- D. MEASURE AND PAYMENT** - The unit of measure for Asphaltic Concrete Curb will be the linear foot. The actual number of linear feet of the width and depth specified, measured complete in place, will be paid for at the Contract unit price per linear foot, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

**606.04 PCC WHEELCHAIR/BICYCLE RAMPS**

- A. DESCRIPTION** - Work includes furnishing all materials for construction of PCC Wheelchair/Bicycle Ramps in accordance with the Contract Documents, or as directed. Work also includes cutting to a neat line, excavation and disposal of all excavated materials when ramps are incorporated into an existing sidewalk and/or curb. Except as amended herein, requirements of 605.01 apply.
- B. MATERIALS** - Materials shall be as specified in 817 for Class F concrete.
- C. COMPOSITION** - The proportions for Portland Cement Concrete used in wheelchair/bicycle ramps shall meet the requirements of 817, Class F.
- D. CONSISTENCY** - The consistency of the Portland Cement Concrete for this Work shall meet the requirements specified in 501.15.
- E. CONSTRUCTION REQUIREMENTS** - Unless otherwise directed, neither reinforcement nor darkening agents shall be used in ramp construction. Ramp surfaces shall be finished with a steel bristle broom.

1. **New construction areas** - Ramps shall be constructed on aggregate base prepared as part of the work under other appropriate items of work. Where gutters are incorporated, the gutter section adjacent to the ramp shall be constructed monolithically with the ramp as part of this work.
  2. **Existing sidewalk and/or curb areas** - The existing sidewalk, curb and/or gutter shall be cut to a neat line. Any damage to adjacent areas shall be repaired by the Contractor at no additional cost to the District. Where existing stone curbs are encountered, the curb sections affected by new ramp construction shall be removed. Wherever possible, a ramp shall be constructed within the confines of 1 curb section. When this is not possible, existing stone curb may have to be cut to accommodate the ramp construction. Where the resulting gap between an edge of a new ramp and the remaining curb section is less than 3 feet in length, new PCC curb shall be constructed in the gap. Where the gap is 3 feet or greater in length, the removed stone curb section shall be cut to proper dimensions and reset in the gap per applicable requirements of 606.02(C)(3). If the Engineer determines that a section of stone curb is unsuitable for resetting, then PCC curb will be constructed. Preformed expansion joint filler shall be placed around the wheelchair/bicycle ramp flush with the finished surface.
- F. MEASURE AND PAYMENT**- PCC Wheelchair/Bicycle Ramps will be measured by either of the following methods as specified in the Contract Documents:
1. The unit of measure will be each. The number will be the actual number of complete ramps constructed in new and existing construction, respectively.
  2. Payment for PCC Wheelchair/Bicycle Ramps will be made by either of the following methods as specified in the Contract Documents:
    - a. *New construction areas* - Payment for PCC Wheelchair/Bicycle Ramps in new construction shall be made at the Contract unit price per each (or per square yard), which payment will include furnishing and placing all materials, all labor, tools, equipment, and incidentals necessary to complete the Work.
    - b. *Existing sidewalk and/or curb areas* - Payment for PCC Wheelchair/Bicycle Ramps incorporated into existing sidewalk and/or curb areas will be made at the Contract unit price per each (or per square yard), which payment will include cutting to a neat line, excavation and disposal of excavated materials, cutting and resetting stone curb if necessary, furnishing and placing all materials, tools, equipment, and incidentals necessary to complete the Work.

#### 606.05 PORTLAND CEMENT CONCRETE DITCHES

- A. **DESCRIPTION** - This Work shall consist of constructing Portland Cement Concrete paved drainage ditches on a prepared subgrade to the lines, grades, and dimensions as indicated in the Contract Documents, or as directed by the Engineer.
- B. **MATERIALS** - Materials shall meet the following requirements:
  - 501.02: PCC
  - 822.09: Geotextile Fabric and Membranes
- C. **CONSTRUCTION REQUIREMENTS** - All Work shall be done in accordance with the applicable provisions of 606 with the following modifications.

Expansion joints shall be installed in all PCC paved ditches at intervals of approximately 45 feet, with contraction joints between them at intervals of approximately 15 feet, unless otherwise directed by the Engineer.

Dowel bars for load transfer devices at expansion joints shall be 1/2 inch in diameter, 16 inches in length, and spaced approximately 1 foot on centers. Dowel bars shall be placed not less than 6 inches from the edge of the ditch paving. Dowel bars at the contraction joints will not be required.

Contraction joints shall be formed by pressing a metal strip vertically downward into the soft concrete surface and removing this strip after the concrete has stiffened sufficiently to hold its form. The strip shall form a slot 3/8 inch wide at the top, and 1/4 inch wide at the bottom, with a depth equals to 1/3 the paving thickness. Alternate methods of joint formation may be used, upon approval of the Engineer.

All expansion and contraction joints in the PCC ditch paving shall be sealed in accordance with the requirements of 501.19.

- D. MEASURE AND PAYMENT** - The unit of measure for paved Portland Cement Concrete flumes will be the square yard. The actual number of square yards measured complete in place on the exposed surface will be paid for at the Contract unit price per square yard, which payment will include excavation and disposal of surplus materials, preparation of subgrade, installation of geotextile fabric, curing, backfilling, all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

#### **606.06 PAVED BITUMINOUS CONCRETE DITCHES**

- A. DESCRIPTION** - This Work shall consist of constructing bituminous concrete flumes on a prepared subgrade to the lines, grades, and dimensions as indicated in the Contract Documents, or as directed by the Engineer.

- B. MATERIALS** - The bituminous concrete mixture shall be 19.0 mm, hot asphaltic concrete pavement, and shall conform to the applicable requirements of 402.

- 822.09: Geotextile Fabric

- C. CONSTRUCTION REQUIREMENTS** - The Subgrade shall be constructed to the depth and dimensions as indicated in the Contract Documents.

The bituminous material shall be placed in accordance with the applicable provisions of 402.03, except that a hand tamper meeting the requirements of 904.06 shall be used for compaction.

- D. MEASURE AND PAYMENT** - The unit of measure for paved Bituminous Concrete Flumes will be the square yard. The actual number of square yards, measured complete in place will be paid for at the Contract unit price per square yard, which payment will include furnishing, hauling, and placing all materials, excavation and disposal of surplus materials, preparation of the Subgrade, installation of geotextile fabric, placing and compacting the bituminous material, backfilling, all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

#### **606.07 BRICK GUTTER**

- A. DESCRIPTION** - Brick gutter shall be constructed in the area and to the grade and pattern shown in the Contract Documents. The brick shall be laid in a mortar bed on a PCC base. Brick is to be laid prior to the start of any asphalt paving.

- B. MATERIALS** - Materials shall meet the following requirements:

- 801.01: Portland Cement
- 803.06: Sand
- 822.01: Water
- 806.01(D): Brick
- 801.02: Masonry Cement
- 807.01(A): Preformed Expansion Joint
- 807.02(A): Sealant

- C. CONSTRUCTION REQUIREMENTS**

- 1. Preparation of concrete base** - Prior to the placement of the mortar setting bed, the surface of the concrete base shall be chipped or ground as necessary to the required Elevations. The base shall be thoroughly cleared of all dirt and debris and shall be free from water before any bed material is laid. If chipping is required, upon completion, the concrete base shall be blown clean of all particles before the mortar setting bed is laid. In particular, the Contractor shall ensure that the concrete base elevations adjacent to the catch basins are such that the finished brick gutter surface elevations match the details shown herein.

2. **Mortar setting bed and joint filler** - The mortar setting bed shall comprise of 1 part by volume of Portland Cement and 2 parts by volume of sand.

Mortar joint filler shall be composed of 1 part by volume of Portland Cement and 2 parts by volume of sand. Mortar joint filler shall contain an approved, black colorant in an amount not to exceed 2 to 3 percent by weight of the Portland Cement. Colorant shall be of a type and quality which will not adversely affect workability, durability, setting, or strength of the mortar joint filler and of a type specifically prepared for use in cement mortar.

3. **Placing mortar setting bed** - The mortar mix for the setting bed shall be thoroughly mixed to uniform color and shall be free from irregularities or streaks of unmixed materials. The mortar setting bed shall be spread on the prepared concrete base to a finished depth of not more than 1 inch or less than 1/2 inch and regulated so as to be exactly parallel to the finished grade of the Roadway when laid. The mortar setting bed shall be uniformly tamped, prior to laying brick.

4. **Placing brick** - At the curb, brick is to be laid perpendicular to the curb alternating between a full brick and a half-brick at the curb. Work will start with a full brick end at the crosswalks and proceed to mid-block. The brick gutter pattern is to be completed continuously along the curb.

Laying of brick shall proceed in such manner that un-laid sections of the mortar setting bed are not disturbed. Any depressions formed in the mortar setting bed shall be corrected prior to placement of brick.

At midblock the joint width between bricks shall be adjusted within the limits specified over such a distance along the gutter that will allow the brick gutter to be completed using full width brick only.

A uniform 3/16 inch joint plus or minus 1/16 inch is to be provided between brick and between brick and granite curb. Joints shall be solidly filled to the full depth with mortar joint filler and care shall be taken not to smear mortar joint filler on the surface of adjoining brick or other surfaces.

After installation, joints shall be finished by tooling with a non-staining jointer to produce a very slightly concave, smooth joint free of cracks. Special care shall be taken to properly protect brick gutter paving immediately after installation against adverse weather and too rapid drying during hot weather.

Expansion joint material shall be installed in the brick gutter and mortar setting bed at joints with the crosswalk granite shorelines. Expansion joints in the brick gutter and mortar setting bed shall also be installed over existing expansion joints located in the Portland Cement Concrete road base. Sealant shall be applied to a depth of 1/2 inch over the expansion joint material. The sealant surface shall be flush with the brick surface.

- D. **MEASURE AND PAYMENT** - The unit of measure for Brick Gutter will be the square foot. The number of square feet of this item will be paid for at the Contract unit price per square foot, which payment will include the furnishing, hauling and installation of all materials, preparation of concrete base, disposal of excess materials, all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

#### 606.08 DETECTABLE WARNING PAVERS ON EXISTING AND NEW WHEEL CHAIR/BICYCLE RAMPS

- A. **DESCRIPTION** - This Work shall consist of furnishing and installing detectable warning pavers on new or existing wheelchair/bicycle ramps as indicated and in accordance with the details shown on the Plans and/or as directed by the Engineer. Furnishing and placing of new ramps will be paid under 606 or 202, as applicable.

- B. **DETECTABLE WARNING PAVERS/TRUNCATED DOMES** - Install detectable warning pavers/truncated domes for a distance of 24 inches from the back of the curb for the entire width of the ramp opening where it is flush with the pavement. Starting at the lower grade break with the Roadway.

1. **General** - Detectable warning pavers shall consist of a surface of truncated domes aligned in a square grid pattern.
2. **Dome Size** - Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inches minimum to 1.4 inches maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 inches.
3. **Dome Spacing** - Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches minimum and 2.4 inches maximum, and a base-to-base spacing of 0.65 inches minimum, measured between the most adjacent domes on square grid.

4. **Contrast** - Detectable warning surfaces shall contrast visually with adjacent walking surfaces either light-on-dark, or dark-on-light. However, a light gray background with dark gray detectable warning surfaces does not provide adequate contrast. A white background with dark gray detectable warning surface or a light gray background with a brick red detectable warning surface provides a much more acceptable level of contrast.
  5. **Size** - Detectable warning surfaces shall extend 24 inches minimum in the direction of travel and the full width of the wheelchair ramp, landing, or blended transition.
  6. **Perpendicular, Parallel, Combination, and Sidewalk Ramps and Blended Transitions** - The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum from the curb line.
  7. **Directional Ramps**
    - a. Where the ends of the bottom of the grade break are in front of the back of the curb, detectable warning surfaces shall be placed at the back of the curb.
    - b. Where the ends of the bottom grade break are behind the back of the curb, and the distance from either end of the bottom grade break to the back of the curb is 5 feet or less, detectable warning surfaces shall be placed on the ramp run within 1 dome spacing of the bottom of the grade break.
    - c. Where the ends of the bottom grade break are behind the back of the curb, and the distance from either end of the bottom grade break to the back of the curb is more than 5 feet, detectable warning surfaces shall be placed on the lower landing at the back of the curb.
  8. **Rail Crossings** - The detectable warning surface shall be located so that the edge nearest the rail crossing is 6 inches minimum and 8 inches maximum from the vehicle dynamic envelope.
  9. **Platform Edges** - Detectable warning surfaces at platform boarding edges shall be 24 inches wide and shall extend the full length of the platform.
  10. Detectable warning surfaces shall be planer and 4 sided. The top and bottom of the detectable warning surface should be parallel.
- C. **MATERIALS** - Pavers will meet Americans with Disabilities Act (ADA) requirements for detectable warning pavers (truncated domes) either ASTM C 902 Pedestrian and Light Traffic Paving Block, Class SX, Type 1; or ASTM C 936 Solid Concrete Interlocking Paving Units; or ASTM C 1272 Heavy Vehicular Paving Brick, Type R.
- Pavers will be laid on top of a 4 inch unreinforced concrete base. Setting bed and joints to be mortared in accordance with manufacturer's instructions or with a maximum 1/2inch thick setting bed of latex modified cement mortar. Mortar joints to a width not greater than 5/32 inch and not less than 1/16 inch. Pavers shall not be directly touching each other unless they have spacing bars. The portion of the concrete ramp that is thickened to 6 inches shall be extended such that a minimum 4 inches of concrete shall be beneath the brick pavers.
- Joints are to be flush with top surface and struck so as to give a smooth surface. Pavers shall be laid such that joints are level with adjoining joints so as to provide a smooth transition from brick to brick, and brick to concrete surface. The top surface of any 2 adjacent units should not differ by more than 1/8 inch in height for mortared brick paving. Bricks shall be placed in a running bond pattern. Pavers that do not conform to the smoothness requirement shall be removed and replaced at the expense of the Contractor as determined by the Engineer. Face of all brick shall be clean of cement and protected so as to avoid chipping during construction.
- Stamping or imprinting systems are not acceptable for forming detectable warning surfaces. However, the Department will consider the employment of composite and metal panels for detectable warning surfaces at those locations where it is shown to be more practicable. When used must be capable of uniformly providing the specified texture and pattern, using the Department's standard class of concrete for sidewalks. The minimum dry static coefficient of friction, as defined by ASTM C 1028, shall be 0.80.
- D. **CONSTRUCTION** - The Contractor shall submit literature describing the following to the Engineer at least 30 days prior to the proposed installation:
1. The detectable warning paving material
  2. All associated materials

3. Preparation requirements
4. In addition, a minimum 12 inches by 12 inches sample of the detectable warning material shall be submitted.

The manufacturer shall demonstrate in writing and by providing references that the detectable warning paving materials have been satisfactorily used for roadway, path or flooring applications, in high pedestrian use and under weather conditions similar to those experienced in the District, for a minimum period of five (5) years.

In no case shall the Contractor permit the application of any materials by untrained personnel or non-approved installers. The material manufacturer's certification of compliance with this requirement shall be provided to the Engineer.

Prior to the start of Work, the Contractor shall show evidence of successful completion of similar installations and provide a job Site sample for the approval of the Engineer. The sample size shall be 4 feet by 2 feet, minimum, and constructed at a location selected by the Engineer.

As many test panels will be constructed as are necessary to achieve a sample panel that meets the satisfaction of the Engineer. All Work shall conform to the appearance of the approved sample to the satisfaction of the Engineer. The sample shall not be incorporated into the Work and will be removed when ordered by the Engineer.

Follow all applicable manufacturers' requirements for environmental conditions, surface preparation, installation procedures, curing procedures, and materials compatibility. The Contractor is responsible for removing any material spatters from areas. The Contractor shall repair any damage that should arise from the installation or the clean-up effort.

Unless otherwise specified, the color of the detectable warning surface shall be red or as specified by Engineer-in-charge. The color shall be uniform over the entire surface, and homogenous throughout the thickness of the material. The color of the detectable pavers shall be as follows: Red shall be used with red brick sidewalk; gray shall be used with Portland Cement Concrete sidewalk; and Beige shall be used with exposed aggregate sidewalk.

If a color other than red is specified in the Contract Documents, the coloring material shall be an approximate visual match to the specified colors. The color shall be uniform over the entire surface and homogenous throughout the thickness of the material.

There shall be a minimum of 70 percent contrast in light reflectance between the detectable warning and adjoining surface. The material used to provide visual contrast shall be an integral part of the detectable warning surface. Both the domes and the underlying surface must meet the contrast requirement.

The contrast in percent shall be determined by:

$$Contrast = \left[ \frac{(B1 - B2)}{B1} \right] \times 100$$

Where:

*B1* = light reflectance value (LRV) of the lighter area and

*B2* = light reflectance value (LRV) of the darker area.

Note that in any application both white and black are never absolute; thus, *B1* never equals 100 and *B2* is always greater than zero.

When visual contrast other than "red" with a concrete ramp or landing is used, provide verification of contrast.

## E. MEASURE AND PAYMENT

Detectable Pavers on Wheelchair Ramps will be measured as specified below:

1. **Detectable Warning Pavers On New Wheelchair/Bicycle Ramps** - No separate measurement will be made for the Detectable Warning Pavers.
2. **Detectable Warning Pavers on existing wheelchair/bicycle ramps/retrofitting existing wheelchair ramps with detectable pavers** - Measurement will be made for the Detectable Warning Pavers per square foot under separate Pay Item, where Work includes all the materials, tools, equipment, labor, and necessary incidentals to install Detectable Warning Pavers on each Wheelchair Ramp.



Detectable Pavers on Wheelchair Ramps will be paid as specified below:

3. **Detectable Warning Pavers On New Wheelchair/Bicycle Ramps** - Payment for the Detectable Warning Pavers on new Wheelchair Ramps will be included in the Contract unit price for the Wheelchair/Bicycle Ramp which payment will include furnishing and placing all materials tools, equipment, all labor and incidentals necessary to complete the Work. There is no additional payment for job Site samples and clean up.
4. **Detectable Warning Pavers On Existing Wheelchair/ Bicycle Ramps/Retrofitting Existing Wheelchair Ramps With Detectable Warning Pavers** - Payment for the Detectable Warning Pavers will be made under the Pay Item for Detectable Warning Pavers.

## 607 TURF ESTABLISHMENT

### 607.01 SEEDING

**A. DESCRIPTION** - This Work shall consist of soil preparation, fertilizing, liming as required, seeding, mulching, and mowing all areas designated for turf establishment as specified in the Contract Documents or as directed by the Engineer.

**B. MATERIALS** - Materials shall meet the following requirements:

- 823.03: Seed
- 823.01: Topsoil
- 823.02: Fertilizer
- 823.02(F): Lime
- 823.04: Mulch

**C. CONSTRUCTION REQUIREMENTS** - Unless otherwise specified, seeding operations shall be during the periods from February 1 to April 30 and from September 15 to October 31. Seed shall be mixture No. 1, mixture No. 2, or mixture No. 3 as specified in the Contract Documents or as directed by the Engineer. Seeding at other than the above dates may be allowed upon written approval of the Engineer. Seeding operations shall not be performed when the ground is frozen or when soil or weather conditions would prevent proper soil preparation and subsequent operations. When hydroseeding is performed, nozzles or sprays shall not be directed toward the ground in a manner that will cause erosion or runoff. The Contractor shall notify the Engineer at least 72 hours prior to beginning seeding operations.

Seed shall be furnished separately or in mixes as required in standard sealed containers. All seed shall be labeled, tagged, or marked per accepted horticultural practice and shall comply with all current state and federal regulations. Seed and mixes shall be furnished with a certification from the seed company stating type of seed, percentages of mixture, purity, germination, and weed seed. Legume seed shall be inoculated with an approved inoculant.

**1. Preparation of seed bed** - The Contractor shall first clear the seeding areas of all stones, clods, and debris. The preparation of the seed bed shall include, under this item, the removal of or the merging into the adjacent area any subsoil material existing back of the Roadway curbing so as to permit placement of the required 6 inches of topsoil in the seeding areas. The seeding areas shall be boarded or bladed, as necessary, to eliminate any irregularities and to establish a uniform subsurface prior to placing topsoil. All areas shall be left in a drainable condition, free of pockets or depressions. The Contractor shall harrow, disk, or otherwise loosen the subsoil to a depth of 4 inches. Cultivation of slopes steeper than 3 to 1 shall be confined to horizontal scarification to a depth of 2 inches. Gullies, washes, and disturbed areas that develop subsequent to final dressing shall be repaired before they are seeded.

Following the approved subgrade preparation, the Contractor shall apply topsoil over the areas in accordance with the requirements of 823.

All areas to be seeded shall meet required finish grade.

**2. Applying lime** - Lime, if necessary to adjust soil pH for grass renovation, shall be applied at the rate of 3,000 pounds per acre. Lime shall then be thoroughly mixed to a depth of 4 inches.

**3. Applying fertilizer** - Fertilizer shall be applied at the rate recommended by the manufacturer. Fertilizer shall then be thoroughly mixed to a depth of 4 inches. The area shall be scarified and raked until the surface is smooth, friable, and of uniform fine texture. The Contractor shall follow Best Management Practices to control fertilizer run-off.

**4. Use of sewage sludge** - The use of sewage sludge will not be permitted.

**5. Applying seed** - Seed shall only be applied to previously prepared seedbeds.

When seed is applied with hydraulic seeders, all mixtures shall be used within 8 hours after mixing.

When seed is sown with mechanical seeders, seed and fertilizer shall be incorporated to a depth not more than 1/4 inch.

All leguminous seeds shall be inoculated as recommended by the inoculant manufacturer. The inoculant shall be stored at room temperatures, out of direct sunlight and away from heating units.

When leguminous seed is sown by hydraulic seeders, 10 times the quantity of inoculant required for dry leguminous seed application shall be used. Seed not used within one (1) hour shall be re-inoculated.

When leguminous seed is sown by mechanical seeders, the seed shall be dampened with water and mixed with the inoculant. The inoculated seed shall then be mixed with the other seed to be used. Inoculated seed not used within 24 hours shall be re-inoculated.

Establishing turf shall be done using mechanical seeding, unless hydro-seeding is specified or directed by the Engineer. Regardless of the method used, the finished surface of any area that is seeded shall not be rougher, more uneven or have more or larger stones, clods, roots, or other foreign materials than the area it adjoins. In built up and residential areas hand raking will be used as required to produce the required smoothness and uniformity, particularly where grading and turf establishment is to be adjacent to lawns.

- a. *Mechanical seeding* - Following the approved seed bed preparation the seed shall then be sown. Mixtures No. 1 and No. 2 shall be sown at the recommendation of the manufacturer. The seed shall be evenly distributed, preferably with wheelbarrow seeders, seed drills, landscape seeders, cultipacker seeders, fertilizer spreaders, or other approved mechanical seed sowing equipment when seed and fertilizer are to be applied in dry form.

Fertilizer in dry form and ground limestone, if required, shall be spread separately at specified rates and incorporated in 1 operation to required depth on those areas indicated. Seeded areas shall be compacted within 24 hours after seeding has been completed.

Hand-operated seeding devices may be used when seed, fertilizer, and lime are applied in dry form. Generally, hand operated seeders shall be used only on areas which are inaccessible to mechanical seeders.

After the seed has been sown, it shall be covered to an average depth of 1/4 inch by means of a brush harrow, chain harrow, cultipacker, rake, or other approved device. Rolling of seed areas shall be done only as requested by the Engineer.

- b. *Hydroseeding* - The seed and fertilizer, or the seed, fertilizer, and suitable mulch shall be mixed in the needed amount of water to produce slurry and then applied under pressure at the rate indicated on the Plans or in the Special Provisions. Hydraulic equipment shall be approved prior to use. When approved, mulch may be applied during or after the seeding operation. When wood cellulose mulch is to be incorporated as an integral part of the slurry mix, it shall be added after the seed and fertilizer have been thoroughly mixed. Lime, when applied hydraulically, shall be a single, separate operation. Wood cellulose mulch shall be applied at the rate of 1,500 pounds per acre or 35 pounds per 1,000 square feet. Any area inadequately covered shall be retreated as directed at no additional cost to the District.

Legume seed, if specified to be used in the seeding mix, shall be inoculated per instructions of inoculant manufacturer. The inoculums used for hydraulic seeding shall be 10 times that recommended for dry seeding. When seeding, or reseeded, fertilizing, and mulching are applied in water, compaction or rolling will not be required.

6. **Seed establishment period** - The Contractor shall protect and care for seeded areas until final acceptance of the Contract. Care shall consist of providing bi-weekly watering protection against traffic by providing approved warning signs and barricades; and shall consist of repairs to any seeded turf areas damaged by wind, water, fire, traffic or other causes. Grass shall be mowed whenever height reaches 6 inches to maintain a height of 4 inches. Damaged areas shall be repaired to re-establish the condition and grade of the area prior to seeding and shall then be re-fertilized, re-seeded, and re-mulched as specified herein at the Contractor's expense.
7. **Mulching** - Mulch shall be spread uniformly in a continuous blanket of sufficient thickness, minimum 2 inches, to hide the soil from view, taking care not to over apply. Mulch may be spread by hand or by machinery. Mulch may be spread before seeding turf but not later than 48 hours after seeding turf unless otherwise approved or directed. Anchorage is required unless otherwise specified in the Contract Documents. Mulch and mulch anchorage shall be applied separately from seeds unless otherwise specified in the Contract Documents.

Straw mulch material, as specified in 823.04(A), shall be satisfactorily secured by applying the asphalt emulsion binder,

making a uniform tacky mat. It shall be applied uniformly at the rate of 0.10 gallon per square yard of mulch surface on slopes 3 to 1 or flatter areas and 0.15 gallon per square yard of mulch surface on slope or bank areas steeper than 3 to 1 and/or as directed by the Engineer.

Mulch may be blown on grass areas. The use of cutters in the equipment used for this purpose will be permitted to the extent that at least 95 percent of the mulch shall be 6 inches or more in length. When mulch is applied by the blowing method, the loose depth in place shall be no less than 2 inches and a uniform distribution and depth of mulch must be obtained.

Mulching by the "Asphalt Mix" method is also permitted. The mulch material shall be applied by blowing, and the asphalt binder material sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the proportion of approximately 1.7 gallons to 45 pounds of mulch or as required by the Engineer; with a minimum of 1.5 gallons and a maximum of 2 gallons to 45 pounds of mulch, depending on the type of mulch and the effectiveness of the binder in securing it. All mulched surfaces shall be properly applied with asphalt binder material so that the surfaces will have a uniform appearance. Bridges, pavements, curbs, walls, and drainage structures must be adequately protected to prevent any asphalt staining. The Contractor shall take care to prevent asphalt binder from marking or defacing structures, pavements, utilities, or plant growth. Any disfigurement shall be repaired at the Contractor's expenses. Mulching which may become displaced shall be immediately replaced and secured.

- D. MEASURE AND PAYMENT** - The unit of measure for Seeding will be the square yard. The actual number of square yards of surface area seeded will be paid for at the Contract unit price per square yard, which payment will include furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein.

## 607.02 SODDING

- A. DESCRIPTION** - Work consists of preparation of sod bed, liming, fertilizing, watering, and furnishing and placing sod as specified in the Contract Documents or as directed by the Engineer.

- B. MATERIALS** - Materials shall meet the following requirements:

- 823.05: Sod
- 823.01: Topsoil
- 823.02: Fertilizer
- 823.02(F): Lime

- C. CONSTRUCTION REQUIREMENTS** - Sodding shall not be done during freezing weather, or when the ground is excessively wet, frozen, or otherwise unsuitable. The Contractor shall notify the Engineer at least 48 hours prior to beginning sodding operations.

- 1. Procuring sod** - The Contractor shall exercise maximum care to retain the soil existing on the roots of the sod during transporting, handling and transplanting operations to include tarping. Dumping or dropping of sod from vehicles will not be permitted. Sod shall be planted within twenty-four (24) hours from the time of harvesting, unless it is tightly rolled, or stored roots-to-roots. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. The maximum period of time from harvesting to planting shall not exceed forty-eight (48) hours.
- 2. Preparation of sod bed** - Areas to be sodded shall be boarded or bladed as needed to eliminate irregularities resulting from soil erosion and to establish an even uniform grade as required. All areas to be sodded except those with slopes steeper than 3 to 1 shall be cultivated to a depth of 4 inches to provide a reasonably firm but friable sod bed. Cultivation on slopes steeper than 3 to 1 shall be confined to horizontal scarification to a depth of 2 inches.

Areas to be sodded shall be free of any plant growth, stones 2 inches in any dimension and larger or other debris. There shall be a minimum of 3 inches of topsoil under all sod unless otherwise specified. Apply topsoil in accordance with the requirements of the Engineer.

3. **Applying lime** – Lime if necessary to adjust soil pH for grass renovation. Lime shall be applied at the rate of 3,000 pounds per acre. Lime shall then be thoroughly mixed to a depth of 4 inches on slopes 3 to 1 and flatter and 2 inches on slopes steeper than 3 to 1 either during or following sod bed preparation.
4. **Applying fertilizer** - Fertilizer shall be applied based on the recommendation of the manufacturer. Fertilizer shall then be thoroughly mixed to a depth of 4 inches on slopes 3 to 1 and flatter and 2 inches on slopes steeper than 3 to 1 either during or following sod bed preparation. The area shall be scarified and raked until the surface is smooth, friable, and of uniform fine texture.
5. **Finish grade for sod** - When laid in strips adjacent to paths, pavements, drain inlets, and other Structures, the finished sod surface shall be flush with surface of the adjacent soil and the adjacent Structures. Sod laid in drainage ways, and areas to be continuously or solidly sodded shall meet the finished grades as shown in the Contract Documents. Grades shall be formed with special care at the junction of drainage ways.
6. **Placing sod** - Sod shall be mowed in the field to a height of not more than 3 inches within five (5) days prior to lifting. All sod shall be in place within 36 hours after lifting from the source. The soil on which the sod will be laid shall be moist. The soil shall be watered prior to sodding, if so directed by the Engineer. Sod shall be placed in successive strips neatly matched with staggered joints tightly butted and all openings shall be plugged with sod. In drainage ways, and where continuous or solid sodding is indicated, and/or specified in the Contract Documents, the sod shall be laid with the longest dimension parallel to the contours.

Gaps or openings which occur at paved or wall areas shall be plugged tight with sod. Sod which is small, irregular, broken, torn or has lost any soil will be rejected. After placing sod it shall be watered thoroughly and rolled with approved equipment.

On slope areas, sod shall be placed parallel to the contour, starting at the bottom of the slope. Vertical joints between sides shall be staggered. On slopes 3 to 1 and steeper, each strip of sod shall be pegged with at least two 1/2 inch x 1/2 inch x 12 inch stakes placed 2 feet apart and driven flush with the top of the grass.

7. **Sod establishment period** - The Contractor shall protect and care for sodded areas until final acceptance of the Contract. Care shall consist of bi-weekly watering, providing protection against traffic by providing approved warning signs and barricades; and shall consist of repairs to any sodded areas damaged by wind, water, fire, traffic or other causes. In locations where mowing is specified, the sod shall be mowed whenever height reaches 5 inches to maintain a height of 3 inches. Damaged areas shall be repaired to re-establish the condition and grade of the area prior to seeding and shall then be re-fertilized, reseeded, and re-mulched as specified herein at the Contractor's expense.

The sod shall be watered at bi-weekly intervals for a minimum of four (4) weeks following installation unless otherwise specified or directed by the Engineer. Additional watering shall be performed if specified in the Contract Documents. When watering, sufficient water shall be applied to wet the sod at least 2 inches into the sod bed. Watering shall be done in a manner that will not cause erosion or other damage to the finished surfaces. Any surfaces that have settled, become gullied or otherwise damaged shall be repaired at the Contractor's expense to re-establish the grade and conditions of the soil prior to sodding and shall then be re-fertilized and re-sodded as specified under this Work.

- D. **MEASURE AND PAYMENT** - The unit of measure for Sodding will be the square yard, with measure taken for actual surface area sodded.

Payment will be made at the Contract unit price per square yard, which payment will include furnishing all labor, materials, equipment, tools, water used during planting, and incidentals necessary to complete the Work.

### 607.03 WILDFLOWER SEEDING

- A. **DESCRIPTION** - This Work shall consist of preparing seed bed, furnishing and placing wildflower and companion grass seed, herbicide and mulch as specified in the Contract Documents or as directed by the Engineer.
- B. **MATERIALS** – Materials shall meet the following requirements:
  - Wildflower Seed Mix: Shall be approved for use in the Washington, D.C. area and shall contain at least 20 to 25 different species. The mixture shall be approximately 70 percent perennials, 20 percent biennials and 10 percent annuals. The purity of species shall be 95 percent minimum. Seed germination shall range from 75 to 98 percent.

- Herbicide: Herbicide shall be an approved United States Environmental Protection Agency chemical to control and prevent re-growth of undesirable vegetation. The herbicide shall be approved for type and rate of application by the Engineer following the recommendation of the manufacturer.
- 823.04: Mulch
- 823.04(B): Hydromulch
- Companion Grass Seed: Grass seed for stabilizing soil prior to germination of wildflower seeds shall be 100 percent hard fescue (*Festuca longifolia*) or Sheep Fescue (*Festuca ovina*). Grass seed shall meet standards for germination in the state where the seed is purchased, shall have high purity of not less than 95 percent, and shall contain no noxious weed seeds. No bluegrass, annual rye, tall fescue, orchard grass or timothy seeds shall be used.

**C. CONSTRUCTION REQUIREMENTS** - The Contractor shall perform all herbicide placement and all seeding, scarifying and mulching operations only at times when local weather and other conditions affecting such work are normal and favorable to the proper prosecution of the Work. No work shall be done when the temperature is 32 degrees Fahrenheit or lower. Seeding shall not be done during windy weather, or when the ground is excessively wet, frozen, or otherwise untillable.

1. **Preparation of seed bed** - All existing grass, weeds, vegetation, stones, and debris shall be removed from the areas to be seeded. Prior to seeding and mulching, the soil shall be hand-raked or mechanically scarified to a maximum depth of 3 inches by power rake, tine-harrow, verti-cutter, or rotary tiller set on highest setting.

2 to 4 weeks prior to sowing seed, the Contractor shall spray a contact herbicide over the scarified seeding area. Precautions in applying herbicide shall be followed in accordance with the manufacturer's instructions and information, and shall be of a type and rate of application approved by the Engineer prior to use. The Contractor shall submit daily herbicide application reports to the Engineer.

2. **Applying seed** - Seeding in the spring, before periods of anticipated rainfall, is the best recommended time for wildflower seeding. In medians and in small areas, seeding shall be applied by hand, or by a drop or cyclone spreader set to dispense seed at the rate of 7 pounds per acre, or 1/4 pound per 1,000 square feet. After seeding, soil shall be firmed with a light-weight roller, cultipacker, or other mechanical means to insure contact between seed and soil. No fertilization of wildflower areas will be required.

Companion grass seed shall be sown separately after the wildflower seeds have been sown. Grass seed shall be planted at the rate of 10 to 15 pounds per acre, or 1/4 pound per 1,000 square feet.

On steep slopes and embankments, the hydroseeding method may be used. The slurry mix of wildflower seed and water shall be applied at the rate of 7 pounds per acre, or 1/4 pound per 1,000 square feet. Wildflower or grass seed should not be immersed in water until immediately before application.

3. **Mulch** - The seed bed shall then be covered with mulch to a 1/4 inch thickness, or 2 to 3 times the depth of the seed. For areas 1 acre or larger, a mechanical seed drill may be used to sow the seeds 1/8 to 1/4 inch deep.

Hydromulching shall be applied separately, after the hydroseeding operations are completed, at the rate of 1,200 pounds per acre, or 27-1/2 pounds per 1,000 square feet. The hydromulch shall be applied in 2 separate passes, or applications. Only 5 to 10 percent of the quantity of hydromulch shall be applied during the first application, so that the wildflower and grass seed will not hang up in the mulch. A second pass, using the remainder of the hydromulch, will then be applied over the first application.

4. **Seed establishment period** - The Contractor shall care for the seeded wildflower areas until final acceptance of the Contract. Care of wildflowers shall consist of keeping the wildflowers in a healthy growing condition by watering, controlling weeds, and by any other necessary operations. Care shall also consist of providing protection against traffic by providing approved warning signs or barricades, and shall consist of repairs to any seeded wildflower area damaged by wind, water, fire, traffic, or other causes. Damaged areas shall be repaired to re-establish the condition and grade of the area prior to seeding and shall be reseeded and re-mulched as specified herein. The Contractor shall mow wildflower establishment areas once a year in the autumn after the seed heads have matured, as approved by the Engineer for the duration of the Contract.

The wildflowers shall be watered at bi-weekly intervals for a minimum of 4 weeks following installation unless otherwise specified or directed by the Engineer. Additional watering shall be performed if specified in the Contract Documents. Watering

shall be done in a manner that will not cause erosion or other damage to the finished surfaces. Any surfaces that have settled, become gullied or otherwise damaged shall be repaired at the Contractor's expense to re-establish the grade and conditions of the soil prior to seeding and shall then be re-fertilized and reseeded as specified under this work.

If the wildflowers have not filled in the planting area completely by the end of the first growing season, the bare areas will be reseeded by the Contractor in the fall, as directed by the Engineer and at no additional cost to the District.

**D. MEASURE AND PAYMENT** - The unit of measure for Wildflower Seeding will be the square yard.

Payment will be made at the Contract unit price per square yard, complete in place, and will include an acceptable stand of wildflowers and companion grass (at least 75 percent germination), all labor, including scarifying and mowing, materials including seed, mulch and herbicide, water used during planting, tools, equipment, and incidentals necessary to complete the Work.

#### 607.04 CROWN VETCH HYDROSEEDING

**A. DESCRIPTION** - This Work shall consist of soil preparation, fertilizing, liming as required, hydroseeding and mulching all slopes greater than 3 to 1 and all areas designated for crown vetch as specified in the Contract Documents or as directed by the Engineer.

The hydroseed shall be a mixture of crown vetch seed with inoculant added, and grass seed.

**B. MATERIAL** - Materials shall meet the following requirements:

- 823.03: Seed Mix No. 3
- 823.01: Topsoil
- 823.02(B): Fertilizer
- 823.02(F): Lime
- 823.04(B): Mulch

**C. CONSTRUCTION REQUIREMENTS** - Hydroseeding operations shall not be performed when the ground is frozen or when soil or weather conditions would prevent proper soil preparation and subsequent operations. When hydroseeding is performed, nozzles or sprays shall not be directed toward the ground in a manner that will cause erosion or runoff. The Contractor shall notify the Engineer at least 72 hours prior to beginning hydroseeding operations.

**1. Preparation of seed bed** - The Contractor shall first clear the hydroseeding areas of all stones, clods, and debris. The preparation of the seed bed shall include, under this item, the removal of or the merging into the adjacent area any subsoil material existing back of the Roadway curbing so as to permit placement of the topsoil in the seeding areas. The seeding areas shall be boarded or bladed, as necessary, to eliminate any irregularities and to establish a uniform subsurface prior to placing topsoil. All areas shall be left in a drainable condition, free of pockets or depressions. The Contractor shall harrow, disk, or otherwise loosen the subsoil to a depth of 4 inches. Cultivation of slopes steeper than 3 to 1 shall be confined to horizontal scarification to a depth of 2 inches. Gullies, washes, and disturbed areas that develop subsequent to final dressing shall be repaired before they are hydroseeded.

Following the approved subgrade preparation, the Contractor shall apply topsoil over the areas in accordance with the requirements of the Engineer.

Other areas designated by the Engineer to be hydroseeded but which are covered with weeds or grass shall have the vegetation mowed or cut down to ground level. All trees and stumps shall be removed, and all clippings and debris shall be cleared from the seedbed area. Prior to hydroseeding, the soil shall be hand raked or mechanically scarified to a depth of at least 4 inches.

All areas to be hydroseeded shall meet required finish grade.

**2. Applying hydroseed mix** - The mixture of crown vetch seed and companion seed shall be sown at the rate recommended by the manufacturer. Fertilizer shall be applied following the requirements of the manufacture of crown vetch.

All leguminous seeds shall be inoculated as recommended by the manufacturer. The inoculant shall be stored at room temperatures, out of direct sunlight and away from heating units. Crown vetch inoculants shall consist of pure-bred cultures of

Rhizobia species of bacteria and shall not be used later than the date indicated on the container or as specified. Seed not used within one (1) hour shall be re-inoculated.

Companion seed – For spring and fall seeding, mix into seeding mixture 60 pounds per acre of 50 percent perennial rye grass and 50 percent Kentucky 31 fescue. For summer seeding, add into this mix 4 pounds per acre of weeping love grass.

The ground limestone, fertilizer, seed, and inoculant shall be combined and thoroughly mixed in a slurry tank and the specified binder then added to the mix.

3. **Applying mulch** - Mulch shall be applied hydraulically immediately after applying the slurry mix. The mulch shall be applied at 1,500 pounds per acre or 35 pounds per 1,000 square feet.
4. **Seed establishment period** - The Contractor shall water weekly, protect and care for seeded areas until final acceptance of the Contract. Care shall consist of providing protection against traffic by providing approved warning signs and barricades; and shall consist of repairs to any hydroseeded areas damaged by wind, water, fire, traffic, or other causes. Damaged areas shall be repaired to re-establish the condition and grade of the area prior to hydroseeding and shall then be re-fertilized, reseeded, and re-mulched as specified herein at the Contractor's expense.

**D. MEASURE AND PAYMENT** - The unit of measure for Crown vetch Hydroseeding will be the square yard.

Payment will be made at the Contract unit price per square yard, complete in place, and will include an acceptable stand of crown vetch (at least 3 healthy and flourishing crown vetch plants per square yard), including an acceptable stand of companion ryegrass, all labor, material, tools, equipment, and incidentals necessary to complete the Work. Topsoil shall be paid for under a separate item.

## 607.05 RENOVATING GRASS

**A. DESCRIPTION** - This Work shall consist of removing all stones, trash, and debris, soil preparation, fertilizing, liming as required, seeding, mulching, and mowing all areas designated for grass renovation as specified in the Contract Documents or as directed by the Engineer. The Contractor shall provide a uniform acceptable stand of grass as per Seed Establishment Period, 607.01(C)(6). Any unacceptable renovated grass areas shall be re-seeded at the Contractor's expense during the immediate seed sowing period.

**B. MATERIALS** – Materials shall meet the following requirements:

- 823.03: Seed shall be Mixture No. 1 listed in Table 823.03. Seed mix for densely shaded areas will be 20 percent by weight America Kentucky Bluegrass and 80 percent by weight Pennlawn Creeping Red Fescue

**C. CONSTRUCTION REQUIREMENTS** - Unless otherwise specified, seeding operations shall be during the periods from March 1 to April 30 and from September 1 to October 31. Seeding at other than the above dates may be allowed upon written approval of the Engineer. The Contractor shall notify the Engineer at least 72 hours prior to beginning seeding operations.

Seed shall be furnished separately or in mixes as required in standard sealed containers. All seed shall be labeled, tagged, or marked per accepted horticultural practice and shall comply with all current state and federal regulations. Seed and mixes shall be furnished with a certification from the seed company, stating type of seed, percentages of mixture, purity, germination, and weed seed. Legume seed shall be inoculated with an approved inoculant.

1. **Preparation of seed bed** - The Contractor shall first clear the seeding area of all stones, trash, and debris; the seeding areas shall be raked to a depth of approximately 3-1/2 inches.
2. **Applying lime** - Lime, if necessary to adjust soil pH for grass renovation, shall be applied at the rate of 3,000 pounds per acre.
3. **Applying fertilizer** - Fertilizer shall be applied as recommended by the manufacturer of the seed product.
4. **Applying seed** - Seed shall be spread evenly with a hand-push type, calibrated fertilizer spreader not to exceed 36 inches in width. After seed is in place and approved by the Engineer, the entire area shall be dragged lightly with a metal or bamboo fan rake.



Seed for densely shaded areas shall be sown at the rate of 3 pounds per 1,000 square feet.

5. **Seed establishment period** - The Contractor shall water bi-weekly, protect and care for seeded areas until final acceptance of the Contract. Care shall consist of providing protection against traffic by providing approved warning signs and barricades; and shall consist of repairs to any seeded turf areas damaged by wind, water, fire, traffic, or other causes. The Contractor shall provide water as necessary to insure proper germination and a uniform stand of grass. Grass shall be mowed whenever height reaches 6 inches to maintain a height of 4 inches. Damaged areas shall be repaired to re-establish the condition and grade of the area prior to seeding and shall then be re-fertilized, reseeded, and re-mulched as specified herein at the Contractor's expense.

- D. **MEASURE AND PAYMENT** - The unit of measure for Renovating Grass shall be the square yard.

The actual number of square yards of surface area renovated will be paid for at the Contract unit price per square yard, which payment will include furnishing all labor, materials, tools, equipment, reseeding if necessary, and incidentals necessary to complete the Work as specified herein.

## 607.06 EROSION CONTROL MATTING

- A. **DESCRIPTION** - This Work shall consist of preparing the ground surface, furnishing, placing, and caring for erosion control matting specified in the Contract Documents or as directed by the Engineer.

- B. **MATERIALS** - All erosion control matting materials shall be made of new material, clean, sound, free of rips or tears.

- TYPE A – Burlap shall be of standard weave with a weight of 3.5 to 5.0 ounces per square yard.
- TYPE B – Jute matting shall be of a uniform, plain weave with warp and weft yarns of about same size, with a width of 45 to 48 inches plus or minus 1 inch, with 78 warp ends per width and 41 weft ends per yard. Cloth shall weigh 1.80 to 1.22 pounds per running yard plus or minus 5 percent.
- TYPE C – Woven paper or woven sisal mesh matting shall be woven from twisted yarns available in rolls 45 to 48 inches wide. Matting may vary from close to open weave, ranging from 1/8 to 1/4 inch opening. Shrinkage after wetting shall not exceed 20 percent of the surface area.
- Matting anchor staples shall be made of No. 8 gauge steel wire, bent U-shaped with a throat width of 1 to 2 inches, and an effective driving depth not less than 6 inches.

- C. **CONSTRUCTION REQUIREMENTS** - The time of placement shall be as specified in the Contract Documents and/or according to manufacturer's recommendations. No erosion control material shall be placed on frozen ground. Matting shall be placed within 24 hours after seeding operations have been completed.

1. **Ground preparation and installation** - Areas to receive an erosion control material shall be shaped, graded and compacted to the lines and grades shown in the Contract Documents or as directed by the Engineer. Except on freshly placed topsoil, areas to receive erosion control materials shall be scarified to a minimum depth of 1 inch immediately prior to installation of the erosion control materials. All loose stones, clods, sticks, or other undesirable material over 2 inches in greatest dimension shall be removed and disposed of by the Contractor.

Matting shall be unrolled in the direction of drainage flow without stretching. Each strip of matting shall overlap the long edge of previous strip at least 4 inches. When joining ends of 2 strips, the up-channel end of lower strip shall be turned down and buried 6 inches deep in a trench. Bottom end of upper strip shall be lapped 12 inches over up-channel end of lower strip. The Engineer may require any other edge exposed to more than normal water flow be buried in a similar manner. Matting edges shall be similarly buried around the edges of catch basins and other structures.

Matting shall be in firm contact with the soil in its entirety. Matting shall be securely fastened in place with staples driven vertically into the soil and flush with the surface. Staples shall be placed at 4 foot intervals along the edges and center of the matting. On all overlapping edges, staples shall be placed 12 inches apart. At all ends of matting, staples shall be placed 12 inches apart. Mats constructed of wood and hydromulch shall also be watered immediately after stapling to bond the mat with the soil. Water shall be applied so it falls on the mat like a normal rainfall. At no time shall the water be directed from a water or hydroseeder spray gun in a direct straight line to the mat.

2. **Care and repair** - The Contractor shall care for the areas where erosion control materials have been placed until a satisfactory turf has developed and approved by the Engineer or final acceptance of the Contract. Where necessary, such care shall consist of providing approved warning signs or barricades for protection against traffic. Any surfaces that have settled, become gullied or otherwise damaged, due to the Contractor's operations, shall be repaired at the Contractor's expense to re-establish the grade and soil conditions that existed prior to placing erosion control materials. Turf shall be re-established as specified in the Contract Documents.

Staples that become loose or raised, and matting that becomes loose, torn, or undermined shall be repaired promptly at Contractor expense. When directed and as part of Work, any portion of matting shall be rolled with a roller weighing not over 65 pounds per foot width of the roller.

- D. **MEASURE AND PAYMENT** - The unit of measure for Erosion Control Matting will be the square yard in place. The number of square yards as measured in place will be paid for at Contract unit price per square yard, which payment will include furnishing all labor, materials, tools, equipment and incidentals necessary to complete and care for the Work as specified.

Measure of overlap will not be taken.

### 607.07 TOPSOIL

- A. **DESCRIPTION** - This Work shall consist of furnishing and placing topsoil in conformance with the grades, limits and depths as shown in the Contract Documents or as directed by the Engineer.

- B. **MATERIALS** – Materials shall meet the following requirements:

- 823.01: Topsoil

- C. **CONSTRUCTION REQUIREMENTS**

1. **Preparation of topsoil areas** - Unless otherwise directed by the Engineer, areas designated to receive topsoil shall be graded so that the completed Work after topsoil is placed, shall conform to the specified grades and limits. The Contractor shall shape and then scarify or till the surface of the subsoil before the topsoil is placed to permit bonding of the topsoil with the subsoil. Tillage by disking, harrowing, raking, or other approved methods shall be accomplished in such a manner that depressions and ridges formed by tillage shall be parallel to the contours. Topsoil shall be applied only when the subsoil is in a loose, friable condition.

Subsoil on slopes that have been horizontally grooved in accordance with the Plans shall not be loosened.

2. **Placing and spreading topsoil** - The loose depth of topsoil shall be sufficient to allow the area to conform to the Elevations shown on the Plans after topsoil settles. After topsoil has been applied, large clods, hard lumps, and stones more than 2 inches in diameter; brush; roots, stumps, litter, and foreign material shall be removed from the area. When the operation is complete, the area shall be in a condition to receive seed, sod, mulch, or plants.
3. **Restoration** - The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable to receive seed, sod, mulch, or plants. Surplus topsoil shall be placed in other locations approved by the Engineer.

- D. **MEASURE AND PAYMENT** - Topsoil will be measured in acres of surface area computed to the nearest 1/10 of an acre and will be paid for at the Contract unit price per acre. This price shall include preparing areas to receive topsoil; furnishing, loading, transporting, and applying topsoil; finishing areas; and restoring damaged areas prior to final acceptance.

## 608 TREES, SHRUBS, VINES AND GROUND COVER

### 608.01 REMOVE TREE AND/OR STUMP

- A. DESCRIPTION** - This Work shall consist of removing complete trees and/or their stumps designated on the Plans or by the Engineer and shall include cutting such trees, removing their stumps and roots from the ground, and properly disposing of the material.
- B. CONSTRUCTION REQUIREMENTS** - All trees designated on the Plans or by the Engineer shall be cut in sections from the top down without danger to traffic or injury to property, public or private. All Work shall conform to ISA Best Management Practices for tree removal, most current ANSI A300, Tree, Shrub, and Other Woody Plant Maintenance – Standard Practice (Pruning).
- All stumps and all surface roots shall be removed to a depth of at least 2 feet below subgrade. Proper precaution shall be taken to protect underground utilities when removing stumps. “Miss Utility” must be contacted to verify if subsurface utilities are at the Project location.
- All trees, stumps, roots, and debris shall be properly disposed of by the Contractor. When Elm trees and/or stumps are removed, it is mandatory that the complete grinding of all parts of the tree are taken to a location determined by the Engineer as a preventive measure to help halt the spread of Dutch Elm Disease. No separate or additional compensation will be allowed for disposal.
- C. MEASURE** - The unit of measure for Remove Tree, Remove Tree and Stump, and Remove Tree Stump will be each. The number of trees will be the actual number of the various sizes of trees, as listed in the Schedule of Prices, which are removed.
- The size of trees shall be the true diameter measured at a point on the tree trunk 4-1/2 feet above the ground line (DBH, Diameter-Breast-Height).
- Trees with multiple trunks growing from a single base shall be measured for payment as a single tree. The sum total of all stems shall determine tree size.
- D. PAYMENT** - The number of the various sizes of trees, trees and stumps, and tree stumps removed, as measured above, will be paid for at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work. Any tree removal that has not been approved by the Engineer or designated on approved Plans will follow the fine schedules in 107 or 608.

### 608.02 PLANTS AND PLANTING

- A. DESCRIPTION** - Work consists of furnishing, delivering, planting and/or transplanting trees, shrubs, vines, and ground cover, plants of types and sizes indicated on the Plans, and as directed, including all excavation and planting operations, plant establishment operations, disposal of waste and other incidentals needed to complete planting Work.
- This Work shall be performed by a qualified landscape Contractor who shall be approved by the Engineer prior to start of Work under this item.
- All Work done under this item shall be inspected by the Engineer.
- B. MATERIALS** - Materials shall meet the following requirements:
- Plants – Plants are defined as trees, shrubs, vines, and plants of all descriptions.
- 1. Quality** - All plants shall be first-class representatives of their normal species or varieties unless otherwise specified. Unless otherwise specified, all plants shall be nursery grown stocks that have been transplanted or root-trimmed 2 or more times, according to the kind and size of plants. Furnished plant materials shall be certified by State or Federal Department of Agriculture to be free from disease or infestation.
- The branch system shall be normal development and free from disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, insect eggs and infestations, or other objectionable disfigurements.
- Trees shall have reasonably straight stems, and shall be well branched, and symmetrical per their natural habits of growth.

Minimum tree size shall be 2 to 2-1/2 inch caliper, 6 to 8 feet in height.

Specimen shall mean an exceptionally heavy, symmetrical tightly knit plant, so trained and favored in its development and appearance, as to be unquestionably superior in form, number of branches, compactness and symmetry.

Plant materials that are weak or that have been cut back from larger grades to meet certain specified requirements will be rejected. All plants shall be freely dug; no heeled-in plants from cold storage will be permitted.

Prior to starting Work, the Contractor shall submit, in writing to the Engineer, an itemized list of sources of all plant items to be used in the Contract.

The Engineer reserves the right to inspect the plant material at the nursery prior to transportation to the Project Site. Trees shall be sealed. Cost for inspection and sealing of plant material shall be borne by the Contractor. The Contractor shall bear all costs associated with meals, lodging and transportation, i.e., air fare, auto rental, parking and tolls. Daily lodging and meal expenses shall not exceed per diem limits allowed under DC Government regulations.

Approval of plants at the nursery shall not be construed as final acceptance of the material. The plant material will be inspected again upon arrival at the Project and after installation.

2. **Plant names** - All scientific and common plant names shall be per Standardized Plant Names, as adopted by the American Joint Committee on Horticultural Nomenclature.

All plants delivered shall be true to name and legibly tagged with the names and sizes of materials.

3. **Grading** - Grading of plants, including Balled and Burlapped Specifications, Bare Root Specifications, Nursery, Collected, Container Grown and Seedling Stock shall be per USA Standard for Nursery Stock, as approved by the American Association of Nursery-men, Inc., latest edition (ANSI Z60.1).
4. **Balled and burlapped plants** - Balled and burlapped (B&B) plants shall be dug so as to retain as many fibrous roots as practicable, and shall come from soil which will form a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, transported, and handled in such a manner that the soil in the ball will not be loosened to cause stripping of the small and fine feeding roots, or cause the soil to drop away from such roots.
5. **Planting soil mix** - Mix shall be 5 parts top-soil by volume thoroughly mixed per 823.01. Thoroughly composted and processed leaf mold organic matter may be added, if available, and approved by the Engineer.
6. **Stakes** - 822.12(D). Malleable iron, arrow-shaped anchors, or oak stakes, as approved by the Engineer, may be used. Arbor tie must be attached to the top of stakes that have been driven into the ground and will provide protection for the tree.
7. **Antidesiccant** - Antidesiccant, for retarding excessive loss of plant moisture and inhibiting wilt, shall be an approved emulsion which will provide a film over plant surfaces permeable enough to permit transpiration. Antidesiccant shall be used only after approval.
8. **Double ground, shredded hardwood, mulch** - Mulch shall be premium medium grade and free of matter injurious to plant growth.
9. **Micropore fertilizer release packets** - Micropore fertilizer release packets shall be used during the planting in accordance with packet manufacturer's instructions, or as specified. Each packet shall be sealed in a polyethylene laminated envelope and shall contain a minimum soluble fertilizer analysis of 16 percent nitrogen, 8 percent phosphorus and 16 percent potash. Packets shall be 4 ounces, eight (8) year release packages as approved by the Engineer.
10. **Herbicides** - Herbicide shall be approved for type and rate of application stated on the product's label.

## C. CONSTRUCTION REQUIREMENTS

1. **Planting seasons** - Unless otherwise directed in writing, planting shall be done during the following seasons:

Deciduous Plants – October 15 to May 1

Evergreen Plants – March 15 to May 1 and September 15 to December 1

Planting and plant establishment periods for Spring Planting Season and Fall Planting Season are as shown in the Standard Drawings.

No planting shall be done in frozen or snow covered ground or when the soil is in an unsatisfactory condition for planting.

2. **Delivery and inspection** - The Contractor shall notify the Engineer not less than five (5) days in advance of plant delivery. All plants shall be available for inspection before being dug. The Contractor shall furnish the Engineer complete information concerning plant source of supply. At the option of the Engineer, a certified Arborist will accompany the Inspector.

Only trees approved by the Urban Forestry Administration shall be selected.

All trees and a representative sample of shrubs shall be sealed. Transportation for inspection and sealing shall be furnished by the Contractor as part of Work. All plants shall comply with state and federal laws controlling inspection for plant diseases and insect infestations, and the Contractor shall deliver to the Engineer all required inspection certificates. All shipments shall include a plant list giving detailed descriptions of the plants and the date of shipment.

3. **Substitutions** - When specified plants are not available at time of planting, the Contractor shall submit written evidence from at least 3 competent sources that specified plants are unavailable. If substitution is approved, plant items in the Contract which are similar in size and type and which will perform the intended function shall be used at the respective Contract Price. If existing plant items are not appropriate and if the Engineer and Contractor can mutually agree on a suitable substitution at the same Contract unit price or less, the substitution will be approved.

4. **Protection and temporary storage** - The Contractor shall keep all plants moist and protected from drying out. Protection shall include the time when plants are in transit tarped, in temporary storage or on the Project awaiting planting. Plants will be inspected by the Engineer at the Project Site and approved prior to planting.

Plants failing to meet Specifications, showing signs of improper handling or arriving with broken seals, broken or loose balls, inadequate protection for tops or roots, shriveled, dry or with damaged roots will be rejected. Rejected plants shall be immediately removed from the Site and replaced.

Care shall be taken in handling plants to prevent injury to branches/canopy or roots. The solidity of balled and burlapped plants shall be carefully preserved.

Plants delivered but not scheduled for immediate planting shall be protected as follows:

Bare root plants shall be separated, roots properly spread and puddled in with moist topsoil into a heeling-in trench.

Balled and burlapped (B&B) plants shall have the Earth balls covered with sawdust, wood chips or other suitable material and kept in a moist condition by watering daily.

5. **Layout** - Plant locations and beds shall be staked on the Project Site by the Contractor. Stakes shall be provided by the Contractor, driven at least 6 inches into the ground and shall remain until all Work in the area is complete. The Engineer may adjust plant locations to meet field conditions.
6. **Plant pit and bed excavation** - Prior to excavating for plant pits and beds, locations shall be approved. Each plant shall be placed in an individual pit unless otherwise shown on the Plans.

Where trees are indicated tree pit shall be excavated to a minimum of 2 feet up to a maximum of 3 feet in depth unless otherwise indicated on construction Plans and backfilled with planting soil mix.

Plant beds on slopes 3 to 1 and flatter shall be prepared by removing all soil, weeds, roots, and other objectionable material unsuitable for backfill.

The bed shall then be cultivated by rototilling, hand digging, back hoeing, or picking to a depth of 12 inches for ground covers, or to the proper depth for shrubs, as shown on the Plans.

Ground cover planting holes shall be dug through the mulch with 1 of the following; hand trowel, shovel, bulb planter or hoe. Before planting, non-biodegradable pots shall be removed. Root systems of all potted plants shall be split or crumbled.

The ground cover (either potted or bare root) shall be planted so that the roots are surrounded by soil below the mulch. Potted plants shall be set so that the top of the pot is even with the existing grade. Bare root plants shall be covered up to the crown of the plant or the soil level.

On slopes steeper than 3 to 1, plants shall be planted in individual pits within the bed area. Existing grass or other soil stabilizing growth between pits shall be cut to a height of 2 inches and the entire bed area mulched to a depth of 3 inches.

Pits shall be excavated to sizes shown on Plans with vertical sides and horizontal bottom surfaces. Excavated material shall be removed from the Site.

Where trees are to be installed contiguous to underground utility lines, the Contractor shall have a representative from each applicable utility company stakeout in the field the exact location of the utility conduits and appurtenances before the pits are dug.

The Contractor shall not excavate any closer than 8 inches to the back face of curbs. Excess PCC foundation for PCC or stone curb or PCC sidewalk which protrudes into planting pit shall be carefully chipped and removed by the Contractor to allow proper placement of tree ball. No additional compensation will be allowed.

Plant pits directed to be abandoned after excavation is started, due to unsuitable conditions, shall be backfilled with borrow embankment fill and compacted to Specifications of AASHTO T 180, Method D, in 6 inch layers to subgrade.

The area shall then be seeded or sodded as directed. Payment for this fill and seed or sod will be made under respective Pay Items.

- 7. Setting plants** - All plants shall be set plumb. The tree and shrub pits shall be at the existing grade. The top of ball shall not be covered with soil and the root flare shall be visible. Facing and/or orientation of plants shall be as directed.

Plant pits shall be promptly backfilled and tamped. Under no condition shall any pit remain open at night unless it is properly barricaded.

Planting of trees and shrubs may be done with approved mechanical equipment. When this method is used the planting pit must be twice the size and of the same shape as the Earth ball on the plant to be moved; planting soil mix backfill will be required. The depth of the hole must be equal to the depth of the root ball.

Balled and burlapped (B&B) plants shall be carefully placed in the prepared pits so as to rest in a firm, upright position. Plants shall be handled and moved only by the ball. Planting soil mix shall then be filled in around the plant ball to half the depth of the ball, then tamped and thoroughly watered. The burlap and wire basket shall then be cut away and removed from the upper half of the ball, after which the remainder of the planting soil mix shall be placed. Earth saucers or water basins shall then be provided and the plant thoroughly watered.

Container grown stock shall be removed from the container before planting. Seedling pines shall be planted in 6 by 6 by 8 inches deep pits.

Plant beds shall be neatly edged. Plant beds on slopes steeper than 3 to 1 shall be constructed with a 3 inch shoulder around the lower edge.

Groundcover plants may be planted after the mulch has been placed.

- 8. Fertilizing** - During the next planting season following spring or fall planting, all plants shall be fertilized once at the rate specified by the manufacturer for the size of plant.
- 9. Watering** - All plants shall be thoroughly watered during and immediately after planting and at weekly intervals during the plant establishment period of one (1) year, as needed. Water shall not contain elements toxic to plant life. At each watering the soil around the plants shall be thoroughly saturated through the use of a slow release or drip device.
- 10. Staking** - Staking must be installed with cloth webbing strap material (Arbor Tie) attached to the stakes.
- 11. Pruning** - Pruning shall be done before or immediately after planting to remove damaged or broken branches. All pruning shall be done by experienced personnel with properly conditioned equipment and in keeping with accepted horticultural practice. Trees with pruned terminal leaders will be rejected.

- 12. Mulching** - Mulch shall be placed over all pit and saucer areas of individual trees, shrubs and over the entire area of plant beds to 2 to 3 inch depth within three (3) days after planting. Mulch shall not touch the bark of the tree.
- 13. Restoration and clean-up** - Excess and waste material shall be removed daily. When planting in an area has been completed, the area shall be thoroughly cleaned up. Where existing grass areas have been damaged or scarred during planting operations, the Contractor shall restore disturbed areas to their original condition as directed as part of Work. The Contractor shall clean up all debris and leave the Project in an acceptable condition.
- 14. Guarantee period & replacements** - The acceptability of plants furnished and planted will be determined at the end of a two (2) year guarantee period during which the Contractor shall employ all practicable means to preserve the plants in a healthy growing condition with a focus on the weekly watering during the first year. Care during this period shall include watering, cultivating, pruning, repair, and adjustment of stakes, and other standard proper care as directed. Plants, saucers, and beds shall be kept weed free. Remulch as necessary to maintain mulch depth as shown. The Contractor shall be responsible for removal of stakes and Arbor Ties at the end of the two (2) year guarantee period.

Dead and unsatisfactory plants as directed shall be promptly removed from the Project. An inspection by the Contractor and the Engineer will be held 30 days before the start of the planting season to determine plant acceptability and number of replacements. During the next planting season following completion of actual spring or fall planting, all dead and unsatisfactory plants shall be replaced in kind and size with live healthy plants installed per Specifications at the Contractor's expense.

Alternate or substituted varieties of plants shall be used only if approved. A final inspection of all plants will be held after the replacement planting has been completed.

If the Contractor fails within 10 days to satisfactorily care for and replace plants as needed or ordered, the District may proceed with labor, equipment, and material to perform the Work, with the cost of such Work charged to the Contractor.

The Contractor shall be responsible for securing plantings against theft, damage or vandalism during construction. After completion of construction the Contractor shall not be responsible for theft, damage or vandalism.

- D. MEASURE AND PAYMENT** - The unit of measure for plants will be per each. Payment for plantings will be made at the Contract unit price per each, which payment will include furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

On the planting construction Completion Date, the Contractor may receive up to 85 percent of plant Pay Item Contract Prices for accepted plants. The balance will be paid prorated as required Work is performed during the plant establishment period. Final payment will be made at the end of the Contract and upon removal of stakes and Arbor Ties.

### 608.03 TRANSPLANTS AND TRANSPLANTING

- A. DESCRIPTION** - Work includes:

1. **Digging up and heeling** - in plantings in the areas specified.
2. **Replanting these plants** - This Work shall be performed by a qualified Landscape Contractor who shall be approved by the Engineer prior to start of Work under this item.

All Work done under this item shall be inspected by the Engineer, and shall conform to the ISA Best Management Practice TREE PLANTING volume and ANSI A300 Part 6.

Upon request from the Engineer, the Contractor shall furnish the unit prices for transplantings from which he arrived at Contract lump sum price. These unit prices will be used in case of adds or deducts.

- B. MATERIALS** - Transplanting materials shall meet the following requirements:

- 823.01: Topsoil
- 608.02(B)(5): Planting Soil Mix

- 823.02(C): Stable Manure
- 822.12(D): Stakes
- 608.02(B)(7): Antidesiccant
- 608.02(B)(8): Double Ground Shredded Hardwood Mulch
- Webbing strap material (Arbor Tie or equivalent) – as per Contract Documents
- Tree Trunk Protector (Arbor Guard)
- Topsoil Water-Saving additive (Terra Sorb)

### C. CONSTRUCTION REQUIREMENTS

1. **Transplant preparation** - Care shall be exercised in preparing plants for movement to assure that they are dug with skill and moved to their new locations in good condition. Transplanting shall be sprayed with a wilt preventive antidesiccant spray material before digging.

Transplanting shall be dug, balled, burlapped, and plat-formed if directed. Size of ball shall be at least 1/4 larger than that specified for that size planting in the A.A.N. Standards for Nursery Stock. Work shall be performed in accordance with the ISA Best Management Practice TREE PLANTING volume and ANSI A300 Part 6.

Transplantings shall be moved to a temporary location to be designated by the Engineer where the plant material shall be heeled-in. Plants shall be heeled-in in moist soil or peat moss.

The Contractor shall provide all necessary care for plant material while they are heeled-in including watering.

Upon completion of construction, the plants shall be installed in locations as shown on Plans or as directed by the Engineer.

2. **Excavation** - All pits shall be excavated to sizes detailed, but never less than twice the diameter of the rootball, with vertical sides and horizontal bottom surfaces.

Where trees are indicated tree pit shall be excavated to a minimum of 2 feet up to a maximum of 3 feet in depth unless otherwise indicated on construction Plans and backfilled with planting soil mix.

Where trees are to be installed contiguous to underground utility lines, the Contractor shall have a representative from each applicable utility company stake-out in the field the exact location of the utility conduits and appurtenances before tree pits are dug.

The Contractor shall not excavate any closer than 8 inches to the backface of curbs. Excess PCC foundation for PCC or stone curb, or PCC sidewalk which protrudes into planting pit shall be carefully chipped and removed by the Contractor to allow proper placement of tree ball. No additional compensation will be allowed.

Excavated material shall be removed from planting areas. All backfilling for the plants and the forming of plant saucers shall be done with planting soil mix only.

Plant pits shall be backfilled immediately with planting soil mix including water saving hydrogel (terra sorb or equivalent) specified herein. Ingredients shall be delivered separately to approve mixing site and mixed completely before backfilling. Under no circumstances shall any plant pit remain open overnight unless it is properly barricaded. Backfill shall be firmly tamped throughout the entire pit area so that excessive settling will not occur.

Any damage to existing grass areas shall be acceptably repaired, as required by the Engineer, and at no expense to the District.

3. **Planting** - Planting will not be permitted when ground is frozen or excessively wet, as determined by the Urban Forestry Administration.

All seals and tags shall be removed before final inspection.

All trees and shrub pits shall be deep enough to allow 1/8 of the ball to be above the existing grade. Top of the ball shall not be covered with soil. Root flare must be evident just above ground level.



Bare root plants obtained from collected areas shall be set at such a level so that after settlement the depth will be the same as it was in the field or native stands.

All plants shall be centered in the planting area and set vertically and the soil mix shall then be filled in around the plant balls to half the depth of the balls and tamped. The remaining burlap and wire rootball basket around the top half of the plant balls shall be cut away and removed. The remainder of the pit shall then be filled with the soil mix tamped and watered, all within the same planting day. Roots of bare root plants shall be properly spread out and the soil mix carefully worked in around them. Soil mix shall be thoroughly tamped into place and watered, all within the same day of planting. Plants shall be removed from pots before planting.

Care shall be taken during backfilling, tamping, and watering to avoid damage to roots and to prohibit air pockets. Any root bruised or broken before or during planting shall be pruned immediately to sound tissue with a clean cut.

Watering shall mean full and thorough saturation of all backfill in the pits on the day the plants are planted. Water shall be applied only by open end hose at very low pressure. In no case shall hoses from tank trucks be laid across ramps, roadways, or other pavements.

Upon completion of planting, outline of plant beds shall be neatly edged. A 3 inch shoulder of planting soil mix or excavated top soil shall be placed at the lower edge of plant beds on slopes. Individual plant pits shall be furnished with a shoulder of soil placed outside of rim of the pits to form a saucer over the entire area of the pits. In shrub beds, the soil shoulder around individual shrubs or trees shall consist of plant soil mix as detailed on Plans.

4. **Mulching** - All plant areas and pits shall be mulched. Mulch shall be spread to the thickness specified on the Plans over the entire area of the pits and plant areas. Mulch shall be raked to an even surface to within 3 to 4 inches of the tree trunk. All mulch shall be applied within four (4) days after planting.
5. **Staking** - All stakes shall be installed within 24 hours of the day the trees are planted. Stakes shall be neat and secure with webbing strap material (Arbor Tie or equivalent).
6. **Webbing strap material (Arbor Tie or equivalent)** - Webbing strap material (Arbor Tie or equivalent) shall be attached to the top of two 5 foot oak stakes which are placed in a configuration parallel to the Roadway 2 feet away from the tree, and attached to the tree in such a manner as to prohibit girdling.
7. **Pruning** - Broken or badly bruised branches shall be removed with a clean cut.

Pruning shall be done by skilled technicians in accordance with ISA Best Management Practice PRUNING and ANSI A300. Pruning of terminal leaders will not be permitted.

8. **Cleanup** - During the course of planting, excess and waste materials shall be removed daily. Areas shall be kept clean and all reasonable precautions taken to avoid damage to existing structures, plants, and grasses. When planting in an area has been completed, the area shall be thoroughly cleaned up. Existing grass areas which have been injured by the Work shall be re-graded and seeded according to 607.01, and the entire areas when completed shall be neat and clean.

The Contractor will not be responsible for the plants once they have been transplanted and the Engineer records them as acceptable.

The Contractor will be liable at his expense for replacement of any transplants which die or become unsatisfactory due to the Contractor's negligence.

- D. **MEASURE AND PAYMENT** - The unit of measure for Transplants and Transplanting will be lump sum. Payment will be made at the Contract lump sum price, which payment will include furnishing all labor, tools, equipment, materials, and incidentals needed to complete the Work.

#### 608.04 PRUNING TREES

- A. **GENERAL** - Work under these items includes pruning of trees in the Project area as specified in the Contract Documents or as directed by the Engineer and designated representatives of the Urban Forestry Administration to facilitate performance of construction activities.

- B. CONSTRUCTION METHODS** - Pruning shall be done by a certified Arborist or Professional Horticulturist in accordance with ISA Best Management Practice PRUNING and ANSI A300. Prior to performing any Work, the Contractor shall submit the qualifications of the workers or Subcontractors to the Engineer for approval. Included shall be descriptions of similar work sufficient to satisfy the Engineer and the Urban Forestry Administration that the workers possess sufficient experience to properly perform the Work.

The selection of trees and subsequent pruning shall be directed by the Engineer in coordination with an arborist of the Urban Forestry Administration. The trees shall be pruned using hand pruners, lopping shears, pruning saws or chain saws. Each designated tree shall be pruned with due regard for the natural form and growth characteristics of the species. Pruning shall be kept to a minimum with only that amount removed to allow the specified Work to be accomplished.

Trees shall be pruned with a clean cut. The main leader shall not be cut. If side branches are cut to balance the tree, all cuts shall be made outside the branch collar to encourage the healing callus to develop. All accumulated plant material shall be removed daily from the Project and disposed properly.

Pruning of American Elm trees shall be limited to that period when the trees are fully dormant, to limit the spread of Dutch Elm Disease.

- C. MEASURE AND PAYMENT** - The unit of measure will be per each designated tree pruned. Payment for these items will be made at the Contract unit price per each, payment will include careful pruning of the tree and proper disposal of removal plant material, all labor, tools, equipment, materials, and incidentals required to satisfactorily complete the specified Work.

#### 608.05 TREE BOX DRAINAGE-AERATION

- A. DESCRIPTION** - Work includes the preparation for an installation of various components for drainage and aeration for tree boxes as described herein and as detailed on the Plans.

- B. MATERIALS** - Materials shall meet the following requirements:

- 803.02: Gravel for Grading No. 57 or 67
- 805.02: Sand (if used for filter or for placement under plants)

1. Filter Screen shall be fiberglass mat of long, strong textile-type glass fibers, bound together with permanent thermosetting resin, and shall meet the requirements of MIL 1 22033, Type 1, Class 2, and shall be 1/4 inch to 1/2 inch maximum thickness. Consistency of the mat shall be such as to prevent soil from passing through but allow the free flow of water.
2. Perforated Fiber Pipe shall meet the requirements of AASHTO M 177 and shall be 4 inches in diameter and a minimum of 2-1/2 feet in length.

- C. CONSTRUCTION METHODS** - Vertical sump holes in the bottom of the tree pits shall be made with a post hole digger or power auger. These shall be 8 inches in diameter and 3 feet in depth. Sump holes and the bottom 8 inches of the tree pit shall be backfilled with gravel, then level. The fiberglass filter screen shall be placed on top of, and completely cover the gravel. During placement of backfill around plants in tree pit, perforated fiber pipe shall be positioned vertically at proper locations, Elevation, and filled with gravel.

- D. MEASURE AND PAYMENT** - The unit of measure for Tree Box Drainage-Aeration will be per each. Payment will be made at the Contract unit price per each; payment will include furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

#### 608.06 ORNAMENTAL IRON TREE FENCE

- A. DESCRIPTION** - This Work consists of furnishing and installing 18 inch high ornamental iron tree fences with top row of rings as indicated in the Contract Documents or as directed by the Engineer. The ornamental iron fence shall meet or exceed the following Specifications: ASTM A 787, ASTM A 653, ASTM A 607

**B. MATERIALS** - Materials shall meet the following requirements:

- Posts – above grade: 1 inch x 1 inch x 1/8 inch tubing, 18 inches in length
- Posts – below grade: 3/4 inch solid steel bars, 18 inches in length
- Top rail embellishment: 1 inch x 1/8 inch flat steel channel
- Top rail: 2 inches molded steel bars
- Mid rail: 1 inch x 1/2 inch x 1/8 inch steel channel punched to accept pickets
- Bottom rail: 1 inch x 1/2 inch x 1/8 inch steel channel punched to accept pickets
- Pickets: 1/2 inch x 1/2 inch solid steel bars
- O-Rings: 4-1/2 inches tubing

Finish: All materials are welded and primed with 1 coat of Red Oxide primer and 1 coat of Black Satin paint (Sumter Coating) mixed with primer.

**C. CONSTRUCTION REQUIREMENTS** - Fence shall be 3 sided unless otherwise specified, open side facing the curb:

- Top-to-mid rail spacing – 5.75 inches o.c.
- Mid-to-bottom rail spacing – 8 inches o.c.
- Bottom rail shall sit approx. 3 inches above grade surface
- Post-to-picket spacing – 5.25 inches o.c.
- Picket-to-picket spacing – 5 inches o.c.

Space O-ring tubing according to picket and post locations; all O-rings shall be welded to adjacent pickets, posts, and rails.

Weld 1 inch x 1 inch x 0.125 inch post tubing at ends and corners and weld an additional post along the length at mid-point. If tree box length exceeds 12 feet, posts should be welded every 4 feet along length.

To provide below grade support in concrete, weld 3/4 inch solid steel bars to all 1 inch x 1 inch x 0.125 inch post tubing.

To deter seating, weld 1 inch x 0.125 inch flat steel channel to 2 inch top rail.

For existing tree boxes: Openings must be measured prior to fabrication to ensure that fences will fit just inside the boxes. The side panels must be fabricated with a minimum setback of 6 inches, and 10 inches from back edge of existing standard curb, and narrow curb respectively, to allow sufficient room for car doors to swing.

For new tree boxes installations: Fence dimensions shall be standardized based on length and width of proposed openings (e.g. 4 feet x 9 feet, 6 feet x 10 feet, etc.), however, the setback for the side panels shall remain consistent at 6 inches and 10 inches from back edge of existing standard curb and narrow curb respectively, to allow sufficient room for car doors to swing.

Use Sonotube forms as per manufacturer's Specifications to set concrete for footings.

Concrete footings shall be approximately 10 inches wide x 24 inches deep. Concreting shall be performed in accordance with the manufacturer's Specifications.

## Requirements:

- Strength: 3,000 psi with a slump of 3 inches
- Air entrainment: 5 percent to 8 percent
- Aggregate size: 3/4 inch max.
- Mortar compressive strength at 28 days: 4,500 psi
- Meets ASTM C 150, Type 1
- Finished concrete shall be 2 inches below existing grade and pitched to direct water away from posts.

Ornamental Iron Tree fence units as detailed in the Contract Documents shall be completely fabricated in the shop. All materials are welded and primed with 1 coat of Red Oxide primer and 1 coat of Black Satin paint (Sumter Coating) mixed with primer. All surfaces shall be dry before shipment. The fencing shall be installed in the field around trees as directed by the Engineer.

- D. MEASURE AND PAYMENT** - The unit of measure for Ornamental Iron Tree Fence will be per each. Payment will be made at the Contract unit price per each, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

### 608.07 TREE PROTECTION AND REPLACEMENT

- A. DESCRIPTION** - Work under this item includes providing protection for existing trees within the Project limits during construction operations. Work shall include protection by fencing of all trees within the Project boundaries as indicated on the Contract Documents.

The Contractor is liable for replacement and repair of trees or compensation for trees damaged or killed through neglect or failure to apply tree protection during construction operations.

Failure of the Contractor to implement tree conservation measures or tree replacement, as directed by the Engineer, will result in compensation or Liquidated Damages to the District according to the schedule of payment contained herein. Any replacement determined to be required by the Engineer must be performed within two (2) weeks of notification, unless outside of the planting season, in which case replacement must occur within the first two (2) weeks of the planting season.

- B. METHODS AND MATERIALS** - Protection from damage caused by the Contractor's equipment or carelessness shall consist of the following methods and measures:

All trees to be preserved shall be protected against damage during construction operations by fencing. The tree protection fencing shall be placed before any excavation or grading has commenced. Details of the minimum acceptable tree protection are shown in the Contract Documents.

No equipment, trailers or materials may be placed within the drip line of existing trees to be retained within the Project limits with the exception of paved areas or areas to be paved.

Any damage done to existing tree crowns or root systems shall be repaired immediately by the Contractor under the direction of an arborist from the District's Urban Forestry Administration.

If any trees not designated to be removed, are severely injured, or killed by the Contractor's operations for any reason, they shall be replaced in kind by the Contractor at no additional cost to the District, or by payment in Liquidated Damages according to the following schedule:

- \$200 per inch of Diameter
- The diameter of the tree trunk shall be measured breast high (4 to 5 feet) above the ground. Replacement shall be done on a DBH inch per DBH inch basis (1 DBH inch of replacement trees per DBH inch of damaged trees). Trees replaced in kind shall be planted in accordance with 608.02. The Engineer shall be solely responsible for determining whether or not a given injury is sufficient to warrant repair, replacement or monetary compensation by the Contractor.

Materials shall meet the following requirements:

- Tree Protection Fencing: Tree protection fencing shall consist of 6 foot tall chain link fence materials. Fencing shall protect an area no smaller than 9 foot x 4 foot.

- C. MEASURE AND PAYMENT** - The unit of measure will be each. No direct measure will be taken. Payment for Tree Protection and Replacement will be made at the Contract unit price per each for tree protection, which payment will include all labor, tools, materials, equipment, and incidentals needed to complete the required Work.

No payment will be made for repair and replacement in kind for trees damaged or killed due to the Contractor's operations. This Work will be performed at the sole expense of the Contractor.

**608.08 TREE ROOT PROTECTION**

- A. DESCRIPTION** - This Work includes precautions to be taken while performing utility trenching, roadway work, sidewalk, and curb installation. Work also includes furnishing and placement of prepared planting soil mix and fertilizer (Fertilizer is not needed unless an element is deficient) backfill around exposed and disturbed roots, and the disposal of excess materials, branches and debris.
- B. CONSTRUCTION METHODS** - Construction operations adjacent to existing trees shall be performed in accordance with 608.07(B) to prevent trunk, crown, and root damage. Tree roots shall not be cut unless specifically authorized by the Department of Transportation's Urban Forestry Administration. If authorized, pruning shall be performed under their supervision in accordance with 107.12 and 608.04(B), or by a certified arborist meeting their approval. When authorized by the Engineer, the Contractor may cut minor roots (less than 2 inches in diameter) with his own forces. When trenching or when old curb, gutter, or sidewalk is removed, damp burlap shall be placed over exposed roots and kept damp at all times until the new work is placed. Trench excavation shall follow 207.03 to avoid root damage to roots larger than 2 inches in diameter. Exposed or cut roots shall be backfilled with prepared fertilizer-enriched planting soil mix to encourage root growth. (Fertilizer is not needed unless an element is shown to be deficient.)

In all operations involving utility trenching, the Work shall be performed as per 207.03. Whenever possible, root cutting shall be avoided; no part of the root ball shall be trenched. Utility trenching shall not be allowed if tree roots are within the trench area determined as the drip-line of the tree. These excavations shall be augured or tunneled, as necessary, to prevent root cutting.

In curb installations, it is recommended that curbing be bridged across the length of the Tree Space, without a dry mix backing block, in order to avoid any trenching excavation in the vicinity of the roots. The length of curbing placed adjacent to the length of the Tree Space shall then be dowelled or pinned to the standard curb construction outside the Tree Space.

Trees located adjacent to construction work shall be watered at ten (10) day intervals throughout the growing season. The Contractor shall supply watering bags of same type that are sold in the industry and fill them according to the manufacturer's Specifications or at a minimum keeping the bag full during the growing season. No equipment, trailers, or material shall be placed within 20 feet or within the drip lines of any tree to be saved, whichever is greater.

Any damage done to existing tree trunks, crowns, or root systems shall be repaired immediately by the Contractor, at his expense, under the direction of an arborist from the Department of Transportation's Urban Forestry Administration.

Protect root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

Do not store construction materials, debris, or excavated material inside tree protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems.

Maintain tree protection zones free of weeds and trash.

Install Mycorrhizal Fungal Inoculation inside the tree protection zone as required by the manufacturer.

Where re-grading is required, the following shall apply:

**Minor Fill:** Where existing grade is 6 inches or less below elevation of finish grade, fill with material as shown in the Contract Drawings. Place material in a single uncompacted layer and hand grade to required finish elevations.

**Moderate Fill:** Where existing grade is more than 6 inches (150 mm) but less than 12 inches (300 mm) below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:

Carefully place drainage fill against tree trunk approximately 2 inches (50 mm) above elevation of finish grade and extend not less than 18 inches (450 mm) from tree trunk on all sides. For balance of area within drip line perimeter, place drainage fill up to 6 inches (150 mm) below elevation of grade.

Place filter fabric with edges overlapping 6 inches (150 mm) minimum. Place fill layer of material to finish grade. Do not compact drainage fill.

Hand grade to required elevations.

- C. MEASURE AND PAYMENT** - No measure will be taken for this Work. No direct payment will be made. This Work is considered incidental to the Work being performed, the cost of which shall be considered when preparing bids for Work in these areas.

## **609 PERMANENT BENCH MARK**

### **609.01 DESCRIPTION**

The Contractor shall furnish and install a permanent bench mark to conform with details and at the location shown in the Contract Documents or as directed by the Engineer.

### **609.02 MATERIALS**

Materials shall meet the following requirements:

- 817: Concrete
- 811.06: Galvanizing
- 815: Malleable Iron

### **609.03 CONSTRUCTION REQUIREMENTS**

The galvanized pipe casing shall be driven vertically and straight and to the depth as shown on the Contract Documents. The metal frame and cover shall be a standard meter box cover with a hinged locking lid, or an approved substitute. The Contractor shall furnish the Engineer with a suitable wrench for access to the bench mark proper.

### **609.04 MEASURE AND PAYMENT**

The unit of measure for Permanent Bench Mark will be each. The actual numbers of Permanent Bench Marks complete in place and accepted will be paid for at the Contract unit price per each, payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

## 610 TRAFFIC BARRIERS

### 610.01 PCC MEDIAN AND ROADSIDE BARRIERS

- A. DESCRIPTION** - Work consists of the construction of PCC traffic barriers in accordance with these Specifications at locations indicated in the Contract Documents and/or established by the Engineer. The types of barrier will be stipulated in the Contract Documents. The PCC Median and Curb Barriers may be precast, cast-in-place, or slip-form. The construction of various types of barrier shall include the assembly and erection of all component parts and furnishing all materials complete in place.

Necessary transition of the PCC Median and Curb Barriers to sections different from the standard uniform section such as at bridge piers, sign pedestals, bridge end walls, or guardrail terminal sections, shall be accomplished in a smooth and uniform manner as shown in the Standard Drawings or in the Contract Documents.

- B. MATERIALS** – Materials shall meet the following requirements:

- 817: Concrete, Class B
- 812.02: Reinforcement
- 812.03: Epoxy Coated Reinforcement Bars
- 807.01: Preformed Joint Filler
- 815.01: Anchor Bolts, Rods, Sleeves, Dowels, etc.
- 807.06: Compression Seals
- 806.05(C): Epoxy Grout
- 807.02(B): Mastic Joint Sealer
- 822.13(B): Barrier Delineators

**C. CONSTRUCTION REQUIREMENTS**

- 1. Cast-in-place barriers** - When casting in place, the forming may be either the conventional fixed form or slip-form method.

Cast-in-place concrete barriers shall be in accordance with the following:

- a. Fixed form method** - Forms shall be steel and of such construction that there shall be minimum interference to inspection for grade and alignment. The condition and the stability of the forms shall be such that they will produce a barrier that shall meet the required tolerance of deviations not exceeding 1/4 inch in ten (10) feet in either grade or alignment. Before concrete is placed against the forms, they shall be thoroughly cleaned and coated with form release compound each time they are used.

Concrete shall be mixed in accordance with 501.09 and placed in accordance with 703.08. Concrete shall be vibrated by means of an approved immersion type mechanical vibrator.

Construction or contraction joints shall be constructed every 20 feet except that joints shall match the joints in the Roadways, footers, and walls where barrier is anchored to the Roadway slab or abuts a wall. However, sections of a minimum of 10 feet in length may be constructed if necessary to make use of delivered concrete. Expansion joints shall be placed at the same location as that of the Roadway or as directed by the Engineer.

Concrete shall be finished in accordance with 703.20. The top of barrier, when finished, shall show no deviation from grade and alignment in excess of 1/4 inch in 10 feet.

The minimum time required before removal of forms will depend on the temperature at the time of pour and shall be as follows:

**TABLE 610.01 TIME TO REMOVE FORMS**

Temperature	Hours
Greater than 50°F (10°C)	12
Between 35°F (2°C) and 50°F (10°C)	24
Less than 35°F (2°C)	72

All honeycombed and damaged areas shall be repaired to the satisfaction of the Engineer immediately after the removal of the forms.

- b. *Slip-form method* - Slip-form equipment shall be approved by the Engineer and include the incorporation of automatic guidance controls to follow line and grade reference. The use of manual control on slip-form equipment is not permitted. Line and grade reference shall consist of taut lines or wire suspended from supports set in the Subgrade or adjacent pavement. The references shall be 25 feet intervals on uniform grades and tangent sections. On vertical and horizontal curves, an additional intermediate support shall be set in the field to establish a reference line acceptable to the Engineer. The use of ski or shoe sensors reflecting variations in grade of existing Roadway surface will not be permitted.

Concrete shall be mixed in accordance with 501.09. The concrete shall be of such consistency that after extrusion it will maintain the shape of the barrier without support. The surface shall be free of surface pits larger than 3/16 inch in diameter. The concrete shall require no further finishing other than light brushing with water only. Finishing with a brush application of grout will not be permitted.

Whenever a tear occurs during the operation of the slip-form equipment, it shall be repaired immediately. The repair shall be made in accordance with good concrete practices that are acceptable to the Engineer. It will be at the sole discretion of the Engineer as to whether the tear can be repaired or whether the areas will require removal and replacement.

Contraction joints shall be sawed or formed at 20 feet intervals in the barrier and footing. Each joint shall be a minimum of 2 inches in depth and 1/8 inch in width. Expansion joints will be required at the same location as that of the Roadway and/or as directed by the Engineer. However, sections of 10 feet length may be constructed if necessary to make use of delivered concrete. At the terminus of any pour less than 20 feet a bulkhead form shall be placed; and 6 No. 8 dowels, 2 feet long, shall be placed through the bulkhead. No joint material is required.

The concrete footing may be constructed by the fixed form or the slip-form method. The construction of the footing and the barrier section as a monolithic pour shall not be permitted.

2. **Precast concrete barriers** - Precast concrete barriers will not be permitted on curves of short radius. They shall be cast in sections having a uniform length of 10 to 12 feet.

The concrete shall be placed, cured and protected in accordance with 703.08 and 703.19. Lifting holes, rings, hooks, or other handling devices, as approved by the Engineer, may be inserted in the precast sections. Holes exposed to completed Work shall be filled with mortar. Other handling devices shall be removed to the satisfaction of the Engineer.

The supporting concrete base shall be constructed by the conventional fixed form method and shall have joints constructed at 10 feet intervals to coincide with lengths of barriers. The joint shall be constructed by sawing or other methods for the width of the base to a minimum depth of 3 inches. The base section shall be doweled to the barrier section as shown in the Contract Documents.

Precast barriers shall be placed in such a manner that there will generally be a joint opening of 1/4 inch between sections. To this specified joint opening, a tolerance of 1/8 inch plus or minus will be permitted throughout the plane of the joint.

The ends of each section of barrier shall have an interlocking configuration and/or mechanical locking device to resist lateral movements when in final position.

All surfaces shall have an ordinary finish as specified in 703.20.

- D. **MEASURE** - The unit of measure for PCC Median Barrier (Cast-In-Place or Precast) and PCC Roadside Barrier will be the linear foot as measured along the top center line of the barrier complete in place. The unit of measure for PCC Median/Curb Barrier (Variable Section) will be the cubic yard. If installation of Barrier Delineators is specified, they will not be measured for payment.



- E. PAYMENT** - Payment for each type of barrier will be made at the Contract unit price per linear foot or per cubic yard as measured above, which payment shall be full compensation for all equipment, labor, materials, such as reinforcement, joint filler, compression seals, epoxy grout, anchorage, and incidentals necessary to complete the various items of Work.

No payment will be made for barrier delineators. The cost of delineators will be included in the Contract unit price for the barrier.

## 610.02 PORTABLE PRECAST PCC BARRIER

- A. DESCRIPTION** - Work consists of furnishing, installing, and maintaining temporary precast PCC New Jersey or F Shape (safety shape barriers. Work also includes replacing any broken sections, maintaining proper alignment, relocating barriers as shown on the Contract Plans, or as per approved traffic control Plans, during the course of the Project, removal from the Work Site after completion of the Project. Work also includes cleaning the barriers as directed.

Barriers shall be either 32 inches in height and 24 inches in width, or 32 inches in height and 18 inches in width for half size as specified in the Contract Documents. Typical section lengths shall be 12 feet but may be varied to insure portability and proper installation. Portable Precast PCC Barriers shall have built-in connections devices meeting the requirements of NCHRP Report 350, TL3. Where specified on the Contract Plans, barriers shall be anchored to the concrete bridge deck at no additional cost to the District. Half size barrier shall not be installed unless anchored by approved methods. Barriers shall have drainage slots or be placed so as to permit drainage of the Roadway surface.

- B. MATERIALS** – Materials shall meet the following requirements:

- 817, Class B: Concrete
- 812.01 (4 x 4): Welded Wire Fabric
- 822.13(B): Barrier Delineators

- C. POSITIVE PROTECTION BETWEEN WORKERS AND MOTORISTS** - All positive protection shall be used in the following situations:

Long term excavation deeper than 6 inches that will last over 2 weeks that will not be steel plated at the end of each work day.

Speeds greater than 45 mph.

Drop offs or reconstruction that does not use a 1:1 slope.

- D. MEASURE AND PAYMENT** - The unit of measure for Portable Precast PCC Barrier will be the linear foot. The length for measurement will be the actual maximum length along the top centerline complete in place. If installation of Barrier Delineators is specified, they will not be measured for payment.

1. **Install portable PCC barrier** – Payment for the delivery and the initial installation of the Barrier in the work zone for the first phase of construction and removal from the job Site upon completion of the Work will be made at the Contract unit price per linear foot. Payment will include all labor materials, tools, equipment, and incidentals necessary to complete the Work. Barrier stored at the Project Site prior to the construction start will not be measured under the item for Move Portable PCC Barrier.
2. **Move portable PCC barrier** – Payment for Move Portable PCC Barrier will be made at the Contract unit price per linear foot of barrier moved for each phase of construction as specified in the approved Traffic Control Plan or directed by the Engineer. Payment will include all labor, material, tools, equipment, and incidentals necessary to complete the Work.

## 610.03 PLASTIC JERSEY BARRIERS (WATER-FILLED TEMPORARY BARRIER TL- 2, TL- 3 SYSTEMS)

- A. DESCRIPTION** - Work consists of furnishing, installing, maintaining temporary Plastic Jersey Barriers, including replacing any broken sections, maintaining proper alignment and relocating Plastic Jersey Barriers as required during the duration of the Project, according to approved maintenance of traffic and traffic control Plans.

The Water Filled Plastic Jersey Barriers shall be either 42 inches in height and 24 inches in width, and 72 inches long or 32 inches in height and 18 inches in width, and 72 inches long. Typical section lengths shall be 6 feet but may be varied to insure portability and proper installation (5 feet, 5-1/2 feet, and 8 feet).

1. **Water-filled temporary barrier TL-2** - The Water Filled Plastic Jersey Barriers (WATER-FILLED TEMPORARY BARRIER) shall meet the acceptance criteria for an NCHRP Report 350 TL-2 crash cushion. The recommended procedures for the safety performance evaluation of highway features making them effective in containing vehicle failure up to 43 mph for longitudinal re-directive barrier. Easily upgradeable to NCHRP 350 TL-3.
2. **Water-filled temporary barrier TL-3** - The Water Filled Plastic Jersey Barriers (WATER-FILLED TEMPORARY BARRIER) shall meet the acceptance criteria for an NCHRP Report 350 TL-3 crash cushion. The recommended procedures for the safety performance evaluation of highway features making them effective in containing vehicle failure up to 60 mph.

The Temporary Barrier TL-3 modules have the same exterior dimensions as Temporary Barrier TL-2 modules acceptance, but that the interior U-bolts at the ends of each module are double-nutted to the interior steel framework in the TL-3 units. Each module is set on two 178 mm high plastic pedestals to raise its center of gravity in order to meet TL-3 evaluation criteria.

Each barrier section shall include an internal galvanized steel framework to provide additional rigidity during handling and impacts, and shall be equipped with a ½ inch (12.7 mm) diameter galvanized steel cable along a recess in the top of the section, for suitable tensioning capability.

Each pedestal shall be designed so that 2 pedestals will support the weight of 1 barrier section that is full of water ballast. Each pedestal shall be constructed to support a barrier section at a height elevated approximately 7 inches (175 mm) above pavement level.

These pedestals are strapped to each individual unit and are also tethered together (in groups of 10) with a braided polyester cord to reduce debris scatter following an impact. All new modules will be made with the 2 nut connection noted above and that all pedestals shipped to the field separately for use with earlier-manufactured modules will include extra nuts and instructions to modify any existing segments that have only a single nut connection.

**B. MATERIALS** – Materials shall meet the following requirements:

- Polyethylene
- Galvanized steel framework
- Polyester cord
- 822.13(B): Barrier Delineators

**C. MEASURE AND PAYMENT** - The unit of measure for Water Filled Plastic Jersey Barrier will be the linear foot. The length for measurement will be actual maximum length along the top centerline complete in place. If installation of plastic barriers delineators is specified, they will not be measured for payment.

1. **Install Water Filled Plastic Jersey Barrier** - Payment for the delivery and the initial installation of the plastic barriers in the work zone for the first phase of construction and removal from the construction Site upon completion of the Work will be made at the Contract unit price per linear foot, which the payment shall include all labor, materials, tools, equipment, and incidentals necessary to complete the Work. Barrier stored at the Project Site prior to the construction start shall not be measured under item for Move Water Filled Plastic Jersey Barrier.
2. **Move Water Filled Plastic Jersey Barrier** - Payment for Move Water Filled Plastic Jersey Barrier shall be made at the Contract unit price per linear foot of barrier moved for each phase of construction as specified in the approved maintenance of traffic or Traffic Control Plan or directed by Engineer. Payment shall include all labor, material, tools, equipment, and incidentals necessary to complete the Work.

## 611 MEMBRANE WATERPROOFING

### 611.01 DESCRIPTION

Membrane waterproofing shall consist of furnishing all materials, labor, tools, and equipment necessary to apply membrane waterproofing at the locations and to the areas shown in the Contract Documents and/or as specified herein.

### 611.02 MATERIALS

Asphalt materials, including primers and waterproofing membrane, shall not be used with coal tar materials.

### 611.03 CONSTRUCTION REQUIREMENTS

**A. GENERAL** - Membrane waterproofing shall not be applied until all provisions for curing concrete have been complied with and the surfaces have thoroughly dried, reasonably smooth, and are free from projections or holes that might puncture the membrane.

The concrete surfaces shall be cleaned of all loose and foreign materials, concrete fins, dirt, and shall be dry. The Engineer may require the surfaces to be scrubbed with water and a stiff brush, after which the surfaces shall be allowed to become thoroughly dry before application of materials.

Membrane waterproofing shall not be done when the temperature is 40 degrees Fahrenheit or lower, or in damp or wet weather.

The surfaces shall first be painted with a primer, either by spraying or brushing. The amount of the primer coat shall be not less than 300 square feet per gallon. The primer shall be applied so as to give a uniform coating. The primer shall not be heated.

**B. MATERIALS** – Materials shall meet the following requirements:

**TABLE 611.03 MATERIALS AND PROPERTY TEST REQUIREMENTS**

PROPERTY	ASTM TEST	REQUIREMENTS
Tensile-Polymeric Membrane	D 412 (Die C)	590 psi min.
Tensile-Carrier Film	D 412 (Die C)	5900 psi min.
Elongation	D 412 (Die C)	455 % Min.
Pliability	D 146	
Water Absorption	D 1970	0.1% 72 hrs max
Puncture Resistance	E 154	60 lbs
Flexibility at -20 F	D 1970	Pass
Thickness- Polymeric Membrane		56 mils
Thickness—Carrier film		4 mils

Care shall be taken to confine all bituminous materials to the areas to be covered and special care shall be taken to prevent disfigurement of any other parts of the Structure by dripping or spreading of the materials.

At the ends of the membrane and at any points where it is punctuated by such appurtenances as drains or pipes, suitable provisions shall be made to prevent water from getting between the waterproofing and the waterproofed surface.

The Contractor is required to follow the manufacturer recommendations for surface preparations, applications, and safety procedures. Prior to the backfilling operation, the Contractor shall install a protection course of semi rigid panels as recommended by the manufacture of the waterproofing membrane.

### 611.04 MEASURE AND PAYMENT

The unit of measure of Membrane Waterproofing will be the square yard. The actual number of square yards of surface area of the concrete, steel, or masonry which is covered by the membrane waterproofing will be paid for at the Contract unit price per square yard, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

## 612 TRAFFIC CONTROL

### 612.01 PERMANENT TYPE WOODEN BARRICADE

- A. DESCRIPTION** - This Work shall consist of the construction of permanent type wooden barricades at the locations other than temporary traffic control zones as indicated in the Contract Documents and/or as directed by the Engineer, and shall meet the design requirements for Type III barricades in accordance with the MUTCD, latest edition.
- B. MATERIALS** - Materials shall meet the following requirements:
- Posts and rails – 822.12(A)
  - Red and white paints shall be retroreflective.
  - All assembly hardware shall be hot-dipped galvanized steel meeting the requirements of 811.08. The bolts shall be 1/2 inch in diameter steel carriage bolts equipped with a hexagonal nut. The washer shall be 14-gauge steel, 1-1/2 inch in diameter with 3/4 inch hole.
- C. CONSTRUCTION REQUIREMENTS** - Excavation for posts shall be roughly circular and shall be of sufficient diameter to permit thorough tamping of the backfill after post placement. Backfill in all cases shall be made with approved embankment materials and shall be thoroughly compacted by tamping to obtain as rigid an installation as possible.
- After the alignment of the rails is approved by the Engineer, the nuts shall be tightened and the projecting threads of the bolts shall be burred to prevent removal.
- After erection, the rails and posts shall be given 2 coats of paint. The posts shall be painted yellow and the rails shall be painted with alternate diagonal 6 inch stripes of red and white.
- All painting shall be done as outlined in 707 using retroreflective coatings.
- D. MEASURE AND PAYMENT** - The unit of measure for Permanent Type Wooden Barricade will be the linear foot. The actual number of linear feet installed, measured along the face of the top rail will be paid for at the Contract unit price per linear foot, which payment will include excavation, erection, backfilling, painting, all labor, materials, tools, equipment, and incidentals necessary to complete the Work

### 612.02 CONSTRUCTION LANE CLOSING

- A. DESCRIPTION** - Work consists of executing the provisions of the Special Provision for Maintenance of Highway Traffic as illustrated by the approved Traffic Control Plan (TCP). The Work includes preparation of the TCP, as specified in 104.02(B), in accordance with Part VI of the Manual on Uniform Traffic Control Devices (MUTCD) and these Specifications; providing a full time Traffic Safety Officer; providing all additional equipment and personnel, including flaggers when required by the Contract Documents, as necessary to control traffic as specified or as directed by the Engineer.
- B. TRAFFIC PERSONNEL** - The Contractor shall provide all necessary personnel for traffic control. Personnel shall be employed in accordance with requirements of Part VI of the MUTCD and these Specifications. In addition, the following personnel shall be required:
- 1. Traffic Safety Officer** - The Contractor shall provide a competent Traffic Safety Officer. The Traffic Safety Officer shall be thoroughly experienced in and qualified for maintenance of traffic safety control work. Prior to commencing work requiring traffic control management, the Contractor shall certify in writing that the proposed Traffic Safety Officer, and any designated substitute, has been certified by the American Traffic Safety Services Association (ATSSA). The Contractor shall submit a certificate verifying successful completion of the ATSSA course and a summary of the Traffic Safety Officer's field experience in the operation of work zone traffic control.

Training provided by another agency or firm may be approved by the Department. The District Department of Transportation will approve training provided by another agency or firm provided that the following minimum requirements are met:

- Successful completion of a comparable work zone traffic control course, including evidence of passing a written examination on the material presented in the course.

- A minimum of one (1) year of documented field experience in work zone traffic control.

The Traffic Safety Officer or an approved substitute, in case of forced absence, is expected to perform the duties on a regular basis and ensure that all traffic maintenance operations are running smoothly at all times by conducting regular inspections along the length of the Project, particularly during peak hours.

The Traffic Safety Officer's prime duty shall be the responsibility for the Contractor's maintenance of traffic operations. Duties shall include, but not be limited to, the following:

- Understand the requirements of the MUTCD and the Contract provisions.
- Be responsible for assuring compliance of the Contractor's maintenance and protection of traffic relative to the requirements of the Contract provisions, including bicycle and pedestrian elements.
- Be responsible for assuring that all deficiencies are corrected.
- Be responsible for coordinating maintenance of traffic operations with the Engineer.
- Be responsible for assuring that all traffic control devices are placed in their proper location and that damaged traffic control devices are promptly replaced.
- Supervise the installation and removal of all temporary traffic control devices and pavement markings.
- Be responsible for daily inspection of the work zone traffic control devices.

Inspection results shall be recorded in a Traffic Control Device Inspection Log.

The Contractor shall submit the form to be used to the Engineer for approval prior to use.

The Engineer or his designated representative shall inspect the traffic maintenance devices and pavement marking layout on a routine basis. Any deficiencies that are noted will be brought to the Contractor's attention for correction. The Engineer's inspection will not relieve the Contractor of any responsibility for maintaining traffic control items in proper position and condition based on his own inspection.

If any deficiency is not corrected within 24 hours from the documented notice given to the Contractor, a payment deduction will be made from the Contractor's next progress estimate. The deduction will be equal to the daily prorated share of the total price bid for Construction Lane Closing or \$500.00 per day, whichever is greater, for each day or portion thereof that the deficiency exists, and will continue until the deficiency is satisfactorily corrected and accepted by the Engineer. The amount of money deducted will be a permanent deduction from the Contract amount and will not be recoverable.

- 2. Flaggers** - When specified in the Contract Documents or when directed by the Engineer, the Contractor shall provide all necessary flaggers required to properly maintain traffic through the work zone. Flaggers shall have completed flagger training and shall be certified by ATSSA or another agency approved by the District and shall meet the requirements of Chapter 6E of the MUTCD.

- C. MEASURE AND PAYMENT** - No direct measure will be made. The unit of measure will be lump sum. Payment for Construction Lane Closing will be made at the Contract lump sum price, which payment will include preparation and submission of the TCP and provision of a Traffic Safety Officer, flaggers and all additional personnel, and equipment necessary to efficiently and safely execute the Traffic Control Plan as approved.

### 612.03 REMOVAL OF LANE MARKINGS

- A. CONSTRUCTION REQUIREMENTS** - In areas of the Roadway where existing pavement markings conflict with the proposed temporary pavement markings indicated on the approved TCP, the existing markings shall be removed prior to the placement of the temporary markings.

Markings may be ground off or removed by a method acceptable to the Engineer. Black paint or spraying with liquid asphalt shall not be acceptable as a method of removal. The Work, however, shall be carefully performed so as not to damage or scar the Roadway surface. Burning shall not be permitted. Damaged asphalt surfaces shall be repaired at no additional cost to the District. All grind marks on AC pavement shall be painted with emulsified asphalt to reduce the visibility of the line removed. Black non-

reflective tape may be used as directed by the Engineer and will be paid under the item for Black Taped Pavement Markings.

During any detouring or lane changes, inappropriate and conflicting pavement markings shall be properly and promptly obliterated prior to placement of detours or new lanes as specified in the TCP. Marking removal shall be accomplished regardless of time of day or climatic conditions.

Requirements of the MUTCD are applicable.

- B. MEASURE AND PAYMENT** - The unit of measure for Removal of Lane Markings will be the square foot, with measurement made on actual width of marking multiplied by length removed.

Payment will be made at the Contract unit price per square foot, which payment will include removal operations, any asphalt material and rolling required to return the pavement surface to an acceptable condition, removal of all surplus materials, all labor, tools, materials, equipment, and incidentals necessary to complete the Work.

#### 612.04 TEMPORARY CONSTRUCTION SIGN SUPPORTS

- A. DESCRIPTION** - Work consists of furnishing, assembling and maintaining Temporary Construction Sign Supports required for construction warning, and detour signs in or adjacent to the Work area, as specified in the TCP. Work also includes removal of the supports from the job Site when no longer required.

Sign supports may be either fixed or portable. Fixed supports requiring 1 or more posts shall be considered as 1 temporary support. Replacement posts, due to damage or relocation, shall not be counted. For fixed supports, work also includes excavation and/or augering, including backfilling and compaction, to firmly set the posts, and eventual removal and restoration of the Site. Posts shall be set plumb.

Portable supports shall be manufactured sign supports, be stabilized, and ballasted according to the manufacturer's direction.

If barricades are approved for use as sign supports, payment will be made at the Contract unit price for the type of barricade used.

All construction sign supports shall be in accordance with Part VI of the MUTCD.

- B. MEASURE AND PAYMENT** - The unit of measure for Temporary Construction Sign Supports will be each. The total shall be the maximum number required and installed according to the approved TCP for any one phase of construction. Fixed sign supports that remain in place according to the approved TCP for succeeding phases of construction will not be re-measured for payment.

Payment will be made at the Contract Price per each. This payment will include furnishing (including sand bags), assembling, maintaining (including replacement of damaged parts of units at no additional cost to the District), and removing all Temporary Construction Sign Supports required.

#### 612.05 CONSTRUCTION WARNING AND DETOUR SIGNS

- A. DESCRIPTION** - Work consists of furnishing, assembling and maintaining construction warning and detour signs as specified in the Traffic Control Plan (TCP) or as directed by the Engineer. Work also includes the removal of the signs from the job Site when no longer required.

All construction warning and detour signs shall be in accordance with the requirements of Part VI of the MUTCD.

When not in use, signs shall either be removed or completely covered. Covers shall be of an opaque material; burlap or black plastic shall not be used.

Where signs are mounted on light standards, traffic signal supports, etc., work includes furnishing mounting bands or clamps, including all installation hardware.

- B. MATERIAL** – Materials shall meet the following requirements:

- 824.02 And ASTM D 4956: Fluorescent Orange Sheeting, Wide Angle Prismatic Lens
- 824.02 And ASTM D 4956: High Intensity Sheeting, Type III

- C. MEASURE AND PAYMENT** - The unit of measure for Construction Warning and Detour Signs will be the square foot. The total shall be the maximum number of square feet required and installed according to the approved TCP for any one phase of construction. Construction Warning and Detour Signs that remain in place according to the approved TCP for succeeding phases of construction will not be re-measured for payment.

Payment for Construction Warning and Detour Signs will be made at the Contract unit price per square foot, which payment will include furnishing, assembling, maintaining (including replacement of damaged signs at no additional cost to the District), and removing all required Construction Warning and Detour Signs from the Project when no longer required.

#### **612.06 REFLECTORIZED TRAFFIC CONES**

- A. DESCRIPTION** - Work consists of furnishing and maintaining traffic cones at the job Site. Traffic cones shall be used for short duration traffic channelization such as installing signs, establishing lane closure, removing or installing pavement markings, and installing raised markers. Work also includes removal of the cones from the job Site when no longer required.

The retroreflectORIZED band on traffic cones shall be of high intensity retroreflective sheeting material. Cones shall be a minimum of 36 inches in height. The retroreflectORIZED band shall be used only during the daytime and not during the nighttime.

- B. APPLICATION** - Cones shall be used in accordance with Part VI of the MUTCD.

- C. MEASURE AND PAYMENT** - The unit of measure for ReflectORIZED Traffic Cones will be each. The total shall be the maximum number required and furnished for any one phase of construction.

Payment will be made at the Contract unit price per each, which payment will include furnishing, maintaining (including replacing damaged units at no additional cost to the District), and removing all traffic cones when no longer required.

#### **612.07 STEADY BURNING AMBER LIGHTS, TYPE C, AND FLASHING AMBER LIGHTS, TYPE B**

- A. DESCRIPTION** - Work consists of furnishing, placing, and maintaining warning lights on the Portable PCC Barriers and when required by the Engineer. Warning lights shall be in conformance with Part VI of the MUTCD. Work also includes removal of the lights from the job Site when no longer required.

Lights shall include hardware necessary to attach lights to traffic control devices, including barriers, and traffic drums that may be used to delineate traffic lanes.

Steady burning lights shall be used to delineate the travel way only if specified on the TCP or at the direction of the Engineer. Flashing lights shall be mounted on advance warning signs as indicated on the TCP.

- B. MEASURE AND PAYMENT** - The unit of measure for Steady Burning Amber Lights, Type C and Flashing Amber Lights, Type B, shall be each. The total measure will be the maximum number required for any one phase of construction. Steady Burning Amber Lights, Type C and Flashing Amber Lights, Type B, that remain in place according to the approved TCP for succeeding phases of construction will not be re-measured for payment.

Payment for these items will be at the Contract unit price per each, which payment will include furnishing, placing, maintaining (including replacing damaged units at no additional cost to the District), and removal of all warning lights as specified.

#### **612.08 ELECTRONICALLY ILLUMINATED TRAFFIC DEVICES (ARROW PANEL)**

- A. DESCRIPTION** - Work consists of furnishing, maintaining and relocating Arrow Boards required to channel traffic away from or through traffic control zone as shown on the TCP, or as directed by the Engineer. Work also includes removal of the Arrow Boards from the job Site when no longer required. Arrow Boards shall be in conformance with Part VI of the MUTCD.

- B. OPERATIONAL REQUIREMENTS** - The Electronically Illuminated Traffic Control Device shall be a Type C Arrow Panel and shall operate as indicated in Part VI of the MUTCD. The size shall be a minimum of 48 inches high and 96 inches long, and shall be finished in with non-reflective black enamel. There shall be a minimum of 15 No. 44121. PART 46, 12 volt amber lamps. The lamp configuration shall have an arrowhead pointing in each lateral direction at each end of the panel, with a minimum of 5 lamps forming the arrow bar (arrow tail). Each lamp shall be provided with a visor and the lamps, when illuminated, shall be visible on a clear, cloudless day, for a minimum distance of 1 mile. The chevron type devices shall only be used in the sequential mode.

The electronic circuitry shall provide 25 and 40 completed operating cycles of the sign per minute in each mode.

A switch controlled changeable dimming device shall be provided on the control panel that will reduce the voltage on the lamps a maximum of 50 percent for nighttime use.

Electrical energy for operating the arrow panel shall be obtained from a noiseless device or source such as a solar-powered or battery-powered source. Alternative noiseless power sources may be used upon prior approval of the Engineer. The source used shall be capable of operating the arrow panel in the manner heretofore specified. The use of gasoline powered or diesel powered motors or generators as energy sources for this work will not be permitted.

Arrow Boards mounted on the cab of a truck shall be mounted to provide a minimum of 7 feet between the bottom of the sign and the Roadway.

Arrow Boards mounted on a trailer, or on other than the cab of a truck, shall be mounted to provide a minimum of 8 feet between the bottom of the sign and the Roadway.

If the Engineer gives advance written approval, a similar alternate flashing arrow sign configuration may be used.

If Arrow Boards, or the vehicle on which said signs are mounted, are damaged from any cause during the progress of the Work, the Contractor shall immediately repair or replace said signs to their original condition and location. Payment for this work will be in accordance with 612.20.

- C. MEASURE AND PAYMENT** - The unit of measure for Arrow Boards will be each or will be per hour as specified in the Contract Documents. The total for each arrow panel will be the maximum number required and used for any one phase of construction. The total per hour will be the actual number of hours the arrow panel is in the operation mode at the location specified for any one phase of construction in the approved TCP or by the Engineer.

Payment for Arrow Boards will be made at the Contract unit price per each sign used or per hour that the sign is in operation in the work zone, whichever unit is specified in the Contract Documents. The unit price bid will include furnishing, relocating as required, maintaining, and removing all units as specified.

#### 612.09 WORK ZONE BARRICADES

- A. DESCRIPTION** - Work consists of furnishing, relocating and maintaining Type I, II, and III PVC Barricades (Polyvinyl-chloride) at the job Site. Barricades shall be in accordance with Part VI of the MUTCD. The retroreflective area of the barricades shall be Type III reflective sheeting specifically designed for barricade use and performance. The barricades shall be placed in areas delineated in the Contract Documents and/or as directed. Each barricade shall be ballasted with deformable weights such as sand bags placed on the lowest section of frames and not on a retroreflective rail. When specified in the Contract Documents, barricades shall be equipped with Type B or Type C lights, meeting requirements of 612.07. Work also includes removal of the barricades from the job Site when no longer required.

- B. APPLICATION** - Type I, II, and III PVC barricades shall be used in accordance with Part VI of the MUTCD.

- C. MEASURE AND PAYMENT** - The unit of measure for Type I, II, and III PVC Barricade will be each. The total number will be the maximum number of each type required and used for any one phase of construction.

Payment will be made at the Contract unit price per each, which payment will include furnishing (including ballast), assembling, maintaining (at no additional cost to the District) and removal of the barricades required.

Measure and payment for Type B or Type C lights affixed to Type I, II, and III barricades will be made in accordance with 612.07(B).

#### 612.10 TRAFFIC DRUMS

- A. DESCRIPTION** - Work consists of furnishing, maintaining and relocating Traffic Drums as required during the duration of the Project. Drums shall be in accordance with Part VI of the MUTCD and shall be made of high impact low density polyethylene or of other approved material and have a smooth sealed outer surface. Drums shall be largely cylindrical in shape with a sufficient number of flat surfaces to prevent rolling. The retroreflective surface of the drums shall be Type III reflective sheeting material specifically



designed for drum use and performance. When specified in the Contract Documents, drums shall be equipped with a Type B or Type C light. Work also includes removal of the drum from the job Site when no longer required.

**B. APPLICATION** - Traffic drums shall be used in accordance with Part VI of the MUTCD.

**C. MEASURE AND PAYMENT** - The unit of measure for traffic drums will be each. The total number will be the maximum number required and used for any one phase of construction.

Payment will be made at the Contract unit price per each, which payment will include furnishing, maintaining, and relocating as required, and removal of the traffic drum from the Project Site when no longer required.

Measure and payment for Type B or Type C lights affixed to drums will be made in accordance with 612.07(B).

## 612.11 REFLECTIVE MARKERS AND DELINEATORS

**A. DESCRIPTION** - Work consists of furnishing and installing Raised Reflective Pavement Markers of the snow plowable and surface mount types as lane and edge line delineation where shown in the Contract Documents. This item shall also consist of furnishing and installing Reflective Barrier Delineators and Reflective Guardrail Delineators.

**B. MATERIAL** – Materials shall meet the following requirements:

- 822.13: Casting, Reflector, Primer, and Adhesive

### C. CONSTRUCTION REQUIREMENTS

**1. Snow plowable raised reflective pavement markers (rpm)** - Markers shall be installed in the locations indicated in the Contract Documents and/or as directed by the Engineer. The casting, as per 822.13(A)(1), shall fit into a groove(s) cut in the road surface. The prismatic retroreflector, as per 822.13(A)(2), shall be approximately even with the road surface, and casting and reflector shall be installed at a height above the Roadway surface not to exceed 0.25 inches. The snow plowable raised reflective pavement markers shall be installed according to the MUTCD for RPMs supplementing other pavement markings and for RPMs substituting for pavement markings.

Markers along lane lines shall be installed centered between skip lines. Markers along edge lines shall be installed along the travel side of the edge line. Where double white markers are indicated, the markers shall be installed laterally to the right and left of the line, and 2 inches between line and marker.

On ramp roadways and sharp radius horizontal curves, care is to be exercised so that the markers are installed at right angles to the direction of headlight beams. The color of the pavement markers shall be white along the right side of all traveled roadways and along the lane lines, and yellow along the left side of all traveled roadways, unless otherwise indicated or directed.

The snow plowable raised pavement markers shall be install by saw cutting 2 parallel grooves into the pavement to a depth and to the dimensions recommended by the manufacturer. The grooves shall be parallel to the adjacent pavement markings. The grooves shall be cut with saw blades having a diameter to match the curvature of the steel casting bottom and the keels. The keel surfaces shall be free from scale, dirt, oil, grease, or any other contaminant that might reduce bonding. The retroreflective lenses and other exposed surfaces of the marker shall be free of any dirt, debris, and adhesive.

The RPM casting keels shall be bonded in the saw cut grooves in the manner recommended by the manufacturer of the marker. The ends of the casting shall be installed flush with the pavement surface. The marker shall be protected against impact until the adhesive has hardened to the point where the marker will not be dislodged by traffic, but in no case less than one (1) hour. Any marker dislodged before completion of the Contract shall be replaced by the Contractor at no cost to the District. The ambient temperature at the time of installation of the snow plowable markers shall be 50 degrees Fahrenheit or higher.

The markers shall be placed so that in all cases the plane of the reflective surface shall be at right angles to the direction of traffic. No pavement marker shall be placed over longitudinal or transverse pavement joints.

**2. Surface mount raised pavement markers** - Surface mount raised reflective pavement markers shall be installed in the locations indicated in the Contract Documents and/or as directed by the Engineer. The surface mount raised reflective pavement markers shall be installed according to the MUTCD for RPMs supplementing other pavement markings and for RPMs substituting for pavement markings.

Markers along lane lines shall be installed centered between skip lines. Markers along edge lines shall be installed along the travel side of the edge line. Where double white markers are indicated, the markers shall be installed laterally to the right and left of the line, and 2 inches between line and marker.

On ramp roadways and sharp radius horizontal curves, care is to be exercised so that the markers are installed at right angles to the direction of headlight beams. The color of the pavement markers shall be white along the right side of all traveled roadways and along the lane lines, and yellow along the left side of all traveled roadways, unless otherwise indicated or directed.

The surface mount raised reflective pavement markers shall be bonded to the pavement surface in accordance with the manufacturer's recommendations. The bonding material shall be in accordance with 822.13(A)2(b). An approved alternative bonding material shall be used in lieu of epoxy on asphalt concrete pavement.

The marker shall be protected against impact until the adhesive has hardened to the point where the marker will not be dislodged by traffic, but in no case less than one (1) hour. Any marker dislodged before completion of the Contract shall be replaced by the Contractor at no cost to the District.

The markers shall be placed so that in all cases the plane of the reflective surface shall be at right angles to the direction of traffic. No pavement marker shall be placed over longitudinal or transverse pavement joints.

- 3. Reflective barrier delineators** - Reflective barrier delineators may be installed on the face of permanent barriers or on the top of temporary barriers as specified in the Contract Documents or as directed. The permanent barrier delineator shall be mounted 24 inches above the Roadway surface, with the retroreflective surface of the reflector at 90 degrees to the pavement surface and normal to the direction of traffic, and the longer axis vertical. The temporary barrier delineators shall be installed on the top of the barrier at intervals specified in the Contract Documents or as directed.

The delineator shall be attached to the barrier as recommended by the manufacturer. If a primer is required for preparing the barrier surface prior to attaching the delineator, the primer shall be that recommended by the manufacturer. The delineator shall be held in place for the time recommended by the manufacturer to provide the sufficient bond to prevent slippage of the delineator from the designated location on the barrier.

- 4. Reflective guardrail delineators** - The delineator shall be installed on the guardrail so as to be completely enclosed by, and flush with, the guardrail. The delineator shall be attached to the guardrail by the means recommended by the manufacturer. The retroreflective surface of the delineator reflector shall be normal to the direction of traffic, with the longer axis vertical.

- D. MEASURE AND PAYMENT** - The unit of measure for Snow Plowable and Surface Mount Raised Reflective Pavement Markers, and Temporary Barrier Delineators will be each. No measure will be taken for either Permanent Reflective Barrier Delineators or Permanent Reflective Guardrail Delineators.

Payment for Snow Plowable and Surface Mount Raised Reflective Pavement Markers, and Temporary Barrier Delineators will be made at the Contract unit price per each, which payment will include furnishing complete delineators and markers and their installation and all other materials, labor, tools, and equipment necessary to complete the Work.

No payment will be made for either Reflective Barrier Delineators or Reflective Guardrail Delineators. The cost of furnishing and installing the delineators will be included in the Contract Price for the respective barrier or guardrail Pay Item.

## 612.12 THERMOPLASTIC PAVEMENT MARKINGS

- A. DESCRIPTION** - Work consists of furnishing and applying lead-free permanent thermoplastic pavement markings on finished asphalt concrete pavement as detailed in the Contract Documents and specified by the Engineer. Pavement markings shall be installed according to the MUTCD. Details of pavement word and symbol markings shall meet the requirements of the MUTCD. The Contractor shall furnish all supervision, labor, supplies, and equipment necessary for the proper conduct and completion of the Work. The Contractor shall also provide all traffic control necessary to maintain and protect traffic according to the MUTCD and the Contract Documents.
- B. MATERIALS** - Materials shall meet the requirement of 821.02.
- C. CONSTRUCTION REQUIREMENTS** - The Contractor shall ensure that the pavement surface is dry and free of oil, dirt, grease, and any other contaminants prior to the application of the pavement markings. The thermoplastic pavement markings shall be

applied by an extrusion method prescribed by the manufacturer. Pans and aprons to regulate the width of lines shall not be permitted. The equipment, including the extrusion die, shall be manufactured and calibrated to maintain the thermoplastic pavement marking material at its proper extrusion, temperature and density, resulting in a pavement marking of the width specified in the Contract Documents. The thermoplastic pavement markings shall have a set thickness range of 80 to 90 mils. The compound shall be extruded at a temperature of 400 to 425 degrees Fahrenheit, ambient air temperature shall be 45 degrees Fahrenheit and rising, and the ground temperature shall be 55 degrees Fahrenheit or higher.

The thermoplastic pavement markings shall be set with straight, clean-cut, parallel edges. The width of the line shall not vary more than 1/4 inch, and the alignment shall not vary more than 3/8 inch in any 40 foot section of Roadway.

Retroreflectorization shall be accomplished by an immediate dispensing of reflective beads from a bead dispenser attached to the applicator at the rate of 7 pounds per 100 feet. Reflective beads shall be applied uniformly in the prescribed quantity so that the completed pavement marking will register 250 mcd/m<sup>2</sup>/lux for white pavement markings, and 150 mcd/m<sup>2</sup>/lux for yellow pavement markings on a 30m geometry retroreflectometer. The retroreflectometer shall be supplied by the Contractor with certification of the calibration by the manufacturer. The pavement markings retroreflectivity shall be determined and comply with the requirements listed under this item within 30 days after the application under the supervision of the Engineer.

**D. DRYING TIME** - Drying time necessary for the stripe to become permanently fixed and to set so that normal traffic will not create distortion shall not appreciably exceed the straight line curve established by the values of two (2) minutes at 50 degrees Fahrenheit, and 15 minutes at 90 degrees Fahrenheit ambient air temperature and 70 percent relative humidity.

**E. COLOR** - White – Federal Standard Color No.595-17886  
Yellow – Federal Standard Color No. 595-13538

**F. MEASURE AND PAYMENT** - The unit of measure of marking stripe will be the linear foot. Measurement for word and symbol markings will be per each.

Payment will be made at the Contract unit price per linear foot for each size of marking stripe complete in place and per each for word and symbol markings. The payment will include conditioning of pavement surfaces, sampling and testing, all extruding and installation operations, including any removal and reinstallation of faulty or otherwise unacceptable marking stripes, necessary protection of marking stripe, all labor, tools, materials, equipment, and incidentals necessary to complete the Work.

### 612.13 PAINTED LANE MARKINGS

**A. DESCRIPTION** - Work consists of furnishing and applying the lane markings as specified in the Contract Documents for non-toxic water borne traffic paint, epoxy markings or polyester marking material for white and yellow pavement markings in the lengths and widths, symbols and letters as specified in the Contract Documents or as directed by the Engineer. The traffic paint, epoxy marking material and polyester marking material shall be suitable for application on asphalt concrete or PCC surfaces.

**B. MATERIALS** - Materials shall meet the following requirements:

- 821.04: Traffic Paint
- 821.10(C): Glass Beads
- 821.03: Epoxy
- 821.10(B): Glass Beads
- 821.05: Polyester
- 821.10(A): Glass Beads

**C. CONSTRUCTION REQUIREMENTS** - The specified marking material shall be applied on a clean and dry surface at the rate recommended by the manufacturer. If no rate is specified, the paint shall be applied at the rate indicated in 821.

Stripes shall be sharp, clean-cut and well-defined lines within the following tolerances:

1. The longitudinal accumulative offset within a 40 foot length of lane line shall be not more than plus or minus 1 inch.

2. The line width shall not vary more than plus or minus 1/4 inch.

**D. MEASURE AND PAYMENT** - The unit of measure for Painted Lane Markings for lane lines will be the linear foot. The unit of measure for Painted Lane Markings for symbols and letters will be each. Payment will be made at the Contract unit price per linear foot or each as specified, which payment will include furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the Work.

#### 612.14 PREFORMED PAVEMENT MARKINGS

**A. DESCRIPTION** - Work consists of furnishing and installing permanent or temporary preformed pavement markings as specified in the Contract Documents. The permanent or temporary pavement markings will be used to delineate traffic lanes, gores, edge lines, crosswalks, stop lines, letters, and symbols as indicated in the Contract Documents or as directed by the Engineer. Work also includes repairing lengths and sections of words or symbols damaged or misaligned during application at no additional cost to the District.

**B. MATERIALS** - Materials shall meet the following requirements:

- 821.06: Permanent Preformed Line Striping
- 821.07: Permanent Preformed Patterned Line Striping
- 821.08: Permanent Preformed Line Striping – Heat Applied
- 821.09: Removable Preformed Line Striping
- 821.08: Permanent Preformed Thermoplastic Pavement Letter, Arrow, Diamond, and Bicycle Symbol

Removable Preformed Line Striping shall conform to the requirements of the MUTCD, latest edition.

The preformed patterned contrast markings shall consist of white or yellow films with clear and/or yellow-tinted microcrystalline ceramic beads incorporated to provide immediate and continuing retroreflection and a black preformed patterned film border, bonded to the edges to form a continuous roll. These films shall be manufactured without the use of lead chromate pigments or other similar, lead containing chemicals.

The total width of the preformed contrast tape shall be an additional 3 inches wider than the standard width specified. This additional 3 inch width shall be a black non-reflective film with 1/2 inches on both sides of the white or yellow film.

The preformed markings shall be capable of being adhered to light colored asphalt cement concrete (ACC) or Portland Cement Concrete (PCC) by a pre-coated pressure sensitive adhesive. A primer shall be used to precondition the pavement surface. The preformed contrast markings shall conform to pavement contours by the action of traffic. The pavement marking film also shall be capable of application on new, dense and open grade asphalt concrete wearing courses in accordance with the manufacturer's instructions. Following proper priming, application, and tamping, the markings shall be immediately ready for traffic. The Bidder, when bidding, shall identify proper solvents and/or primers to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure effective product performance. The preformed contrast markings shall be suitable for use for one (1) year after the date of receipt when stored in accordance with the manufacturer's recommendations.

**Composition:** The retroreflective, patterned pliant polymer pavement markings shall consist of a mixture of high quality polymeric materials, pigments, and glass beads distributed throughout its base cross sectional area, with a reflective layer of microcrystalline ceramic beads bonded to a durable polyurethane topcoat surface. The patterned surface shall have approximately 50 percent plus or minus 15 percent of the surface area raised and presenting a near vertical face (angle of zero to 60 degrees) to traffic from any direction. The channels between the raised areas shall be substantially free of exposed beads of particles.

**Reflectance:** The white and yellow portion of the markings shall have the following initial expected retroreflectance values as measured in accordance with the testing procedures of ASTM D 4061. The photometric quantity to be measured shall be coefficient of retroreflected luminance (RL) and shall be expressed as millicandelas per square foot per foot-candle  $[(\text{mcd ft}^{-2}) \text{fc}^{-1}]$ . The metric equivalent shall be expressed as millicandelas per square meter per lux  $[(\text{mcd m}^{-2}) \text{lx}^{-1}]$ . The test distance shall be 50 feet.

**1. Expected initial retroreflectance**

**TABLE 612.14 EXPECTED INITIAL RETROREFLECTANCE**

	White			Yellow		
Entrance Angle	86.0°	86.5°	88.8°	86.0°	86.5° *	88.8°
Observation Angle	0.2°	1.0°	1.05°	0.2°	1.0°	1.05°
Retro Reflected luminance RL [(mcd · ft-2) · fc-1]	1100	700	500	800	500	300

These retroreflectance values are based on dark room photometric readings per ASTM D 4061.

The Ecolux Retroreflectometer measurement geometry uses an 86.5 degree entrance angle and 1.0 degree observation angle.

Beads: Index of Refraction: All microcrystalline ceramic beads bonded to the polyurethane coated, patterned surface of the material shall have a minimum index of 1.75 when tested using the liquid oil immersion method. The glass beads mixed into the pliant polymer shall have a minimum index of refraction of 1.5 when tested by the liquid oil immersion method.

**2. Testing procedure for refractive index of beads by liquid immersion**

**a. Equipment required**

- Microscope (minimum 100X magnification)
- Light source - preferably sodium light or other monochromatic source, but not absolutely essential
- Refractive index liquids\*
- Microscope slide and slide cover
- Mortar and pestle
- \*Available from R.P. Cargille Laboratories, Inc., Cedar Grove, NJ.

**b. Procedure** - Using the mortar and pestle, crush a few representative beads and place a few of these crushed particles on a microscope slide.

Place a drop of a refractive index liquid, with an index as close to that of the glass as can be estimated, on the particles.

Cover the slide with a microscope slide cover and view the crushed particles by transmitted light normal to the slide surface (illuminated from the bottom).

Adjust the microscope mirror to allow a minimum light intensity for viewing. This is particularly important if sodium light is not used.

Bring a relatively flat and transparent particle into focus.

By slightly raising and lowering the objective (microscope tube), look for one or both of the following:

- i.** Becke Line - This light line will appear to move either into the particle or away from it. In general, if the objective is raised, the line will move toward the material of higher refractive index, if the objective is lowered, the line will move toward the material of lower index.
- ii.** Variation in Particle Brightness - When raising the object from a sharp focus, the particle will appear to get brighter or darker than the surrounding field. If it becomes brighter, the glass has a higher refractive index than the liquid. If it becomes darker, the glass has a lower refractive index than the liquid. In both cases, the opposite will be true if the object is lowered.

This test can be used to confirm that the beads are, above or below a specified index. It can also be used to give an

accurate determination of the index (plus or minus 0.001). This is done by using several refractive index liquids until a match or near match of indices occurs. The index of the glass will equal that of the liquid when no Becke line and no variation in bead brightness can be observed. The size and quality of the beads shall be such that the performance requirements for the retro reflective pliant polymer shall be met.

- iii. Acid Resistance - The beads shall show resistance to corrosion of their surface after exposure to a 1 percent solution (by weight) of sulfuric acid. The 1 percent acid solution shall be made by adding 5.7cc of concentrated acid into 1000 cc of distilled water. CAUTION: Always add the concentrated acid into the water, not the reverse. The test shall be performed as follows:

Take a 1 x 2 inch sample, adhere it to the bottom of a glass tray and place just enough acid solution to completely immerse the sample. Cover the tray with a piece of glass to prevent evaporation and allow the sample to be exposed for 24 hours under these conditions. Then decant the acid solution (do not rinse, touch or otherwise disturb the bead surfaces) and dry the sample while adhered to the glass tray in a 150 degrees Fahrenheit (66 degrees Celsius) oven for approximately 15 minutes.

Microscopic examination (20X) shall show no more than 15 percent of the beads having a formation of a very distinct opaque white (corroded) layer on their entire surface.

- iv. Color - The preformed markings shall consist of white and yellow films with pigments elected and blended to conform to standard highway colors and a black preformed patterned film border.

**C. CONSTRUCTION REQUIREMENTS** - The pavement surface to which the preformed pavement markings are to be applied shall be clean of all dirt and debris to permit proper adhesion of the preformed markings to the pavement surface. The manufacturer's recommendations shall be followed for application of markings, application of primers and temperature requirements.

**D. MEASURE AND PAYMENT** - The unit of measure for Preformed Pavement Markings lines of specified width will be the linear foot. The unit of measure for Preformed Pavement Markings symbols and letters will be each. Payment will be made at the Contract unit price per linear foot or per each as specified, which payment will include all materials, all labor, tools, equipment, and incidentals necessary to complete the Work. The removal and disposal of Removable Preformed Line Striping will be paid under 612.03.

#### 612.15 TRUCK MOUNTED ATTENUATOR (TMA)

**A. DESCRIPTION** - Work consists of furnishing, installing, maintaining, and moving a Truck Mounted Attenuator (TMA) at the Project Site meeting the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 for Test Levels 2 and 3 as specified in the Contract Documents. The Contractor shall provide a copy of the Federal Highway Administration (FHWA) acceptance letter documenting that the specific TMA used on the Project Site conforms to the requirements of NCHRP Report 350.

**B. TMA REQUIREMENTS** - The truck mounted attenuator shall be capable of being mounted on the rear of a truck provided by the Contractor. The TMA support truck shall have a gross vehicle weight (GVW) range recommended by the attenuator manufacturer, and shall be equipped with the standard trailer lighting systems as required by the Federal Motor Vehicle Safety Standards (FMVSS) 108. The TMA shall be installed and operated according to the manufacturer's recommendations. The supporting documentation for the truck weight and the TMA manufacturer's recommendations shall be supplied by the Contractor to the Engineer prior to the TMA set up in the work zone. Weight may be added to the support truck to achieve the manufacturer's recommended GVW, and the support truck shall be installed with the transmission set in second gear or park for automatic transmissions.

The TMA shall be equipped with a minimum of 1 high intensity amber strobe light in operation while the TMA is installed in the work zone. An electronic arrow panel operated in the caution mode may be substituted for the high intensity strobe light at the direction of the Engineer.

The TMA shall also be equipped at the rear panel with a chevron object marker consisting of orange and black stripes 6 inches wide sloped at a 45 degrees angle from the top of the panel in both directions. The orange stripes shall be fabricated from fluorescent orange prismatic lens sheeting conforming to 824.02. The chevron shall cover a minimum of 75 percent of the rear panel area, and shall be visible to traffic at all times.

The TMA shall be not less than 72 inches wide and not more than 96 inches wide. The color of the TMA shall be yellow or orange,

and conspicuity markings shall be provided.

The TMA shall be equipped with a hydraulic system for tilting to a vertical position on the truck when not in use. Hand operated jacks with steel swivel casters shall be provided if necessary to facilitate installation and removal of the TMA from the support truck.

The support truck shall not be used for other purposes while the truck-mounted attenuator is being used to protect the work zone.

**C. CONSTRUCTION REQUIREMENTS** - The truck mounted attenuator shall be kept in operating condition at all times during construction. Should the TMA(s) become damaged from any cause during work zone protection so that the TMA ceases to function as designed on the Project Site, the work protected by the TMA shall be suspended until, the Contractor immediately repairs or replaces the parts as in accordance with 612.20. All other costs related to the maintenance of this unit shall be reflected in the bid price for this item. At the completion of the Project, the unit shall remain the property of the Contractor and shall be removed from the Project Site.

**D. MEASURE AND PAYMENT** - The unit of measure for Truck Mounted Attenuator shall be per each unit or for each hour per unit furnished, maintained and installed at the Project work zone. The unit of measure will be specified in the Contract Documents.

Payment for Truck Mounted Attenuator shall be at the Contract unit price per each or for each hour per unit as specified in the Contract Documents, and shall include furnishing, installing on a suitable vehicle, maintenance, repair, and disposal of the unit and all materials, parts, labor, tools, and incidentals needed to perform the required work.

#### 612.16 CONSTRUCTION ZONE ATTENUATOR

**A. GENERAL** - Work under this item consists of furnishing, installing, and maintaining, in accordance with the manufacturer's Specifications for the speed (MPH) specified in the Contract Documents, re-directive stationary crash cushion systems meeting the requirements of NCHRP Report 350, Test Level 3, for temporary protection during construction as shown on the approved TCP or as directed by the Engineer. The Contractor shall furnish the manufacturer's certification of the NCHRP Report 350 letter of approval from FHWA for the type of attenuator proposed for the Project prior to the installation. All elements and materials of the system shall be the same as those tested for the FHWA certification. Work also includes relocating the attenuators as work progresses and removal of the attenuators from the Project Site when no longer required for protection.

A Type 3 hazard marker shall be installed on the nose of the unit.

As part of this Work, the Contractor shall have available for replacement sufficient parts, as recommended by the manufacturer, to repair the unit if needed. Replacement parts will be paid in accordance with 612.20.

**B. MATERIALS** - All materials for this Work shall be as specified by the manufacturer.

#### **C. ATTENUATOR ELEMENTS**

Energy Absorbing Cartridges – Frangible or collapsible weather resistant cartridges. Diaphragms – Galvanized steel frames containing the energy absorbing cartridges. Fender Panels – Galvanized steel thrie beam or Quad-beam™ guardrail sections bolted at their front ends to each side of the diaphragms.

Nose Wrap – Yellow high density polyethylene molded nose cover matching thrie beam or Quad-beam™.

Transition Panels – The transition panels shall be supplied with the construction zone attenuator and suitable for connection to the walls, parapets, barrier, or guardrail existing in the work zone.

Hazard Marker – A hazard marker, meeting the requirements of the MUTCD, shall be attached to the nose of each attenuator. The hazard marker shall face oncoming traffic.

**D. APPLICATIONS** – Construction Zone Attenuators shall be required at approach ends of portable PCC safety barriers and other fixed objects in the work zone identified in the Contract Documents or by the Engineer.

**E. CONSTRUCTION REQUIREMENTS** – Installation of the attenuators shall be accomplished by the Contractor with experienced workers in accordance with the recommendations of the manufacturer of the crash cushion system for the work zone. The Contractor shall ensure that the anchorage for the crash cushion system can be installed according to the manufacturer's directions.

Grading and excavation to make the anchorage area suitable for the installation will be paid under the appropriate Contract items for the Work.

- F. SHOP DRAWINGS** – Shop drawing shall be submitted and approved for the crash cushion system prior to installation.
- G. MEASURE AND PAYMENT** – The unit of measure for Construction Zone Attenuator for the size specified in the Contract Documents will be each. The number will be the maximum number required for any one phase of construction.

Payment for Construction Zone Attenuator will be made at the Contract unit price per each, which payment will include furnishing, placing, relocating and removing when no longer required of the attenuator, as measured above. The payment shall also include labor for replacing parts, all labor, materials, including appurtenances and hazard markers, tools, equipment, and incidentals needed to complete the Work as specified herein.

#### 612.17 SAND FILLED IMPACT ATTENUATOR MODULES

- A. GENERAL** - Work consists of furnishing, installing, relocating as required, maintaining and removing temporary attenuators of the frangible sand-filled inertial module type, to be placed at each traffic-facing end of the portable concrete barriers and at other locations as shown on the Traffic Control Plan and/or as directed.

Also included as part of this Work shall be; furnishing and installing hazard markers, meeting requirements below. 1 hazard marker shall be attached to the lead module of each installation. The marker shall face oncoming traffic.

- B. MATERIALS** – Materials shall meet the following requirements:
- Each module shall consist of cylinder, core, lid and sand. Cylinders, lids, and cores shall be of an approved type. Cylinders shall be yellow in color.
  - 803.01: Sand shall be dried to contain no more than 1 percent moisture by weight, and contain an antifreeze element in proportions recommended by the manufacturer.
  - Hazard Markers shall meet requirements of the MUTCD .
- C. FIELD INSTALLATION** - Assembly and installation of inertial modules shall be in accordance with the recommendations of the manufacturer for the speed (MPH) indicated in the Contract Documents.
- D. MEASURE AND PAYMENT** - Unit of measure for Sand Filled Impact Attenuator Module will be per each module. The total will be the maximum number in use at any one time. Payment will be made at the Contract unit price for each module and include all labor, equipment, tools, and incidentals to complete the Work.

No measure or payment will be made for hazard markers. Furnishing and installing hazard markers will be considered as incidental part of the work under this item.

#### 612.18 PORTABLE CHANGEABLE MESSAGE SIGNS

- A. GENERAL** – Work under this item consists of furnishing, locating, operating, and maintaining self-contained, trailer-mounted, changeable message signs where shown in the Contract Documents or as directed by the Engineer. The changeable message signs are to be used for motorist advisory information.
- B. MECHANICAL AND OPERATIONAL REQUIREMENTS** - Changeable message signs shall be capable of displaying messages legible from distances of 1/2 mile under ideal day and night conditions and legible at distances of 900 feet under all weather conditions. A changeable message sign unit shall be mounted on a 2-wheeled trailer. The trailer-mounted changeable message sign units shall be structurally adequate to withstand sustained freeway travel speeds of 55 miles per hour with the sign panels in the travel position. The sign panels and the trailers shall be within legal height and width limits, and meet all State and Federal requirements for towed units, when in the travel position. The complete message sign units shall be designed to operate in the ambient temperature range of negative 31 to 158 degrees Fahrenheit. When in operation, the units shall be capable of withstanding wind gusts up to 80 miles per hour with all stabilizing devices in place. The units shall not be affected by mobile radio



transmissions. All controls shall be located in lockable enclosures, which shall also be weather and shock resistant. A changeable message sign shall consist of the following:

1. **Sign panel assembly** - The sign panel assembly shall be of aluminum or stainless steel construction. The sign panel shall consist of 3 lines of individually changeable orange characters on a black background that are at a wavelength of 590 nanometers. Each line shall be capable of displaying 8 characters equally spaced a minimum of 3 inches apart. Each character shall be a minimum of 1 foot 5 inches in height and 1 foot in width. Each character shall be made up of a matrix of bulbs or the following:

A cluster of 35 LED lamp pixels that have a minimum of 4 LEDs and maximum of 6 LEDs per pixel, or a full LED matrix character board.

The lamps for a bulb matrix sign shall be rugged, high performance, bayonet, or screw base units. Each lamp shall be a minimum of 20 watts with a life expectancy of at least 8,000 hours. The lamps shall have a minimum light output to meet visibility requirements. All wiring shall be suitable for outdoor use. Each connector point of the wiring harnesses shall be properly marked. The sign panel shall be covered for increased legibility of the sign messages. A bulb matrix sign shall be covered by a sun screen which has fixed horizontal black louvers tilted at 15 to 20 degrees to the horizontal. An LED sign shall be covered with a clear polycarbonate ultraviolet inhibited material to prevent fading.

2. **Controller** - The controller shall be a fully self-contained, compact, solid state, modularized unit with at least 199 pre-programmed messages and with additional capability for storing an additional 199 user generated messages. The unit shall be furnished with the dual capability of message generation at the unit by an integral or plug-in type keyboard system or by remote control by a digital cellular phone. The controller display shall show a miniaturized version of the message being displayed, or to be displayed, on the sign panel. For security purposes, password coding or key entry access shall be provided to lockout the keyboard. No message shall be displayed unless approved. The antenna for cellular phone reception shall be mounted on top of the sign panel assembly to prevent theft or tampering. The controller shall be designed so that it can accept a pre-programmed default message or indicator. In the event of power failure, the pre-programmed default message or indicator shall automatically be displayed and remain until such time that repairs can be made, or a minimum of 12 nighttime viewing hours. The default message or indicator can be a single or double flashing or pulsating light (i.e. any warning system that will indicate that the unit is on, but not functioning properly). A diesel and battery powered unit shall be equipped with a photocell to reduce the lamp intensity at night thereby eliminating glare to the motorist. A designated representative of the Contractor, familiar with the operation and programming of the unit, shall be available on the Project.
3. **Power supply** - A changeable message sign shall be battery powered having the capability of operating alternately on 120-volt AC commercial electrical service. The power supply shall conform to the following:

The battery-powered changeable message sign shall consist of banks of batteries recharged by a solar panel array. The number and size of the battery banks and solar panel array shall be sufficient to operate the sign panel for a period of 18 days without the array being exposed to sunlight. The solar panel array shall be capable of recharging the battery banks at a rate of 4 hours of sun for 1 twenty-four (24) hour period of sign usage. The battery powered unit shall incorporate an automatic intensity control feature to keep the LED lamp matrix intensity constant with a reduction in battery voltage. The battery powered unit shall be designed to also accept recharging from an internal or external diesel engine driven alternator power supply, should there be a lack of proper sunlight. A diesel generator shall be available on the Site to charge the batteries in the event the batteries become sufficiently discharged, thereby making the changeable message sign non-functional.

4. **Structural support system** - The structural support system shall be designed to allow for the sign panel assembly, controller, and power supply to be assembled into a unit that is easily mountable on a trailer. The structural system shall support the sign panel assembly at the proper height and orientation required for visibility, as indicated in Part VI of the MUTCD.

The structural support system shall provide adequate support to allow for complete sign operation, including the raising and lowering of the sign panel at sustained wind speeds of 30 miles per hour. The raising and lowering mechanism can be either motor-driven or manually operated. If motor-driven, a manual back-up shall be provided in case of electrical failures.

The trailer and sign support system shall be painted safety orange.

- C. **MEASURE AND PAYMENT** – The unit of measure for Portable Changeable Message Sign will be per each sign delivered to the job Site and accepted by the Engineer or will be per hour as specified in the Contract Documents. The total for each sign will be the maximum number required and used for any one phase of construction. The total per hour will be the actual number of hours the sign is in the operation mode at the location specified for any one phase of construction in the approved TCP or by the Engineer.

Payment for Portable Changeable Message Sign will be at the Contract unit price per each sign used or per hour that the Changeable Message Sign is in operation in the work zone, whichever unit is specified in the Contract Documents. The unit price bid shall include all labor, tools, materials, and incidentals necessary to provide changeable message signs as specified. The Contractor shall operate the changeable message signs including setup, programming, placing, providing all messages specified in the Contract Documents or requested by the Engineer, maintenance and fueling, for which payment shall be reflected in the Bid Item for this Work.

### 612.19 STEEL PROTECTION PLATE

**A. DESCRIPTION** - Steel Protection Plates shall be used to protect open excavated areas, potholes, and areas where fresh concrete has been placed, all as specified in this section and in conjunction with Contract Documents, and/or as directed by the Engineer. All open trenches or holes in the public Right-of-Way which are not backfilled and compacted by the end of each work day shall be plated. Steel plates shall be used to protect these areas for no longer than five (5) Calendar Days unless otherwise approved by the Engineer. Hot Mix Asphalt or High Performance Cold Mix, as defined in Section 819, shall be placed and compacted around the plate and feathered to meet the existing pavement. Each plate shall be fastened to the existing hard pavement with a minimum of 6 spikes unless otherwise specified in the Contract Documents. Each plate shall be a minimum of 1 inch thick and of a suitable size to adequately protect the excavated area with 18 inches of additional bearing width overlapping on to the existing hard and secure pavement. Work also includes removal of the plate from the job Site when no longer required. Steel Plates shall be clearly marked with the name and contact information of the owner and user of the plate. The identifying marks shall be on the steel plate itself. The installation of steel plates shall be accompanied with warning signs that read, "Steel Plate Ahead."

**B. SPECIFICATION AND PROVISION FOR PROPER PLACEMENT OF STEEL PLATES** - Trench walls and adjacent soils shall be sufficiently stabilized prior to the use of steel plates for bridging.

Steel Plates that will remain in place for less than five (5) days may be set in a bed of hot-mix asphalt or high performance cold mix. Asphalt shall be placed under the plate on all 4 sides and additional feathered edges on the outside perimeter of the plate at a rate of 3 inches of asphalt feathered and tapered to meet the existing surface per/inch of steel plate elevation. (8 percent or lesser slope).

Steel Plates shall be attached to the Roadway by a minimum of 6 spikes; 4 spikes predrilled into the corners of the plates and 1 spike predrilled into each side parallel to the trench. Spikes shall be drilled a minimum of 3 inches into the hard pavement.

The Steel Plate shall extend no less than 18 inches beyond the edge of the trench on all sides.

A non-skid surface treatment shall be applied to the entire surface area of the plate in cases where the plate is within a pedestrian crosswalk, designated bicycle path or a plate is placed at an intersection or within 75 feet of a traffic signal or stop sign/stop line.

The Contractor should avoid using long series of steel plates that run parallel to traffic. Prior to setting more than 2 steel plates in series, the Contractor shall contact the Engineer and obtain permission. If allowed, the length of a series of plates running parallel to traffic wheel paths shall not exceed 50 feet.

The trench shall be adequately shored on all sides to support the steel plates and traffic loads. All steel plates lying in pedestrian crosswalks or within 3 feet of pedestrian crosswalks shall meet the current requirements of the ADA for temporary walking surfaces.

Steel Plates shall be installed to operate with minimum noise.

All steel plates within the Right-of-Way, whether used in or out of the traveled way, shall be without deformation and flush to the existing pavement. (Free from any clips, chains, attachments, weldments, or surface irregularities).

**C. STEEL PLATE INSTALLATION** - Steel Plates shall be installed in the following manner.

Installation of steel plates in-place for less than five (5) consecutive days may be placed on top of the existing surface and shall be laid in a bed of no less than 1.5 inches of hot-mix asphalt or high performance cold-mix asphalt, and shall be fastened to the hard secure surface by pinning/staking on all 4 sides using 6 pins.

Installation of steel plates in-place for five (5) consecutive days or more shall be recessed into the street surface parallel and even with the existing surface (flush, plum and level) with no difference in elevation with the existing surface. This shall be accomplished by milling existing hard surface to the depth of the steel plate on all 4 sides. Any gaps or differences in elevation shall be leveled with hot-mix asphalt to match the elevation of the existing surface. When installing a steel plate in this manner, there shall be no more than 1/4 inch of variance in elevation between the steel plate and the existing surface. The plate shall be pinned in such a manner that the elevation of the pin heads are no more than 1/4 inch higher than the elevation of the pavement surface. If it is

deemed impossible to recess the plate then it shall be installed on a bed of asphalt on top of the existing surface with transitional ramps (hot mix asphalt or high performance cold mix) on all 4 sides of the plate, with pinning and feathered edges to match the existing asphalt (8 percent or a lesser slope).

On all steel plate installations, the leading and trailing edges of the plate shall contain 2 pins on each side and 1 pin on each parallel and shall be leveled with asphalt to provide a smooth transition for pedestrians and cyclists.

Steel Plates shall be attached to the Roadway by a minimum of 6 spikes; 4 spikes predrilled into the corners of the plates and 1 spike predrilled into each side parallel to the trench. Spikes shall be drilled 3 inches into the pavement.

- D. TEMPORARY FEATHERING OF STEEL PLATES** - All steel plates shall require temporary feathering on all 4 sides in order to provide smooth approach and decent by vehicular, cyclist, and pedestrian traffic.

The Contractor shall feather all edges from the existing pavement to the concrete or asphalt base course with temporary hot mix asphalt or high-performance cold mix, as defined in 819, at a rate of 3 inches per each inch of vertical elevation.

Pedestrian Safety and Work Zone Standards: If required due to an uneven surface, the Roadway shall be leveled using asphalt patching. Temporary metal plates are not to be used at any point as the floor of an open walkway in the Roadway.

- E. TEMPORARY TRAFFIC CONTROL SIGNS (MOT)** - All steel plate locations shall have pre-warning signs that read "Steel Plate Ahead" temporary traffic control sign to warn motorists, cyclist, and pedestrians approaching from all directions.

Each temporary warning sign shall be placed within 50 feet of the steel plate and must conform to latest MUTCD Standards.

- F. STEEL PLATE INSPECTION** - Contractor shall inspect steel plate locations on a daily basis including weekends and Holidays to ensure that each steel plate has not shifted or moved from its original setting. The plate shall be secure, free of defects and noise as traffic travels over the plate. All steel plate locations shall be provided pre-warning signs that read "Steel Plate Ahead" in all directions of approach until such time that the steel plate is removed.

Contractor must supply twenty-four (24) hour emergency contact information to the Engineer in case of emergency response to unsecured steel plates.

Contractor shall respond to a location of a shifted plate within one (1) hour after being contacted by the Engineer.

- G. FEES** - Any Contractor or entity placing a steel plate in the public right-of way regardless of ownership shall be charged a \$1,000 service fee if for any reason the District Department of Transportation must mobilize District forces to respond to a shifted or unsecured steel plate. This fee does not include any additional fines or charges assessed for breach of construction permitting requirements and/or contractual obligations.

- H. MEASURE AND PAYMENT** - Unit of measure for Steel Protection Plate will be each. The total number will be the maximum number of plates used for any one phase of construction. Payment will be made at the Contract unit price per each, which payment will include furnishing and placing plates and asphaltic concrete, spiking, relocating if required, and removal of the plates.

## 612.20 REPAIR OF DAMAGED MAJOR TRAFFIC CONTROL DEVICES

- A. DESCRIPTION** - Work consists of repairing, or replacing, if needed, major traffic control devices when damaged by vehicular traffic or vandalism that is deemed to be beyond the Contractor's control. For the purposes of this section, major traffic control devices are described under:

- 612.08: Sequential Arrow Boards
- 612.15: Truck Mounted Attenuator
- 612.16: Construction Zone Attenuator
- 612.17: Sand-Filled Impact Attenuator Module
- 612.18: Portable Changeable Message Sign

- B. MATERIALS** - Replacement materials are as described elsewhere for the original items.

The ordering of materials shall be in accordance with the manufacturer's or supplier's recommendations.

- C. CONSTRUCTION REQUIREMENTS** - Construction requirements for use of each of the listed items are found in the section for that item and in the Contract Documents. Repair of listed devices shall be conducted in accordance with the manufacturer's recommendations. Regular maintenance (e.g. replacement of bulbs and lighting devices, etc.) and damage caused by the Contractor's own activities shall not be paid for under this item, and the cost of said Work shall be considered when preparing bid prices for the original item.
- D. MEASURE AND PAYMENT** - The District will insert an estimated cost for this Work in the Bid Forms and Proposal. No action is required of the Bidder. The actual cost paid under Repair of Damaged Major Traffic Control Devices for repair of each of the listed items will be the manufacturer's invoice cost plus 10 percent for all devices repaired or replaced as agreed to by the Engineer. In cases where the manufacturer or supplier is needed to perform the repair, the associated labor costs shall be included in this item with the concurrence of the Engineer. No payment will be made for the Contractor's labor involved in the repair of the device beyond the standard 10 percent markup indicated above.

When repair costs exceed the maximum dollar amount established by the District for this item, said amount will be increased to cover the estimated future costs of this Work.

### 612.21 FLAGGER SERVICE

- A. DESCRIPTION** - Work consists of providing Flagger Service at times and locations as requested by the Engineer. Flagger Service may be requested for times when the Contractor is not actively working at the Project Site and for locations that are outside the Project limits. Flaggers included in Traffic Control Plans or otherwise used to complete the Contract work shall not be paid for as Flagger Service.
- B. FLAGGER CERTIFICATION** - Flaggers shall be certified by the American Traffic Safety Services Association (ATSSA) or another agency approved by the Engineer and shall meet the requirements of the MUTCD. Flaggers shall carry their certification cards at all times. Flaggers shall be under the direction of the Traffic Safety Officer.
- C. CONSTRUCTION REQUIREMENTS** - The Engineer will notify the Contractor of times, locations, and number of flaggers required for Flagger Service. The Contractor shall provide flaggers at the requested location at the requested time, or within 2 hours of the Engineer's notification for an immediate response. Flaggers shall perform all work in conformance with the MUTCD and these Specifications. Flaggers may be requested to supplement efforts of police or District Traffic Control Officers (TCOs) and in such cases shall comply with directions from the respective officers. If Flagger Service is requested for more than 12 hours, substitute flaggers shall be provided.

Flaggers shall treat the public and Department employees in a courteous and professional manner at all times. The Contractor shall permanently remove any flagger not acting in such a manner from the Contract work.

If more than one flagger is requested, the Contractor shall designate one flagger as a lead flagger. The lead flagger shall function as a liaison between the Department and the Contractor's flagging personnel.

- D. MEASURE AND PAYMENT** - Flagger Service shall be measured by the hour for each flagger requested by the Engineer. The start of measurement shall begin at the latter of the requested time or the time Flagger Service starts at the requested location. The end of measurement shall be the time that Flagger Service is stopped.

Flagger Service shall be paid at the Contract unit price per hour for each flagger.

## 613 TRAFFIC SIGNALS

### 613.01 DESCRIPTION

Traffic Signal work shall consist of furnishing all labor, equipment and materials and installing all electrical equipment, cabinets, conduits, manholes, handboxes, pull boxes, wiring, traffic signals, pedestrian signals, poles, and incidentals as shown in the Contract Documents, and as specified in this section for a complete working traffic signal system.

Wherever the word “provide” is used, it shall mean “furnish and install complete in place and ready for use.”

Items for traffic signal equipment shall consist of products of the same manufacturer, as far as practicable. The traffic signal system shall conform to the Department Specifications and National Electrical Manufacturers Association (NEMA) standards as to voltage, amperage, frequency, and type specified.

In order to provide the proposed traffic signal and lighting system the Contractor shall coordinate with the Potomac Electric Power Company (PEPCO). PEPCO will supply the power required for the locations outlined in the Contract Documents.

### 613.02 CODES AND STANDARDS

Material, equipment and installation shall conform to the following:

- American Society for Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- Certified Ballast Manufacturers
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Power Cable Engineers Association (IPCEA)
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- Underwriters Laboratories, Inc. (UL)
- District of Columbia Electrical Code
- National Electric Safety Code
- United States of America Standards Institute (USASI)
- Rules and Regulations of the Potomac Electric Power Company (PEPCO)
- American Association of State Highway and Transportation Officials (AASHTO)

Electrical Contractors must be bonded in the District and their electricians must have District licenses. The Contractor must secure a permit approved by the Electrical Engineer, D.C., prior to the beginning of any work, and the traffic signal work must at all times be inspected by electrical Inspectors and traffic signal technicians of the District Department of Transportation (the Department).

No work shall be covered or enclosed at any time prior to inspection.

The Contractor must have approved Shop Drawings, catalog cuts, and Specifications available at the jobsite for inspection by the Engineer and the Department’s electrical Inspector and traffic signal technician.

### 613.03 MATERIALS

- A. GENERAL** - New first quality materials shall be furnished in conformance with 825. Material and equipment must be UL listed and labeled. All electrical parts, wire, and other elements of the traffic signal installations shall be of ample capacity to carry required current without excessive heating or causing an excessive drop in potential. Except as otherwise provided herein, each individual item of traffic signal equipment shall bear a nameplate or other type of indelible marking or brand that shall identify it as to type, catalog number, and manufacturer. This applies to hardware and miscellaneous materials.

**B. COORDINATION WITH OTHER TRADES** - It shall be the responsibility of the Contractor to coordinate the location of equipment, conduit, devices, fixtures, etc., furnished and installed under other sections and by other trades to the extent that interference among such items is avoided. Relocation of items required as a result of failure of the Contractor to coordinate his work with the work of other trades shall be at the expense of the Contractor and at no additional cost to the District.

**C. STANDARD PRODUCTS** - Unless otherwise indicated, materials furnished shall be standard products of a manufacturer regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design complying with the specification requirements.

Where materials, equipment, apparatus, or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the bid. Specified materials shall be furnished.

**D. SAMPLES** - When samples are required they shall be submitted to the Engineer for approval within eight weeks after Award of Contract or prior to start of work, properly marked for identification and free of expense to the District. The District reserves the right to mutilate or destroy any sample submitted when considered necessary for testing purposes. Samples not so mutilated or destroyed will be returned to the Contractor at his expense when no longer necessary for the performance of the Contract.

The Contractor shall submit the following:

1. The name and manufacturer of the equipment he proposes to furnish.
2. Such data and descriptive materials as may be necessary for the mechanical trades in connection with maintenance.
3. All signal wiring or necessary diagrams and drawings for approval.
4. Any additional samples if deemed necessary.

**E. MATERIAL AND WORKMANSHIP** - Installation work shall be in accordance with the Contract Documents. Defective equipment or equipment damaged in the course of installation or test shall be replaced or repaired by the Contractor in a manner meeting the approval of the Engineer without additional compensation.

The Contract Documents indicate the extent and general arrangement of the conduit and wiring systems. If departures from the Contract Documents are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted as soon as possible to the Engineer for approval. No departures shall be made without prior written approval.

Materials and items of work shall be as specified herein in 825, and/or in the Contract Documents.

**F. GUARANTY** - The Contractor shall guarantee all traffic signal work to be in accordance with Contract requirements and free from defective or inferior materials, equipment, and workmanship for a period of two (2) years from Substantial Completion per 103.01 ARTICLE 12.

If, within the guaranty period, the Department finds that guaranteed work needs to be repaired or changed because of the use of materials, equipment, or workmanship which are inferior, defective or not in accordance with the terms of the Contract, the Department shall so inform the Contractor in writing and the Contractor shall promptly and without additional expense to the District: (1) Place in a satisfactory condition all such guaranteed work; (2) Make good all damage to equipment, the Site, the Structure, and/or related appurtenances, which is the result of such unsatisfactory guaranteed work; (3) Make good any work, materials, and equipment that are disturbed in fulfilling the guarantee.,

Should the Contractor fail to proceed promptly in accordance with the guarantee, the District may cause such work to be done and the Contractor and the Surety or sureties under the bond shall be jointly and severally liable for the cost of same.

#### 613.04 CONTRACT PLANS AND MANUFACTURER'S DRAWINGS

**A. TRAFFIC SIGNAL PLANS** - These Plans indicate the general arrangements of the traffic signal, pedestrian signals, circuits, and conduits and the locations of poles, manholes, pull boxes and handboxes. The Contract Documents are intended to show and describe the work entirely. However, every item necessary to complete the Work may not be specifically shown or described. Incidentals not shown or specified, but necessary for the proper operation of the traffic signals at specific intersections or within the traffic signal system, shall be included in the Work. The Contractor shall be responsible for furnishing all materials for the installation, complete, so as to insure the successful operation of the signalized intersection or traffic signal system.

- B. MANUFACTURER'S DRAWINGS** - Manufacturer's drawings shall consist of all shop and installation drawings, catalogs, photometric curves, performance data, pole installation details, etc. The Contractor shall secure and/or prepare these drawings and submit them as required by 105.02 before purchasing materials or proceeding with construction. Shop drawings shall show complete details of construction for all portions of the Work included. The Contractor shall check each drawing to insure conformance with the Contract Documents, and each drawing shall bear the Contractor's signature and certification. Drawings and data not clearly identified will be returned without approval to the Contractor.

Transmittals accompanying all Shop Drawings shall contain names and addresses of the Contractor, Subcontractors, and suppliers. Project title, reference to prior actions on submissions, and specification reference shall also be indicated.

### 613.05 GENERAL CONSTRUCTION NOTES

All Work shall be performed in conformance with applicable provisions of the latest editions of the D.C. and the National Electrical Code. All Work shall be performed in a neat, professional and workmanlike manner; cables in the controller cabinet, manholes, hand boxes and pole transformer bases shall be neatly arranged, tied, and securely racked.

The Work to be performed, as indicated specifically on the Plans or as directed by the Engineer, includes but is not limited to:

1. Installation of above-ground traffic signal equipment including traffic signal controllers and cabinets, metal poles, mast arms, vehicular and pedestrian signal heads, pedestrian and vehicular detectors, and street light equipment.
2. Installation of underground electrical conduit for traffic signals, and traffic signal communications.
3. Installation of electrical conductors for traffic signal equipment, street light equipment, and traffic signal communications.
4. Installation of traffic signal pole, streetlight pole, and controller cabinet foundations.
5. Installation of electrical manholes, pull boxes and hand boxes.
6. Removal of existing above-ground traffic signal and street light equipment including traffic signal controllers and cabinets, metal poles, electrical cable, vehicular and pedestrian signal heads, and street light luminaries.
7. Demolition and removal of abandoned pole and controller cabinet foundations.
8. Installation of temporary and permanent street cut repairs.

Traffic signal and street light equipment removed from each intersection shall be returned to the Department storage yard, as directed by the Engineer. The Work shall also include the proper disposal of all non-salvageable equipment and unsuitable excavated material and all other work necessary to obtain a complete and final product as shown on the Contract Plans and as specified herein and/or as directed.

### 613.06 COORDINATION WITH THE POTOMAC ELECTRIC POWER COMPANY

PEPCO will furnish power for the street lighting and traffic signal systems. All work involved with PEPCO facilities shall be performed in conformance with the PEPCO requirements. The Contractor shall install the new feeder cables into PEPCO's facilities, under PEPCO's supervision and inspection. All new service taps onto PEPCO's electrical system will be done by PEPCO forces.

It shall be the Contractor's responsibility to notify and coordinate with PEPCO throughout the construction of the Project in connection with all PEPCO services and facilities in the construction area, such that removal and restoration of services can be done in a timely and orderly manner at all times. Construction delays as a result of inadequate coordination shall be the Contractor's responsibility.

It should be noted that the D.C. electrical system is unfused, unprotected with no disconnecting means other than cutting the cable from the feed source. The Contractor shall be expected to perform electrical work on D.C. cables with the knowledge that the circuits are energized.

The Contractor shall coordinate with PEPCO for the following:

- Payment to PEPCO for manhole entry before any entry into their manholes.
- Payment to PEPCO for any PEPCO forces work (SLF and TSF – Work Orders).
- To have each "PEPCO MANHOLE" inspected by PEPCO forces in the presence of the Electrical Contractor on this Contract for safety, clearing of the cables racked on the walls, spotting of the wall for new conduit penetrations and the knowledge of the location of each feed manhole for the streetlights.

- Calling PEPCO when it is necessary for PEPCO Forces to make the taps onto their Electrical System to energize the street lighting and signal systems.
- Calling PEPCO for the final inspection of their manholes after all electrical work is complete in the PEPCO manholes as called for in this Contract.

All Work performed within PEPCO facilities shall be performed in conformance with all PEPCO requirements. The Contractor shall initiate communication with PEPCO as early as possible after execution of this Contract for the purpose of establishing scheduling guidelines to exchange telephone numbers between principal points of contact and to develop a contractual relationship to facilitate payment .

- A. GENERAL** – This section specifies payment to PEPCO for service connection, disconnection, and PEPCO manholes entry fees. Only 2 visits/inspections by PEPCO forces may be required. The PEPCO Manhole Entry Fee package is enclosed in this Contract.

To avoid repeat visit by PEPCO forces, the Contractor shall comply with PEPCO requirements for manhole inspection. The Contractor shall include in this bid price the amount shown in the Pay Item Schedule as a payment to PEPCO for Work performed as required in the Contract. PEPCO will submit all invoices to the Contractor for payment. After payment has been made, the Contractor shall submit the paid invoices to the Engineer for reimbursement by the District. The District will pay the Contractor only that invoice amount based on the specified PEPCO visits as stated in the Contract. No Contractor mark up will be allowed.

- B. MEASURE AND PAYMENT** – The unit of measure will be lump sum.. Payment will be made to the Contractor based on the paid PEPCO invoices without any Contractor mark up.

#### **613.07 EXCAVATION AND BACKFILL**

- A. GENERAL** - Trench excavation and backfill shall conform to the requirements of 207 and 614.12. Cuts through existing hard surface pavement shall be made by saw cutting to a minimum depth of 3 inches (75 mm) along the trench limit and the using pneumatic tools as required to make even, neat edges.
- B. MEASURE AND PAYMENT** - This specification features NO measure and payment provision. The cost for excavating and backfill and all incidentals required to support this specification shall be included in the cost of furnishing and installing electrical conduits, manholes and handboxes, holes and foundations, as appropriate.

#### **613.08 CONCRETE ENCASUREMENT OF ELECTRICAL PVC CONDUIT**

- A. GENERAL** - PCC mix design for encased conduits shall meet the requirements of 817.03 for Class F General Use, minimum twenty-eight (28) day compressive strength of 3,500 psi on field test cylinders made in the field and cured in the laboratory. All conduits shall be encased to provide a 4 inch minimum cover all around the conduit.

If existing utilities or conduits are present in the trench, these utilities or conduits shall be surrounded with an encasement of at least 3 inches of sandy fill, free from objects, which might damage the conduit. PCC encasement shall then be placed over that sand encasement to the appropriate level.

The use of dry pack PCC mix 2500 psi for conduit encasement is prohibited. Wet mix encasement, as described herein, shall be used.

Backfilling over or placing any materials over PCC encasement shall not commence for at least four (4) hours after the PCC encasement has been placed, except as directed by the Engineer.

Conduit encasement shall not be begin until the D.C. Inspector surveys the conduit installation and approves the placement of concrete. The Contractor shall be required to make needed adjustments to correct confirmed discrepancies before concrete is poured.

- B. MEASURE AND PAYMENT** - No direct measure will be made. The cost of concrete encasement shall be incidental to the PVC conduit specification and to the various conduit Pay Items.

#### **613.09 MANHOLES AND HANDBOXES**

- A. GENERAL** - The Contractor shall furnish and install manholes and handboxes conforming to the requirements of 614.05, 614.11,



and these Specifications.

2 manhole sizes shall be used. 1 manhole shall feature inside dimensions of 3 feet long by 3 feet wide by 3 feet deep. The other manhole shall feature inside dimensions of 4 feet long by 4 feet wide by 4 feet deep. All manholes shall be load bearing. Knockout panels for electrical conduit shall be provided on all 4 manhole walls. The concrete floor of each manhole shall feature a hole for ground rod placement and a sump hole for water drainage. The top slab shall fit on top of the manhole in a tongue and groove pattern, and shall contain a circular hole in the center for the frame and cover.

The handboxes shall conform to Sheet 10 of 22 on D.C. Drawing No S-2100.

Manholes and handboxes shall be constructed at locations shown on the individual Plans. They may be pre-cast or cast-in-place and shall comply with the following requirements:

- PCC Mix Design – Shall conform to 817.03 for Class B, structural, minimum twenty-eight (28) day compressive strength of 4,500 psi on field test cylinders made in the field and cured in the laboratory.
- Curing Material – Shall conform to 814.02 for Membrane Cure.
- Reinforcing Steel – Shall conform to 812.02 of the Standard Specifications, for Grade 60.
- Frame and covers – Shall be gray iron casting conforming to the requirements of 815.04. The word “DCSL-TS” in 1 inch letters shall be cast in the center depression of the top of cover and shall be flush with the surface of cover.
- Pre-cast Reinforced Concrete – Shall meet the requirements of 817.03.
- Cable racks shall be galvanized steel with cable insulators.

The tops of manhole frames and covers shall be installed flush with ground, pavement or sidewalk. The drain hole shall be filled with aggregate conforming to the requirements of 805, Grading No. 67.

Conduit entering manholes shall be terminated flush with the inside wall. Conduits shall be aligned in as nearly a straight line as possible to allow for ease of pulling cable.

The space remaining between the conduit and the structure wall shall be filled or patched with concrete or acceptable equal so there will be no leakage. Manholes shall be seated on trench fill meeting the requirements of 804.05 in order to prevent settlement.

The frame and cover shall be painted battleship gray before installation with 1 field coat of primer meeting the requirements of 811.03. Covers for manholes and handboxes shall clearly be marked “DCSL-TS” on the outside. Marking shall be placed parallel to the long side of the cover. Each cover shall have two 0.875 inch pick holes to allow the cover to be removed. The Contractor shall be responsible for all excavation and shoring necessary in order to install the manholes and handbox shown on the Plans. A 0.75 inch x 10 foot long copper clad ground rod shall be installed in the bottom of each manhole and hand box. The ground rod shall extend not more than 6 inches above the floor. The Contractor shall electrically ground all metallic objects comprising the manhole or handbox including the frame and cover, cable racks and reinforcing steel, as appropriate. Cable racks shall be installed in the manhole, as directed by the Engineer.

The Contractor shall adjust the manhole to grade using a poured concrete collar. The Contractor shall also be responsible for temporary patching around the manhole and handbox and maintenance of the patch until the permanent street cut repairs have been made.

The Contractor will submit catalog cuts of all precast manholes and handboxes that he/she proposes to install.

All structures to be installed in the Roadway or areas subject to vehicle loading shall meet AASHTO’s loading criteria. The Contractor will not use brick in adjusting the neck of the manhole to grade.

- B. MEASURE AND PAYMENT** - Each individual manhole and pullbox/ handbox (paid under the “pullbox” Bid Item) will be paid at the Contract unit price. Payment will include all labor, tools, materials, equipment, excavation, shoring, de-watering, steel plating of roadways, manholes, and hand boxes, ground rod, cable racks, frame and cover, backfilling, compaction of fill, temporary patching, maintenance of the cut until permanent repairs are made, and all incidentals necessary to complete the Work described herein.

#### **613.10 ENCASED PVC ELECTRICAL CONDUIT**

- A. GENERAL** - The Contractor shall furnish and install electrical conduits conforming to the requirements of 614.14, 614.12, 820.12

and these Specifications. The number of conduits to be provided at a signalized intersection is as follows:

**TABLE 613.10**

Controller Cabinet to PEPCO Manhole	1-2 inches
Controller Cabinet to DC Manhole	1-2 inches, 2-4 inches
DC Manhole to DC Manhole	4-4 inches
DC Manhole to PEPCO Manhole	4-4 inches
DC Manhole to Any Pole	1-2 inches, 1-4 inches
DC Manhole to Hand box	1-4 inches
DC Manhole to DC Manhole (Mainline)	6-4 inches

1.5 inch conduit will be used in foundations to provide a raceway for ground rods. 2 inch and 4 inch conduits shall be used where shown on the Plans and as described in this special provision to protect and provide a routing for electrical cables.

The Contractor shall install electrical conduits in conformance with the D.C. Standard Drawings.

All conduits shall be rigid, gray, Polyvinyl Chloride (PVC) Schedule 40 conforming to the requirements of 820.12

Conduits shall be installed to proper line and grade. Conduits shall be installed with a minimum 36 inches of cover below final grade, or at greater depths only if necessary to obtain necessary clearance from other utilities. Conduits shall slope at a minimum rate of 3 inches per 100 feet of length to a foundation or manhole. Conduit runs shown on the Plans may be changed to avoid underground obstructions only with written approval from the Engineer.

The conduit shall be installed at full lengths using standard manufacturer supplied elbows, bushings, reducers, bends, nipples, couplings, and other hardware of the same material and treatment as that of the straight conduit pipe. If the Contractor is required to make field cuts of the conduit, the conduit ends shall be reamed to remove any rough edges before coupling. All conduit runs shall be cleaned and cemented, and conduits shall be joined together tightly. All joint fittings shall be watertight. Where 2 or more conduits are being installed in the same trench, the Contractor shall use spacers between the conduit runs. All bends in the conduit shall be of long sweep, free from kinks, and of such easy curvature as to permit cable pulling without undue tension on conductors or damage to insulation.

There will be instances when the Contractor will be required to penetrate existing PEPCO Manholes with proposed conduit. The wall penetration of PEPCO manholes will be performed in accordance with all PEPCO rules and regulations, and under the supervision and direction of PEPCO field personnel. The penetration of D.C. manholes will be performed under the supervision and direction of District of Columbia personnel. Conduit entering any PEPCO or DC Manhole or handbox shall be terminated flush with the inside wall or the manhole or handbox. Cut conduits shall be reamed to remove rough edges. The space remaining between the conduit and the manhole wall shall be filled or patched with concrete over the full width of the manhole or hand box wall so that there will be no leakage. The inside of the conduit shall be cleaned of all patching debris immediately before the concrete sets.

At the end of each workday, the Contractor shall seal the ends of all conduits to prevent the entrance of dirt, water and other foreign materials into the conduit system.

After concrete encasement has been completed, all wood forms and trench shoring shall be completely removed during the backfill operation. Backfill shall be placed in layers of 6 inches and compacted before the next layer is added. In paved areas, the backfill shall be brought to within 6 inches of the surface and temporarily patched. In all unpaved areas, the top 6 inches shall be composed of topsoil and sod.

All soil, broken paving, wood forms, trench shoring and trash shall be removed from the worksite at the end of each workday.

The Contractor shall furnish and install pull tape or dragline in each conduit run installed. The dragline shall be continuous, extend the entire length of the conduit and contain at least 3 feet of slack at each end. The dragline shall be comprised of materials which cannot conduct electricity and shall be of sufficient strength and design to allow the Contractor to easily pull cable through the conduits without damage or excessive pressure on cable insulation and conductors.

Existing conduits that are to be abandoned shall be left in place.

- B. MEASURE AND PAYMENT** - The unit of measure will be per linear foot measured from the center of the manhole, hand box, or foundation. The measurement will be made along the centerline of the conduit. Payment shall include all labor, tools, materials, equipment, excavation, shoring, de-watering, steel plating of roadways, concrete encasement, manhole and hand box penetration, compaction of fill, temporary patching and maintenance of the cut until permanent repairs are made, and all incidentals necessary to complete the Work described herein.

### 613.11 GALVANIZED RIGID STEEL ELECTRICAL CONDUIT

- A. GENERAL** - After receiving the Engineer's approval of the catalog cuts, the Contractor shall procure galvanized rigid steel electrical conduit along with supporting hardware and couplings, and install at locations specified on engineering Plans. The Contractor shall be required to furnish all materials, labor, and equipment required for the proper installation of galvanized rigid steel electrical conduit. Galvanized rigid steel electrical conduit is intended for installation below ground in areas where trenching cannot be done and/or when encasement of conduit in wet mix concrete is not possible.

The installation of galvanized rigid steel electrical conduit shall generally follow the methodology outlined in 613.10, Encased PVC Electrical Conduit. The galvanized rigid steel electrical conduit shall satisfy the technical Specifications in Section 809. Galvanizing shall comply with 811.06.

- B. MEASURE AND PAYMENT** - The unit of measure will be per linear foot measured from the center of the manhole, hand box or foundation. The measurement will be made along the centerline of the conduit. Payment shall include all labor, tools, materials, equipment, excavating, shoring, de-watering, steel plating, manhole and handbox penetration, compaction of fill, temporary patching, maintenance of any excavated area until pavement repairs can be made, and all incidentals, including maintaining a clean and neat Work Site, to complete the Work described herein.

### 613.12 REPAIR-REPLACE EXISTING PVC ENCASED ELECTRICAL CONDUIT

- A. GENERAL** - This section is to be used when the Contractor is required to pull traffic signal and/or communications cable through an existing underground electrical conduit and is prevented from doing so by an obstructed conduit. The Contractor shall make every effort to clear the obstruction using industry accepted techniques which will not damage cables and infrastructure. Failing to clear the obstruction, the Contractor shall determine the precise location of the obstruction, excavate and expose the obstructed conduit segment, and detach and remove the obstructed conduit segment without impacting adjacent conduits or cables within the damaged cable segments. New conduit shall be installed to replace the obstructed conduit and a watertight seal shall be made at all points where new and old conduit meet and are coupled together. All seals must be watertight and secure enough to prevent the intrusion of wet mix concrete encasement material into the inside of the conduit. The Contractor shall replace obstructed conduit with the same size (diameter) as that removed. The conduit segment shall be tested to ensure continuity and no additional obstructions before the replaced conduit segment is encased in wet mix concrete and covered with backfill.

The Contractor shall replace obstructed conduit with Schedule 40 PVC conduit. The Contractor shall install the new conduit in compliance with appropriate provisions in 613.07, Excavation and Backfill, 613.08, Concrete Encasement of Electrical PVC Conduit, and 613.10, Furnish and Install Encased PVC Electrical Conduit. In cases where the obstructed conduit is situated in a bank of other conduits, the Contractor shall take care to avoid damaging or rendering unusable any adjacent conduit. The Engineer shall be apprised when excavation discloses the need to remove and replace other conduits within the conduit bank in order to access the obstructed conduit. The Engineer will determine which conduits shall be removed in this case. The Contractor shall be paid for the total number of linear feet of conduit removed and replaced.

- B. MEASURE AND PAYMENT** - The unit of measure will be per linear foot measured from the edge of 1 cut to the edge of the other cut. The measurement shall be made along the centerline of the conduit. Payment shall include all labor, tools, materials, equipment, excavation shoring, de-watering, steel plating of roadways, couplings and fittings, conduit cement, manhole and handbox penetration, compaction of fill, temporary patching, maintenance of any excavated area until permanent repairs can be made, and all incidentals, including maintaining a clean and neat Work site, to complete the Work described herein.

### 613.13 PCC FOUNDATIONS

- A. GENERAL** - This item of work shall consist of constructing concrete foundations for traffic signal controller cabinets and for traffic signal poles or pendent post street light poles mounted on transformer bases complete with necessary electrical conduit, anchor bolts, a ground rod, reinforcing steel, wire mesh, ground wires, ground clamps and PCC mix design.

The materials for reinforced Portland Cement foundations shall meet the following requirements:

- PCC Mix Design – Shall conform to 817.03 for Class B, Structural, minimum twenty-eight (28) day compressive strength of 4,500 psi on field test cylinders made in the field and cured in the laboratory.
- Curing Materials – Shall conform to 814.02 for Membrane Cure.
- Reinforcing Steel – Shall conform to 812.02, for Grade 60.
- Wire mesh for reinforcement of controller cabinet foundations shall conform to 812.01 WELDED WIRE FABRIC. Wire mesh shall be 4 inches x 4 inches.
- Corrugated Metal Pipe – Shall conform 809.02, for steel material.
- Anchor Bolts – Shall conform 822.06 for High-Strength Bolts.
- Conduit – Sleeves shall conform to 613.10 “ENCASED PVC ELECTRICAL CONDUIT.”
- Galvanizing – Shall conform 811.06.
- Ground Rods – Shall be copper-clad rods conforming to the requirements of UL-467. Ground rods shall have a diameter of at least 19mm (3/4 inch) and a length of at least 3.05 meters (10 feet).
- Ground wires – Shall be at least No. 6 AWG bare solid copper for traffic signal and at least No. 8 AWG for streetlight conforming to the requirements of ASTM B 2.
- Ground Clamps – Shall be heavy duty bronze or brass or galvanized malleable iron conforming to the requirements of ASTM A 220, any grade.

The exposed portions of the foundations shall be formed to present a neat appearance. The bottom of the concrete foundation shall rest on firm, undisturbed ground.

Forms shall be true to line and grade. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Conduit ends shall extend a minimum of 501 mm (2 inches) and a maximum of 1002 mm (4 inches) above the top of the finished foundation.

It shall be the responsibility of the Contractor to ensure that all anchor bolts, ground rods, conduits, and other appurtenances are properly located before concrete is poured. Anchor bolts for the controller cabinet must be aligned so that the front door of the controller opens to allow the signal technician to observe the entire signal display while working in the controller. The Contractor shall be required to confirm the location of the controller anchor bolts before pouring concrete.

## **B. FOUNDATIONS FOR TRAFFIC SIGNAL CONTROLLER CABINETS**

1. The Contractor shall furnish all labor, equipment and materials necessary to construct a foundation for the traffic signal controller cabinet, as shown on the Plans, in conformance with the requirements for a Model 336S or 336SS Controller cabinet foundation, as detailed on the latest edition of applicable Department Standard Drawings, and in conformance with appropriate provisions from the GENERAL paragraph.

The foundations shall be installed 36 inches from the face of curb to centerline of foundation or as noted on the Plans. Forms shall be true to line and grade. Conduit ends and anchor bolts shall be placed in proper position and to the proper height, and shall be held in place by means of template until the concrete sets. The foundation shall have 5 conduits installed. A 1.5 inch conduit shall be installed through the foundation for the installation of the ground rod. A 2 inch diameter conduit shall be routed to an existing PEPCO manhole shown on the Plans for electrical service. A second 2 inch diameter conduit shall be routed to the proposed DC manhole shown on the Plans for the communications cable. The two 4 inch conduits shall be routed to the proposed DC manhole shown on the Plans for cables to traffic and pedestrian signal heads. The conduit shall extend a minimum of 2 inches and a maximum of 4 inches above the top of the finished foundation. The 3/4-inch diameter ground rod, #6 solid copper ground wire, ground clamps, shall be included in the cost for this Pay Item. The anchor bolts shall be set to the correct location and project 3 inches above the foundation. The foundation shall be allowed to set for a minimum of three (3) days before installing the cabinet. All dirt excavated and other debris shall become the property of the Contractor and shall be disposed of by him/her at no additional cost to the District.

It is further noted that all conduits shall be schedule 40 PVC. Each conduit installed to accommodate cable shall feature a radius sweep of 36 inches so as to meet the underground electrical conduit at the proper elevation beneath grade. In addition, the 0.75 inch copper-clad ground rod shall be of sufficient length to ensure that a minimum length of 8 feet is driven into undisturbed soil.

2. **Measure and payment** - Each individual foundation constructed will be paid at the Contract unit price. The price shall include the cost of excavation, the PCC concrete mix, the anchor bolts, the ground rod, reinforcing steel, ground clamps, No. 6 Solid ground wire and Schedule 40 conduits with the entire 36 inch sweep length where appropriate. The price shall also include all labor, materials, equipment and incidentals necessary to complete the Work and completely clean up the Site.

#### C. FOUNDATIONS FOR TRAFFIC SIGNAL POLE AND PENDANT POST STREET LIGHT POLE

1. The Contractor shall furnish all labor, equipment and materials necessary to construct a foundation for a traffic signal pole or a pendant post streetlight pole as shown on the Plans, in conformance with the Standard Drawings for a 15 inch diameter bolt circle foundation, and in conformance with appropriate provision from the GENERAL paragraph. The distance from the face of the curb to the centerline of the foundation shall not be less than 36 inches or as noted in the Plans. Forms shall be true to line and grade. Conduit ends and anchor bolts shall be placed in proper position and shall be held in place by means of a template until the concrete sets. The foundation shall have 3 conduits installed. All conduits shall be Schedule 40 PVC. A 1.5 inch diameter conduit shall be installed through the foundation for the installation of the ground rod. One 2-inch diameter and one 4-inch diameter conduit shall be routed from the foundation to the manhole(s) designated on the Plans. The conduits shall extend a minimum of two inches and a maximum of 4 inches above the grade of the foundations. Each conduit installed to accommodate cable shall feature a radius sweep of 36 inches so as to meet the underground electrical conduit at the proper elevation beneath grade.

The 4 anchor bolts shall be set at the correct location forming a 15 inch diameter bolt pattern as shown on the drawings. Each bolt shall project 3 inches above the top of the foundation. The foundation shall be allowed to set for a minimum of three (3) days before installing the pole hardware or transformer base. All excavated material and other debris shall become the property of the Contractor and shall be disposed of by him at no additional cost to the District.

The 0.75 inch diameter copper clad ground rod, No. 6 solid ground wire, and ground clamps shall also be included. The ground rod shall be sufficient length to ensure that a minimum length of 8 feet is driven into undisturbed soil.

2. **Measure and payment** - Each individual foundation constructed will be paid at the Contract unit price. The price shall include the cost of excavation, the PCC concrete mix, the anchor bolts, the ground rod, reinforcing steel, ground clamps, No. 6 solid copper ground wire and Schedule 40 conduits with the entire 36 inch sweep, where appropriate. The price shall also include all labor, materials, equipment, and incidentals necessary to complete the Work and completely clean up the Site.

#### D. FOUNDATIONS FOR TRAFFIC SIGNAL POLE WITH MONOTUBE MAST ARM

1. **Description** - The Contractor shall furnish all labor, equipment and materials necessary to construct a foundation for a traffic signal pole with a monotube mast arm, as shown in the Contract Documents and Plans, in conformance with the applicable Standard Drawing. The length of the round steel monotube mast arm shall determine whether the Contractor constructs the foundation for mast arms up to 20 feet in length or beyond 20 feet in length. PCC concrete for the foundation shall conform to 817.03 (A) Class B, Structural. The distance from the face of the curb to the centerline of the foundation shall not be less than 36 inches or as noted on Contract Drawings. The Contractor shall excavate soil to the required depth and diameter to ensure that concrete is poured against undisturbed soil. Forms shall be true to line and grade. Conduit ends and anchor bolts shall be placed in proper position and shall be held in place by means of a template until the concrete sets. The foundation shall have 2 Schedule 40 PVC conduits installed. One 2-inch diameter and one 4-inch diameter conduit shall be routed from the foundation toward the manhole(s) designated in the Contract Documents and Plans. The conduits shall extend above the top of the foundation at the distance range specified in Standard Drawing. Each conduit installed to accommodate electrical cable shall feature a sweep radius of 39 inches so as to meet underground electrical conduit at the proper elevation below grade.

The 4 anchor bolts shall be set at the correct location to form the bolt pattern consistent with the requirements of the applicable Standard Drawing. The anchor bolt diameter, length, and bolt pattern varies according to arm spread and is detailed on the applicable Standard Drawing. Each anchor bolt shall protrude above the top of the foundation at the distance range specified in the Standard Drawing, shall be threaded at the top for a distance of 9 inches, and shall feature a 6 inch L-bend at the bottom. Anchor bolts shall be in conformance with 822.06 (B). Anchor bolts shall be aligned to ensure that the monotube mast arm is oriented perpendicular to the adjacent face of curb or at a specific angle as shown on the Plans or as directed by the Engineer.

The foundation shall be allowed to set for a minimum of three (3) days before affixing pole hardware. All excavated materials and other construction debris shall become the property of the Contractor and shall be disposed of at no additional cost to the District of Columbia.

A 0.75-inch diameter copper clad ground rod, a No. 6 solid copper ground wire, and heavy-duty ground clamps shall also be included. The ground rod and the ground clamp are not to be installed within the foundation; they are to be installed as prescribed in the Grounding Notes for Mast Arm Pole Foundations, as detailed in Standard Drawing Number 617.02. The ground wire shall extend from the ground rod through the electrical conduit to the tapped ground lug on the pole.

2. **Measure and payment** - The unit of measure for Foundation for Traffic Signal Pole with Monotube Mast Arm will be each. The payment for Foundation For Traffic Signal Pole With Monotube Mast Arm will be at the Contract unit cost for each foundation and will include excavation, PCC concrete, anchor bolts with hex nuts, ground rod, reinforcing steel, heavy duty ground clamps, No. 6 solid copper ground wire, grout, and Schedule 40 electrical conduits with the entire 36 inch sweep where appropriate. The payment will also include all labor, materials, equipment and incidentals necessary to complete the Work specified herein and to completely clean all debris from the Site.

#### E. TEMPORARY PORTABLE CONCRETE BASE

1. The Contractor shall furnish all labor, equipment and materials necessary to construct a temporary portable concrete base. 2 types of temporary portable concrete bases are required; one capable of supporting a model 336-S or 336-SS controller cabinet and one capable of supporting a 20 foot tall steel traffic signal pole mounted on a transformer base.

Each temporary, portable concrete base shall be constructed in accordance with the dimensions and Specifications shown on the Standard Drawings. The Work associated with the construction of each temporary portable concrete base shall conform to the following requirements:

Concrete shall be Class F Portland Cement Concrete Mixture, as defined in Table 817.03 and in Section 817.

Each conduit sweep shall conform to Section 820.12. Schedule 40 PVC conduits shall be used.

Each anchor bolt shall conform to the requirements of Section 822.06(A). High strength steel bolts shall be used.

Each temporary portable concrete base constructed to support a controller cabinet shall feature an anodized aluminum adaptor base bolted to the foundation after concrete has set. The adaptor base shall conform to that shown in the Standard Drawings. The adaptor base shall be attached to the temporary, portable concrete base by tightening the bolts to a suitable torque. A linear bead of outdoor weatherproof caulking shall be applied where the 2 surfaces meet at the outside of the adaptor base.

2. **Measure and payment** - Each temporary portable concrete base featuring all required amenities will be measured and paid at the Contract unit price.

#### F. RELOCATE TEMPORARY PORTABLE CONCRETE BASE

1. The Contractor shall furnish all necessary labor and equipment required to relocate a temporary portable concrete base from one location to another, as described in the Plans and as directed by the Engineer. The temporary portable concrete bases shall be those used to support a controller cabinet or a 20 foot tall steel traffic signal pole mounted on a transformer base. The following relocations shall be performed by the Contractor:

- From the Contractor's facility to the location where Work is to be performed;
- From one field location to another where Work is being performed; and
- From the field location to the Contractor's facility.

Initially, separate Pay Items will be identified to mount the controller cabinet and the adaptor base, and the pole and transformer base onto the temporary portable concrete base when it is delivered from the Contractor's facility to the first field location. Subsequent relocations of the temporary portable concrete base between field locations shall occur with the controller cabinet/adaptor base assembly or the pole/transformer base assembly in place during the relocation for use at the next intersection. The assemblies shall be removed from the temporary, portable concrete base at the conclusion of the Contract at the direction of the Engineer when the temporary, portable concrete base is returned to the Contractor's facility.

Each temporary portable concrete base shall become the property of the Contractor when it is returned to the Contractor's facility at the conclusion of the Project. Each controller cabinet adaptor base shall become the property of the District of Columbia at the conclusion of the Project.

2. **Measure and payment** - Each individual temporary portable concrete base relocation will be measured and paid at the Contract unit price.

#### 613.14 GROUNDING AND BONDING

A. **GENERAL** - The Contractor shall furnish all necessary labor, materials, and equipment necessary to furnish and install an electrical grounding system consistent with the requirements of the latest editions of the National Electrical Code and the District of Columbia Electrical Code.

B. **MATERIALS** - Material used for installation of grounding systems shall meet the following requirements:

- Ground Rods – Shall be copper-clad rods conforming to the requirements of UL-467. Ground rods shall have a diameter of at least 3/4 inches and a length of at least 10 feet. The length of the ground rod shall be sufficient to ensure that at least 8 feet of the rod is in contact with undisturbed soil, and that the resulting system passes all required grounding tests.
- Ground Wires – Shall be at least No. 8 AWG for streetlight grounding and #6 solid bare copper wire for traffic signals.
- Ground clamps – shall be heavy-duty bronze, brass or galvanized malleable iron conforming to the requirements of ASTM A 220, any grade.

All manhole post ground rod connections shall be made using exothermic welding.

The Contractor shall, in each District owned manhole, bond the neutral conductor and the system ground wire to the manhole grounding electrode.

Any D.C. Manhole that is worked in under this Contract will be checked to affirm the existence of an existing ground rod; if no ground rod is found, a ground rod must be installed through the floor of the manhole in such a way as to have a minimum soil contact of 8 feet.

The Contractor must make the electrical connections between the GROUND ROD-NEUTRAL CONDUCTOR AND ANY GROUND WIRES in the existing D.C. manholes.

1 solid copper clad ground rod shall be installed in each manhole, hand box, traffic signal controller cabinet foundation and each traffic signal and street light pole foundation.

The grounding electrode conductor shall be sized in accordance with Section 250 of the most current edition of the National Electrical Code and these Specifications. The Contractor shall install ground wires in a continuous length without splices. The Contractor must make the electrical connections between the ground rod-neutral conductor and any ground wires using exothermic welds in District of Columbia manholes. Ground wires shall be installed at the same time as other conductors, when they are pulled. The Contractor shall exercise care when installing the ground wire to avoid damage or kinks to the cable. Damaged or ineffective ground wire shall be removed and replaced by the Contractor at no cost to the District of Columbia.

Grounding shall be accomplished as soon as materials are in place to which the grounding wires are to be attached. Traffic signal controller cabinets, termination cabinets, manholes, hand boxes, poles and transformer bases should be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. The grounding system shall be installed, connected, tested, and deemed acceptable to the Engineer before energizing current-carrying conductors.

C. **MEASURE AND PAYMENT** - No measure and payment provision are provided for this item of work. The cost of the grounding system is covered in sections dealing with manholes, hand boxes and foundations. Grounding system costs shall be appropriately distributed over applicable Pay Items.

#### 613.15 ELECTRICAL CABLE FOR TRAFFIC SIGNALS

A. **GENERAL** - Electrical cables shall be looped in and out of controller cabinets, communications termination cabinets, manholes, hand boxes, poles and transformer bases to provide a minimum 3 feet of slack. Cable shall be pulled to ensure minimum stress on

cables, conductors and connectors. All cable runs are to be continuous with no splices permitted in conduits, manholes, transformer bases, poles, or hand boxes.

Electrical cables for traffic signals shall be routed through conduits, manholes and overhead as shown on individual Plans. Cable routings shall be adapted to match field changes resulting in conduit, manhole, foundation, controller, or hand box relocations.

## B. SPECIFICATIONS

1. **Cable between the controller and signal heads** - The cables running between the traffic signal controller and signal heads shall be 7 Conductor 14 AWG stranded cable conforming to the most recent requirements of the International Municipal Signal Association, Inc. (IMSA) Specification No. 19-1. A signal head shall be defined as a traffic signal head, pedestrian signal head, school or warning flasher, neon sign or fiber-optic or LED electronic regulatory or lane control sign.
2. **Detector lead-in cables** - The cables running between the traffic signal controller and specified detection equipment shall be 4 conductors 18AWG shielded, stranded cable. This cable is "Non IMSA spec" and frequently goes by the catalog code as No. 4C18 B7 OS-F. Detection equipment shall be defined as pedestrian push button, microwave vehicle detector, loop detector, or Accessible Pedestrian Signal (APS) unit. Cables serving loop detectors shall be coiled in the appropriate hand box.
3. **Communication cables** - Underground communications cable shall satisfy all of the requirements of IMSA 60-2 or REA PE-39. Aerial (overhead) communications cable shall meet all of the requirements of IMSA 40-2 or REA PE-22. Communications cable which runs partly overhead and underground shall meet the requirements of IMSA 60-2 or REA PE-39. The District of Columbia uses 12 pair, 25 pair, 50 pair, and 100 pair communications cables in its traffic signal plant. Precise cable routing as with the number of pairs required are shown on each individual plan set. All signal conductors shall be color coded in accordance with IMSA Specification 19-1-1967, Table 2. The Contractor shall furnish a manufacturer's certification that the cables conform to the requirements of IMSA or ASTM Specifications referenced for each type of cable furnished.
4. **Connectors and terminals** - Connections and terminals shall conform to the requirements of NEC 110 for the type of cables specified in the Plans and shall conform to the manufacturer's recommendations.

## C. INSTALLATION PROCEDURES

The following wiring procedures will be strictly adhered to when wiring electrical devices to operate as part of a signalized intersection.

1. All cable segments shall be identified with a waterproof tag securely affixed to the cable in the controller cabinet, all pull boxes, hand boxes, and manholes, and in all transformer bases.
2. All cable shall satisfactorily pass the Megger tests. Cable failing the Megger test shall be replaced by the Contractor at no cost to the District of Columbia.
3. Cables shall be pulled through electrical conduits, manholes, controller cabinet, poles, and mast arms in accordance with the following procedures:
  - a. Cables shall be installed and pulled so as not to damage the cable or exceed the manufacturer's recommendations for bending radius or pulling tension.
  - b. Cables may be installed or removed in duct lines that may contain energizing cables. All duct rodding shall be performed with a non-conductive rod and appropriate safety precautions shall be followed.
  - c. Cables shall be pulled in and through the conduit with a cable grip designed to provide a firm hold on the exterior covering of the cable. Cable shall be pulled with a minimum of dragging on the ground or pavement.
  - d. Powdered soapstone, talc, or other approved lubricants may be used to facilitate the pulling of cable. In any event, lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer.
  - e. Cables shall be looped in and out of the controller cabinet, manholes, hand boxes, and poles to provide adequate slack and the minimum amount of stress on conductors and connectors. Cable runs shall be continuous with no splices in the conduct, manholes, hand boxes, transformer bases or anywhere going along an overhead cable run.



- f. No branch splices of cable shall be permitted between the traffic signal controller and any signal head, detection device, or communications facility. Straight splices of cable are permissible only with the approval of the Engineer utilizing splice kits which totally encapsulate the cable and produce a waterproof splice.
  - g. Cables shall be racked neatly and securely supported in all manholes.
4. All cables shall be identified with a waterproof tag securely affixed to all cables in each manhole, hand box, transformer base and controller or termination cabinet. The Contractor shall prepare and affix each cable tag. Traffic signal system cables entering or leaving a controller cabinet shall be tagged to identify the type of signal head (vehicle, pedestrian, flasher, electronic sign) or detection device (push button, microwave detector) number as defined by the signal configuration package or the traffic signal sequence of operation. Communications cable shall be identified by trunk and cable pair number. Identification tags shall contain the following minimum information:
- CABLE No. 1 SIGNAL No. 1 – for cables servicing vehicle or pedestrian signal heads, flashers, electronic signs.
  - CABLE No. 2, PED P.B.A. – for cables serving pedestrian push buttons
  - CABLE No. 3, HANDBOX A, LOOP L-1 – For cables to be spliced into specific loop detectors in designated hand boxes.
  - CABLE No. 4, Microwave Detector A – For cables servicing microwave vehicle detectors.

**D. VEHICLE SIGNAL HEADS**

1. All cable to contain 7 conductors.
2. The cable to be used shall be 14 AWG, stranded, THHN, manufactured according to the IMSA 19-1, specification.
3. Conductor color codes are as follows:

**TRAFFIC SIGNAL CABLE COLOR CODES**

**TABLE 613.15 VEHICLE SIGNAL HEADS**

7 Conductor 14 AWG Stranded Cable		
ISMA Cable Color Code	Green	NB/SB Traffic
	Orange	
	Red	EB/WB Traffic
	Blue	
	Black	
	White/Black	AC-
White		
Old Cable Color Code	Green	NB/SB Traffic
	Yellow	
	Red	EB/WB Traffic
	Green/Black	
	Black	
	Red/Black	AC-

4. The conductor coded with white insulation will be the system neutral.
5. The conductors coded with Red, Orange, and Green or Red, Amber or Yellow and Green insulation will be used for vehicle signal heads controlling traffic moving in the north-south direction.
6. The conductors coded with Blue, Black, and White with a Black Tracer or Red with a Black Tracer, Black and Green with a Black Tracer will be used for vehicle signals heads controlling traffic in the east-west direction.

7. Unused conductors to each signal head will be reserved for use in the event that the sequence of operation of modified and additional sections are required, or if one or more of the conductors currently in use fail.
8. A separate segment of 7 conductor cable shall be routed from the traffic signal controller to each vehicle signal head. However, cable may be routed between the terminal blocks of 2 signal heads if the following criteria are satisfied:
  - a. The 2 vehicle signal heads must operate identically;
  - b. The 2 vehicle signal heads must be mounted on the same pole, or
  - c. 1 of the 2 vehicle signal heads must be pole-mounted and the other is mounted on a mast arm.
  - d. The cable shall not exist in the underground conduit network.
9. No branch splices of cable shall be permitted at any point between the traffic signal controller and the signal head, or between vehicles signal heads which are wired between their terminal blocks. Straight splices of cable shall not be made unless approved by the Engineer.
10. In the event of a cable malfunction involving new and existing cable installed by the Contractor in accordance with these policies, the following policies apply:
  - a. All new cable is required to be replaced if found defective or damaged.
  - b. If there are a sufficient number of unused conductors in the existing cable, they will be used in lieu of the defective conductors. The cable shall be tagged in the controller cabinet to indicate which conductors are defective.
  - c. If there are an insufficient number of unused conductors in the existing cable to replace the defective conductors, a new segment of 7 conductor cable shall be pulled from the controller cabinet to the signal head.
  - d. Under no circumstances will it be permissible to replace the defective segment of cable with a new segment of cable utilizing straight splices connecting the new with the old cable.
11. Unless otherwise specified in the Plans, all cable for vehicle signal heads is to be furnished and installed by the traffic signal installation Contractor.
12. If inspection of the traffic signal work by District of Columbia forces shows any unauthorized deviations from the provisions of this policy, the Contractor shall be obligated to make appropriate revisions at no cost to the District of Columbia before final payment for the job is released.

#### **E. PEDESTRIAN SIGNAL HEADS**

1. The provisions of item No. 1, 2, 3, 4, 7, 10, 11, and 12 for vehicle signal head apply for pedestrian signal heads.
2. The conductors coded with red and green insulation will be used for pedestrian signal heads controlling pedestrians in the north-south direction.
3. The conductors coded with White w/Black tracer and blue or Red w/Black tracer and Green w/Black tracer will be used for pedestrian signal heads controlling traffic in the east-west direction. The Orange and Black conductors shall be used together where additional conductors are required.
4. All new signal installations and modifications are to be designed so as to install a pair of pedestrian signal heads on the same pole. A separate segment of 7 conductor cable shall be routed from the traffic signal controller to each pair of pedestrian signal heads. The appropriate conductors and the system neutral are to be routed through the brackets to the terminal block of the signal head.
5. In instances where pedestrian signal heads on the same corner of the intersection must be mounted on separate poles, a separate segment of 7 conductor cable is to be routed to each pedestrian signal head.
6. No branch splices of cable shall be permitted at any point between the traffic signal controller and the signal head. Straight splices of cable shall not be made unless approved by the Engineer.

#### **F. PEDESTRIAN PUSH BUTTONS**

1. All cable to contain 4 conductors.

2. The cable to be used shall be 18 AWG, stranded, twisted, shielded cable manufactured according to these Specifications.
3. A separate segment of cable shall be rerouted from the controller cabinet to each pedestrian push button.
4. In the event of a cable malfunction involving cable installed in accordance with these policies, a new segment of 18 conductor cable shall be pulled from the controller cabinet to the pedestrian push button. Under no circumstances will it be permissible to replace the defective segment of cable utilizing straight splices connecting the new with the old cable.
5. Unless otherwise specified in the Plans, all cable is to be furnished and installed by the traffic signal installation Contractor.
6. If inspection of the traffic signal work by the District of Columbia forces shows any unauthorized deviation from the provisions of this policy, the Contractor shall be obligated to make appropriate revisions at no cost to the District of Columbia before final payment for the job is released.

**G. LOOP DETECTOR LEAD-IN CABLE** - The provisions of items 1, 2, 3, 4, 5 and 6 for pedestrian push buttons apply for loop detector lead in cable. In the aforementioned policy statements, the term pedestrian push button is to be replaced by the term loop detector hand box.

**H. MICROWAVE VEHICLE DETECTOR LEAD-IN CABLE** - The provisions of items 1, 2, 3, 4, 5 and 6 for pedestrian push buttons apply for microwave vehicle detection or lead-in cable. In the aforementioned policy statements, the term pedestrian push button shall be replaced by the term microwave vehicle detector.

**I. LOOP DETECTOR CABLE**

1. All cable to contain 1 conductor.
2. The cable to be used shall be 14 AWG, stranded, THNN manufactured according to the latest IMSA Specifications.
3. The cable is to be routed from the loop detector hand box, around the slot cut into the pavement and back to the loop detector hand box.
4. The dimensions of the loop detector and the number of turns of cable required will be clearly identified on the Plans.
5. The cable shall contain no splices other than those made with the shielded lead-in cable in the hand box.
6. In the event of a cable malfunction, a segment of 1 conductor cable shall be pulled in a newly cut pavement slot according to the provisions of item 3. Under no circumstances will it be permissible to replace the defective segment of cable utilizing straight splices connecting the new with the old cable.
7. Unless otherwise specified in the Plans, all cable is to be furnished and installed by the traffic signal installation Contractor.
8. If inspection of the traffic signal work by the District of Columbia forces shows any unauthorized deviation from the provisions of this policy, the Contractor shall be obligated to make appropriate revisions at no cost to the District of Columbia before final payment for the job is released.
9. All splices between the loop detector cable and the loop detector lead-in cable shall be made in the loop detector hand box utilizing waterproof, encapsulating splice kits satisfying District of Columbia Specifications.
10. Whenever practical, loop detectors shall be cut in the PCC roadway base before the surface course is applied. The Megger test shall be given to the loop detector cable both before and after the surface course is applied. The loop detector shall be recut, at no cost to the District of Columbia, if the cable fails the Megger test. It will be permissible to cut the loop detector in the surface course after the surface course has been applied.

**J. LIGHT EMITTING DIODE (LED) ELECTRONIC SIGNS**

1. The provisions of item No. 1, 2, 3, 4, 7, 10, 11 and 12 for vehicle signal heads apply for electronic Light Emitting Diode (LED) signs.
2. The color coded conductors used to operate the electronic signs are to be noted in the controller cabinet.
3. A separate segment of 7 conductor cable is to be routed from the designated traffic signal controller to each electronic sign.

4. No branch splices of cable shall be permitted at any point between the designated traffic signal controller and the electronic sign. Straight splices of cable shall not be made unless approved by the Engineer.

**K. FLASHING BEACONS FOR SCHOOL OR WARNING SIGNS**

1. The provisions of item No. 1, 2, 3, 4, 5, 7, 10, 11 and 12 for vehicle signal heads apply for cable to flashing beacons.
2. Unless otherwise noted, flashing beacons are to be installed in pairs; 1 above and 1 below each sign.
3. A separate segment of 7 conductor cable is to be routed from the designated traffic signal controller to a control cabinet to be mounted on the pole to which the beacons are affixed. This cable will terminate at the terminal block, and be furnished and installed by the traffic signal installation Contractor.
4. A separate segment of 7 conductor cable is to be routed from the terminal block of the pole mounted cabinet to each pair of flashing yellow beacons. Unless otherwise noted on the Plans, this segment of cable will be furnished and installed by the Contractor.
5. The conductor color coded red will be routed from the controller through the pole mounted cabinet to the top beacon, visible to northbound or southbound traffic.
6. The conductor color coded green will be routed from the controller through the pole mounted cabinet to the bottom beacon visible to northbound or southbound traffic.
7. The conductor color coded White w/Black tracer or Red w/Black tracer shall be routed from the controller through the pole mounted cabinet to the top beacon visible to eastbound or westbound traffic.
8. The conductor color coded Blue or Green sw/Black tracer shall be routed from the controller through the pole mounted cabinet to the bottom beacon visible to eastbound or westbound traffic.

**L. TWISTED PAIR COMMUNICATION CABLE**

1. Underground communications cables shall meet all of all requirements of IMSA 40-2 or REA PE-39. Aerial (overhead) communication cable shall meet all of the requirements of ISA 40-2 or REA PE-39. Communications cable runs that are partly overhead and underground shall meet the requirements of IMSA 60-2 or REA PE-39.
2. Cable shall be pulled in conduit with a cable grip designed to provide a firm hold on the exterior covering of the cable. Cable shall be pulled with a minimum of dragging on the ground or pavement. Powdered soapstone, talc, or other approved lubricants shall be used to facilitate the pulling of the cable. Under no circumstances shall the Contractor use a motorized vehicle to assist in pulling cable.
3. Communication cable shall also be installed on messenger cable when shown on the Plans as overhead cable. Cable shall be looped in and out of controller cabinets and ground-mounted termination cabinets at termination points or splice points as indicated on the Plans.
4. Communications cable shall be installed for the traffic signal control system. Cable runs shall be continuous with no splices in the conduit, manhole, pull boxes, or overhead runs.
5. All large cables, over 25 pairs, shall terminate in termination cabinets only. Connection between the terminating cabinets and the intersecting controllers shall be made with 12 or 25 pair cables only as indicated on the Communications Cable Schematic Sheet of the Plans.
6. The communications cable in an intersection controller shall be terminated by the Contractor on a terminal block mounted in the cabinet. The cable connection between the terminal block and the communication modem shall be through the controller's communication connector (C2).
7. Cable ends shall be taped to exclude moisture and shall remain so until terminal equipment is attached by the Contractor. For cable connections in termination cabinets, connectors approved for outside use shall be used.
8. Cables shall be looped in and out of controller cabinets, termination cabinets, manholes and pull boxes to provide adequate slack and the least amount of stress on the conductors and connectors.
9. If an emergency cable condition exists, where a splice is permitted in underground and overhead runs, the splices should be made in the appropriate manner using a waterproof splice kit conforming to the requirements of the National Electric Code

(110b.14): Boxes or kits should be of sufficient size to allow free space to all conductors therein. All splices shall be capable of operation when submerged in water. All splices and conductors, including spares, shall be made waterproof and mechanically and electrically secure.

10. Before any cable is pulled into the conduit, provisions shall be made for supporting the cable ends on racks in the manholes.
  11. Cable shall not be allowed to lie on the manhole floor.
  12. The channels that support the racks shall be securely fastened to the manhole wall with expansion bolts. The spacing between racks adjacent to the proposed cable joint shall be a minimum of 36 inches.
  13. Communication cable shall be furnished on reels and pulled with a minimum of dragging on the ground or pavement.
  14. This Work item shall also include the removal and disposal of existing communications cable that will be replaced by the new cable run.
  15. The Contractor shall disconnect the old and connect the new communications cable in all controller cabinets. The Contractor shall pull the cable into the cabinets.
  16. When modifying or upgrading existing signalized intersections, the Contractor shall not disconnect existing communications cable from the controller cabinet until new communications cable is already terminated at the new controller cabinet, or until all new communications cables have been pulled, tested, and in place awaiting controller change out on the same foundation.
- M. MEASURE AND PAYMENT** - The unit of measurement for all electrical cable shall be the number of linear feet installed. Each linear foot of cable installed will be paid at the Contract unit price. The price shall not include termination of cables as this is included in the price of other units of Work comprising the total job. The price shall include all labor, equipment, materials and incidentals required to procure, install and test the cables, and to complete all Work specified herein.

#### **613.16 FIBER OPTIC CABLE SYSTEM**

This Work includes the installation of fiber optic cable and equipment, in compliance with 825.28, including but not limited to the following:

- Cable
- Interconnect
- Patch cords
- Pig tails
- Cable related hardware
- Connectors
- Conduit
- Spacers
- Encasement
- Splices
- Closures
- Temporary systems
- Testing
- Training
- Other fiber optic products specified on the Plans or in any other Section of these Specifications.

#### **A. RELATED REFERENCES**

##### **1. Standard Specifications**

- Traffic Control
- Strain Poles for Overhead Sign and Signal Assemblies

- Traffic Signal Installation
- Electrical Wire, Cable and Conduit

**2. Referenced documents**

- TIA/EIA Standard FOP-11, Test Condition 1
- TIA/EIA-492AAAA, "Detail Specification for 62.5 μm Core Diameter 125 μm Cladding Diameter Class IA Multimode, Graded Index Optical Waveguide Fibers", Current Edition
- TIA/EIA 492-BA000 Class 4A, Current Edition
- TIA/EIA-598-A, "Color Coding of Fiber Optic Cable"
- National Electrical Code Section 770:
  - Applicable Flame Tests: UL 1581 and UL 1666 (Non-Plenum Applications)
  - Applicable Flame Test UL 910 (NFPA 262-1994) (Plenum Applications)
- United States Department of Agriculture Rural Utilities Service (RUS) standard 7 CFR 1755.900:
- FOTP-25, "Repeated Impact Testing of Fiber Cables"
- FOP-41, "Compressive Loading Resistance of Fiber Optic Cables"
- FOP-123, "Measurement of Optical Fiber Ribbon Dimensions"
- FOP- 18 1, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components"

**B. SUBMITTALS** - Prior to any Work, obtain approval from the Engineer for the products and procedures to be used on the Project.

The following chart provides the Contractor with an outline of the submittal requirements for the equipment and components for this Pay Item. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

**TABLE 613.16.01 SUBMITTAL REQUIREMENTS**

Materials	Catalog Cuts	Mfg. Spec.	Factory Test	Materials Cert.	Lab. Test Reports	Install. Proced.	Test Schedule	Test Plan	Test Reports	Submittal Due Date (Cal. Days after NTP)
F.O. Cable (OSP&IP)	X	X		X		X	X	X	X	60 Days
Patch Cords 7 Pig Tails	X	X						X		60 Days
Drop Cable	X	X						X		60 Days
F.O. Connectors	X	X								60 Days
Splice closure	X	X	X		X					60 Days
Mech. Lab Splice	X	X								60 Days
FDC	X	X								60 Days
Transceivers	X	X								60 Days

Submit submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items within sixty (60) Calendar Days after the Notice to Proceed and prior to any installation, unless noted otherwise in the Contract Documents.

Submit to the Engineer for approval, 6 copies of the manufacturer's descriptive literature (catalog cuts), technical data, operational

documentation, service and maintenance documentation and all other materials required within these Specifications.

Provide submittal data that is neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item

1. **Cable certification** - Prior to installing any fiber optic cable on the Project, obtain approval for the cable type, cable manufacturer, fiber content, design and installation procedure from the Engineer. Request approval by submitting catalog cuts and factory Specifications for the fiber optic cable.
2. **Underground splice closures** - Provide certification from an independent testing laboratory that certifies that the splice closures conform to the Specifications and test procedures.
3. **Splicing procedures** - Submit for Department approval the procedure to be used for the splicing of all cables on this Project. Within the submittal documents, include the proposed process, cleave tool and the specific fusion splicer to be used.
4. **Training** - Prior to training, submit resume and references of instructor(s) to Engineer for approval. The instructor shall be qualified in his/her respective field as determined by the Engineer. Submit an outline of the training course and a training plan within 120 days of the Notice to Proceed for approval by the Engineer. Explain in the Training Plan in detail the contents of the course and the time schedule of when the training shall be given. Coordinate actual training with installation schedules as approved by the Engineer.
5. **Fiber optic test documentation** - Provide the date, time and location of any tests required by this specification to the Engineer at least 24 hours before performing the test. Provide 2 copies of documentation of the test results to the Engineer within five (5) working days of completion of the test for review and approval, or else retest the represented fiber optic cable and provide the documentation within five (5) working days of the retest. Bind the test documentation and include the following:

a. *Cable & fiber identification*

Cable ID

Cable Location - begin and end point

Fiber ID, including tube and fiber color

Operator Name

Date & Time

b. *Setup parameters*

Wavelength

Pulse width Optical Time Domain Reflectometer (OTDR)

Refractory index (OTDR)

Range (OTDR)

Scale (OTDR)

c. *Test Results*

i. OTDR Test

Total Fiber Trace (mile)

Splice Loss/fGain (dB per mile)

Events > 0.10 dB

Measured Length (Cable Marking)

Total Length (OTDR) (mile)

Also provide traces on a diskette to the Engineer.

ii. End - To - End Attenuation Test

Length, number and type of splices and connectors

Link attenuation

### 613.16.01 CONSTRUCTION REQUIREMENTS

#### A. PERSONNEL

1. **Technician requirements** - Employ only fiber optic technicians that are listed on the Department's "Approval Listing - Fiber Optic Technician" for all termination, splicing and testing.

Technicians not previously approved by the Department will be considered for approval upon submission of a qualifications package to the Traffic Maintenance Center (TMC) Manager. Include in the qualifications package documentation showing that the technician meets the following requirements:

- a. *Education Requirement* - The technician shall have attended and successfully completed at least 1 four (4) day "Installation of Fiber Optic Products School." This school shall be conducted by a major manufacturer of fiber optic products or a Department-approved independent generic 4-day school that encompasses all aspects of fiber optic technician certification.
- b. *Work History Requirement* - Employ only technicians demonstrating a minimum of two (2) years work experience with the splicing, termination, and testing of fiber optic cable.

To apply for approval (see application form), the applicant shall submit a resume providing a summary of qualifications and a general description of professional experience, education and training in fiber optic installation techniques (termination, splicing and testing). The applicant shall also provide a work record for the previous two (2) years detailing specific projects, types of installations, testing and a customer reference for each Project.

2. **Certification compliance** - The approved technician shall carry evidence of his/her Department provided approval on their person at all times while working on the Project. The Department reserves the right to revoke the approval of any technician not demonstrating the skill and knowledge to perform at accepted industry standards or to the quality required in this specification.
3. **Certification cancellation** - An approved certification is subject to cancellation upon determination by the Department that the technician's work does not meet the Department's requirements or common industry standards.
4. **Certification renewal** - The certification issued is for two (2) years. For renewal, submit a work history to the Department for that two (2) year period, no less than thirty (30) days prior to expiration, for review. Include in the history the type and duration of each Project and a reference for each. Include as much additional detail as reasonable to facilitate approval.

- B. **EQUIPMENT** - Furnish a portable fiber optic light source and power meter test set for testing the fiber optic cable. Provide a test set matched, calibrated and referenced to work as a synchronized test system. Include 850 and 1300 nm light sources by LED and 1300 and 1550 nm light sources by laser. Provide a power meter capable of measuring the optical loss from all of the above sources. Provide a power meter capable of a resolution of at least 0.1 dB and a power range of at least +10 to 40 dB.

Provide connectors and adapters for ST and duplex SC connectors. The light sources and power meter shall be capable of 120 VAC line power or rechargeable battery power. Provide a portable battery-operated printer for direct reports of test measurements, and provide PC software for uploading and storing test measurements on a computer. Provide protective padded carrying cases for all test set components, including test cables and adapters. Include complete instruction and training in the use of the test set in the training. This equipment shall remain the property of the Contractor.

#### C. FABRICATION

**Fiber optic connectors** - Furnish and install connectors with ceramic ferrules, with the fibers permanently secured within the ferrule with epoxy, heat set or air dried, as specified by the connector manufacturer.

Install connectors according to the manufacturers recommended practice.



## D. CONSTRUCTION

1. **OSP and IP Cable Installation** - Submit for approval a detailed construction and installation procedure (SOP) covering all aspects of the construction and installation process for each and all specific cable to be used on this Project. Secure from the cable manufacturer the construction and installation procedures to be used on the Project. The SOP shall be submitted for review by the Engineer.

2. **Cable Installation Procedures and Standards**

- a. *Safety Precautions* - Follow all appropriate OSHA and industry standards related to safety when working in manholes or underground vaults and when handling optical fibers.
- b. *Cable Handling* - Install all fiber optic cable according to the manufacturer's recommended procedures and these Specifications.
- c. *Pulling Tension* - Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer.
- d. *Allowable Bend Radius* - Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:

20 X Cable Diameter      Short Term - During Installation

10 X Cable Diameter      Long Term - Installed

- e. *Cable Installation Guidelines* - Before the installation begins, carefully inspect the cable reels for imperfections such as nails that might cause damage to the cable as it is unreeled.

Take all necessary precautions to protect reeled cable from vandals or other sources of possible damage while unattended. Any damage to the cable sections may require replacement of the entire section.

Whenever unreeled cable is placed on the pavement or surface above a manhole, provide means of preventing vehicular or pedestrian traffic through the area.

Use the "figure-eight" cable layout configuration to prevent kinking or twisting when the cable is unreeled or backfed.

Do not coil fiber optic cable in a continuous direction except for lengths of 100 feet or less. The preferred size for the "figured-eight" is 15 feet in length, with each loop 5 feet to 8 feet in diameter. When "figure-eighting" cable, exercise care to relieve pressure on the cable at the crossover of the 8. This may be done by placing cardboard shims at the crossover or by forming a second "figure-eight".

Keep the cable continuous throughout the pull. Cable breaks are allowed only at designated splice points.

Where messenger cable is required, as shown in the Plans, lash aerial fiber optic cable to a steel strand wire messenger cable of the size specified in the Plans that conforms to the appropriate Standard Drawing.

- f. *Cable End Sealing* - Where a cable ends without termination in a fiber optic closure, seal the end of the cable by re-using a cable end cap that is shipped with a cable reel. Use a cap that is size-matched to the cable to be sealed. Clean the end of the cable.

Partly fill the cap with a waterproof silicone adhesive sealant and press the cap fully onto the cable end, rotating the cap to fully encapsulate the cable end with the sealant in the cap. Apply a full sealant bead between the end of the cap and the cable jacket.

3. **Cable storage** - At designated intervals throughout the cable Plant, pull and store excess cable for slack for future terminations or splicing.

- a. *Cable Storage Requirements* - Underground (OSP) & IP - Unless otherwise noted on the Plans, the following are the requirements for cable storage for underground and IP applications:

- i. PullBox - 20 ft

- ii. Hub Building - 65 ft
- iii. Traffic Control Center & Transportation Management Center (OSP splice vault) - 65 ft
- iv. Traffic Control Center & Transportation Management Center (IP at equipment room) - cable entrance to distribution panel bay plus 20 ft
- v. Electrical Communication Box (ECB) (Type 1, 2, 3, 4, 5) - Apply the following storage requirements for the indicated cable/closure situations. More than 1 situation may occur in a single electrical communication box, in which case, apply each appropriate requirement.

Trunk cable with no closure - 110 ft.

Trunk cable with 1 closure - 110 ft. Measure the storage amount from the top of the ECB manhole opening. Install closure in the center of the 110 ft. cable loop, so that the closure can be removed from the ECB approximately 55 ft. If a drop cable(s) is spliced to the trunk cable at this point, store 55 ft. of each drop cable.

Trunk cable with 1 closure and trunk cable ends - 95 ft. Install closure at 55 ft from the ECB on the trunk cable. If a drop cables spliced to the trunk cable at this point, store 55 feet of each drop cable.

Trunk cable ends with no closure - 95 feet.

- b. *Minimum Cable Storage Requirements - Aerial Applications* - Unless otherwise noted on the Plans, the following are the minimum requirements for cable storage for aerial applications:

Install a minimum 65 ft storage loop approximately 1/2 the distance between every equipment drop. Where equipment drops are greater than 1000 ft apart, install a minimum 65 ft storage loop for every 1000 ft of uninterrupted cable length.

Additionally, at aerial splice closures, install enough cable slack to allow the fully assembled closure, including the trunk cable and drop cable, to be lowered to ground level for maintenance purposes.

- c. *Cable Storage* - Properly store all cable to minimize susceptibility to damage. Maintain proper bend radius, both short and long term, during cable storage.
  - i. Communication and Pull Boxes - Store the excess or slack cable in the pull box or communication box in accordance with the Plan details.
  - ii. Hub/TMC/TCC - Properly store the cable in cable troughs and plenum applications which meet NEC requirements.
  - iii. Aerial Installations - Store the excess or slack cable at splice closures and storage loops in a "bow tie" configuration on the messenger strand. Install a device (a "snowshoe") that maintains the proper bend radius in the fiber cable in the bow tie configuration.

- 4. **Cable splicing** - Splice together each individual reel of fiber optic cable that makes up the continuous length of installed cable called for on this Project. Splice cable only at splice points designated on the Plans. Make no splices within a patch cord assembly.
- 5. **Mid Span/Drop Access** - At points where mid span/drop access is required, keep all fibers intact except those that are being accessed for the equipment drop. Use a suitable tool for removing fibers from the buffer tube to prevent damage to the fibers that will remain intact.
- 6. **Connector termination procedures** - Only use procedures for the termination of the connectors that meet the process set out in that connector manufacturer's standard operating procedure (SOP) for the field installation.
- 7. **Cable marking**
  - a. *Materials* - Use 2-1/2" wide, 4" long, wrap-around type cable marker. Print text in bold black type on orange PVC marker. Use base material that is minimum 0.015" thickness PVC. Pre-print the following text legibly on labels used for trunk cables:

Cable ID: XXXXXXXX

DDOT

### Optical Cable

Where XXXXXXXX is the appropriate cable ID as defined in the Plans.

Pre-print the following text on labels used for drop cables:

Cable ID:

DDOT

Optical Cable

Print the text specified above twice on every cable marker with the text of the second image reversed and abutting the first image. The end result shall be text which "reads right" when either short edge of the cable marker is held horizontally upright.

Use only permanent marking pens, as recommended or provided by the manufacturer, for labels requiring a handwritten cable ID. Per manufacturer's recommended procedure, apply an optically clear protective 2" x 3" Mylar (polyester) overlay to the marker, covering the written text.

- b. *Installation* - Clean the installed cable of all dirt and grease before applying any label. Follow the label manufacturer's recommended procedure for applying cable labels. Label all cables in every communications hub, electrical communications box, pull box, handbox, and equipment cabinet.

Place cable labels in the following locations:

Within 18 inches of every cable entry to a box

Within 18 inches of every splice enclosure at cable entry points

Within 6 inches of every FDC or splice cabinet in which a cable terminates or enters

Every 10 feet for the length of a cable in maintenance coils in electrical communications boxes or pull boxes

Label drop cables to devices within 18 inches of the splice enclosure where spliced to a trunk cable. Use cable labels with pre-printed cable ID numbers when labeling trunk cables. For drop cable applications, legibly print the drop cable ID number as shown in the Plans with a permanent-marking pen as recommended by the label manufacturer and seal with a laminate covering.

## 7. Fusion splicing

- a. *Use* - Unless otherwise noted, fusion-splice all fiber optic splices.
- b. *Procedure* - Fusion splicing consists of aligning the cores of 2 clean, cleaved fibers or a group of such fibers and fusing the ends together with an electric arc. Position the fiber ends under a microscope or a high-resolution video monitor and then align them using precision movement micro-positioners. High-voltage electrodes contained in the splicer conduct an arc across the fiber ends as the fibers are moved together, thus linking the fibers together. Verify maximum core alignment prior to splicing and estimate splice loss after the fusion process by the use of light injection and detection devices or profile alignment algorithms.

Install all splice enclosures according to the manufacturer's recommended guidelines.

- c. *Splice Protection* - Adequately protect all fusion splices in splice trays or organizers in an enclosure. When splicing inside a building, use a splice center where rack or wall space is available.

Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the splice tray or organizer manufacturer. Use splice types compatible with the tray design.

Protect fusion splices with a heat shrink tubing that protects the splice and extends over the fiber coating. No bare fiber may be exposed.

## 8. Mechanical splicing

- a. *Use* - Where designated on the Plans, splice fiber optic cable using a mechanical splice.

- b. *Procedure* - Make all mechanical splices of the strain relief locking type requiring no adhesive or polishing of the fiber ends.

Ensure the fibers are self-aligning upon the closing of the mechanical splice. The splices shall have the capability of splicing multi-mode or single mode fiber, and with any combination of buffer coating (250 µm and 900 µm). The splice shall be of 1-piece construction. Ensure that there is no stress on the fiber in the alignment area. Install all splice closures according to the manufacturer's recommended guidelines.

- c. *Lab Splice* - Use a mechanical fiber optic lab splice when a temporary joining of 2 fibers is required, such as in the testing of non-terminated fiber. These splices may be used on single mode or multi-mode optical fiber. Ensure the lab splice is reusable for up to 50 matings. The lab splice shall accommodate optical fibers with cladding diameters between 120 and 145 µm.

## 9. Fiber optic cable fan out

- a. *Inside Plant* - Provide all inside Plant cable with a fan out in accordance with the manufacturer's recommended guidelines. In protected environments such as a splice case, protect the fiber with a minimum 900 µm jacket. In all other instances, protect the fiber with 3 mm fan out tubing. Install only connectors meeting the requirements for connectors set forth in Subsection 614.03 and
- b. *Outside Plant* - Up-jacket individual 250 or 900 micron fibers to 3 mm using fan out tubing. Include an outer protective jacket. The individual leg length shall be 3 ft 2 in .

**10. Temporary fiber optic cable** - Furnish and install 1 continuous temporary fiber optic cable system as shown in the Plans. Terminate the cable and patch cords as required in the Plans, Splice the cable along cable route at the points indicated in the Plans.

**11. External transceivers** - Mount external transceivers on a shelf in a manner that does not restrict the placement of other components in the cabinet housing. In Type 170 cabinets mount the transceiver on an aluminum shelf permanently attached to the EIA cabinet rack in the rear of the cabinet.

**12. Fiber distribution center (FDC)** - Array connectors in a vertical pattern with number 1 being at the top left position. Do not install mechanical splices or field installed connectors. Equip unused panel slots with blank panels. Provide inter-cabinet and inter-bay bend radius and jumper management on each side of the FDC. Install all hardware according to the manufacturer's recommended procedures and Department standards. Determine specific hardware sizing from the Project documents.

## E. QUALITY ACCEPTANCE

**1. Underground splice closures** - Ensure that an independent testing Laboratory has performed all tests described herein. Provide certification from an independent testing Laboratory.

- a. *Installation Test* - Upon completion of the cable installation, splicing, and termination, and a minimum of fourteen (14) days before equipment hookup, test all fibers for continuity, events above 0.10 dB, and total attenuation of the cable. In the event that fiber optic cable installed on this Project is connected to existing fiber optic cable, perform installation testing on both the new cable and existing fibers to which it is spliced or connected.

Submit both printed and electronic (diskette) OTDR.

- b. *Test Requirements*

- i. **OTDR Test** - For all single mode and multi-mode fiber links, test and document the installation using OTDR testing.

A certified technician (shall conduct the installation test using an optical time domain reflectometer (OTDR) and optical source/power meter. The technician is directed to conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.

Use a factory patch cord of a length equal to the "dead zone" of the OTDR to connect the OTDR and the cable.

Optionally, the Technician can use a factory "fiber box" of 325 feet minimum with no splices within the box.

Conduct the tests at 1300 nm for multimode cable and at 1310/1550 nm for single mode cable.

- ii. Attenuation Test - For all single mode and multi-mode fiber links, test and document attenuation by a standard power-meter test.

For every fiber installed or connected to under this Contract, perform end-to-end attenuation test. For the test, use a calibrated optical source and power meter using the standard 3-stage procedure. Determine acceptable link attenuation by the cumulative value of standard losses based on length, number and type of splices and connectors.

- c. *Fiber Optic Cable Acceptance* - Use the following criteria for acceptance of the cable:

Provide test results demonstrating that the dB/km loss does not exceed +3 percent of the factory test or 1 percent of the cable's published production loss. Consider the error rate for the test equipment in the test.

No event can exceed 0.10 dB. If any event is detected above 0.10 dB, replace or repair that event point.

The total dB loss of the cable, less events, cannot exceed the manufacturer's production Specifications as follows:

**TABLE 613.16.02**

Cable	Max. Attenuation dB/km	Test Wavelength
Single mode	0.30	1550 nm
	0.40	1310 nm
Multimode	1.0	1300 nm

If the total loss exceeds these Specifications, replace or repair that cable run and assume all expenses, both labor and materials. Elevated attenuation due to exceeding the pulling tension during installation will require the replacement of the cable run at no expense to the Department for either labor or materials.

NOTE: The Department may allow the "bi-directional averaging" process of OTDR testing, particularly when splice losses are being unfavorably affected by "mode field diameter misalignment," "core off-set" or "core misalignment."

- 2. **Fusion splicing** - Ensure that the maximum splice loss for any fusion splice does not exceed 0.10 dB.
- 3. **Mechanical splicing** - Ensure that the maximum splice loss for mechanical splices does not exceed 0.70 dB.

**F. CONTRACTOR WARRANTY AND MAINTENANCE** - Provide a manufacturer's support (usual and customary warranties) period for all equipment and materials furnished and installed as part of Fiber Optic System. Transfer Manufacturer's and Contractor's warranties or guarantees to the agency or user responsible for the device or system maintenance. The warranties and guarantees shall be continuous throughout their duration, and state that they are subject to transfer.

**G. TRAINING** - Provide both installation and maintenance training on fiber optic cable to selected Department personnel. Personnel trained by the manufacturer of the fiber optic cable furnished on the Project and authorized by said manufacturer shall perform the training. Furnish a training notebook in a labeled 3-ring binder to each trainee. Provide a location to hold the courses that is an acceptable indoor and comfortable location near the Project area. If requesting that the training be conducted away from the Project area, pay all costs associated with travel and accommodation of all students.

As a minimum, include in the fiber optic training the following:

Provide installation and maintenance training for up to 8 people. Include in this training both classroom training and hands-on training. All training shall be conducted in half-day sessions. 2 half-day sessions may be held on the same day.

The total of the installation and maintenance training shall consist of at least 40 clock hours of training for each participant. Cover all aspects of inside Plant and outside Plant fiber optic cable installation, maintenance, and troubleshooting including the use of all recommended test equipment.

**613.16.02 MEASURE**

Fiber optic system, temporary fiber optic system, testing and training that is complete, in place, accepted and of the kind, size, and type specified is measured as follows:

- A. FIBER OPTIC CABLE** - Fiber optic cable is measured for payment by the actual number of linear feet installed, complete, functional, and accepted.
- B. PIG TAILS** - Pig tails are measured for payment by the actual number of linear feet installed, complete, functional, and accepted. Factory-connected pigtails associated with drop cable assembly will not be measured separately for payment.
- C. CLOSURES** - Underground splice closures, aerial splice closures, and FDCs are measured for payment by the actual number of units installed, complete, functional and accepted.
- D. FIBER OPTIC SPLICE** - Fiber optic splices, whether fusion, mechanical, or lab, are measured for payment by the actual number of splices made, complete, and accepted. Fiber optic splices associated with factory-connected pigtails will not be measured separately for payment.
- E. FIBER OPTIC CABLE FAN OUT** - Fan out kits are measured for payment by the actual number of units installed, complete, functional and accepted.
- F. FIBER OPTIC CONNECTORS** - Fiber optic connectors are measured for payment by the actual number of units installed, complete, functional and accepted. Fiber optic connectors associated with the use of factory-connected pigtails will not be measured separately for payment.
- G. PATCH CORDS** - Patch cords are measured for payment by the actual number of units installed, complete, functional and accepted.
- H. FIBER OPTIC SNOWSHOE** - Fiber optic snowshoes are measured for payment by the actual number of units installed, complete, functional, and accepted.
- I. TEMPORARY FIBER OPTIC SYSTEM** - Payment for Work on the Temporary Fiber Optic System will be lump sum and will be considered full compensation for all installed materials and labor associated with the Temporary Fiber Optic System. Specific items include but are not limited to timber poles, guys, anchors, lashing, messenger cable, conduit directional boring, conduit, fiber optic cable, fusion splicing, hardware attachments, splice enclosures, equipment rentals, and disposal of materials.
- J. TRANSCEIVERS** - External drop and repeat transceivers and external star transceivers are measured for payment by the actual number of transceivers installed, complete, functional, and accepted.
- K. TESTING** - Testing is measured as a lump sum for full delivery of testing and acceptance requirements. Measurement of testing includes subsistence necessary to conduct the testing.
- L. TRAINING** - Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

**613.16.03 PAYMENT**

Fiber optic cable, pig tails, closures, splices, fiber optic cable fan out, fiber optic connectors, patch cords, fiber optic snowshoes, temporary fiber optic system, and testing are paid for at the Contract Unit Price for the various items. Payment is full compensation for furnishing and installing the items complete and in place according to this Specification.

Training is paid for on a partial payment basis as follows:

The Department will pay 25 percent of the total Contract bid amount for this item upon approval of the Training Plan. The Department will pay the remaining 75 percent after completion of all training. The total sum of all payments cannot exceed the original Contract amount for this item.

Payment will be made under:

**TABLE 613.16.04**

Outside Plant fiber optic cable (type, mode, size)	Per linear foot
Inside Plant fiber optic cable (type, mode, size)	Per linear foot
Fiber optic pigtail (mode, size)	Per linear foot
Fiber optic closure	Per each
Fiber optic splice	Per each
Fiber optic fan out kit	Per each
Fiber optic connectors (mode)	Per each
Fiber optic patch cord (mode)	Per each
Fiber optic snowshoe	Per each
Temporary fiber optic system	Per lump sum
External transceiver (mode)	Per each
External star transceiver (mode)	Per each
Testing	Per lump sum
Training	Per lump sum

**613.17 GALVANIZED STEEL TRANSFORMER BASE**

- A. After receiving the Engineer’s approval of the catalog cuts, the Contractor shall procure the transformer base and all hardware designated in the Specifications conforming to the technical Specifications in 825.23 and the applicable Standard Drawing.

The Contractor shall furnish all necessary labor, equipment, and materials for the installation of the transformer base. The galvanized anchor bolts, nuts and washers must have previously been installed in conjunction with the fabrication of the PCC foundation for poles. The transformer base shall be set on the foundation with the anchor bolts protruding through the designated holes in the base of the transformer base. The transformer base shall be oriented on the foundation such that the door side is 180 degrees from the side of the base facing and closest to the curb.

The Contractor shall place metal shims, if required, between the transformer base and the concrete foundation to level the transformer base. After the transformer base has been leveled, the Contractor shall affix the transformer base to the foundation using the galvanized nuts and washers provided with the anchor bolts. The Contractor shall tighten the nuts to ensure a stable, secure connection. The Contractor shall furnish and install 1 unspliced segment of No. 6 solid bare copper ground wire between the ground rod in the foundation and the grounding nut holder in the transformer base. The connection between the ground cable and the ground rod shall be accomplished with a standard bronze ground rod clamp fabricated from a high strength corrosion resistant alloy and engineered to fit on a 0.75 inch diameter copper clad ground rod.

- B. **MEASURE AND PAYMENT** - Each individual transformer base with all hardware designated in the technical Specifications will be paid at the Contract unit price. The price will include the transformer base, hardware, ground wire, ground wire clamp and all labor, equipment and materials required to install the transformer base.

**613.18 STEEL TRAFFIC SIGNAL POLE**

- A. **DESCRIPTION** - The Work consists of providing Steel Traffic Signal Poles of the length specified in the Contract Documents. All holes necessary to allow for cable entry into signal heads, mast arms, and pedestrian and vehicular detection equipment shall be drilled and finished prior to the erection of the pole onto the transformer base. All holes must be made prior to the installation of any cable into the pole.

The Contractor shall set the pole on a leveled and trued transformer base with the holes in the pole base casting lining up with the holes on the top of the transformer base. The Contractor shall use the 1" x 3" galvanized steel bolts with nuts and washers, provided with the procurement of the transformer base, to attach the pole to the transformer base. The Contractor shall apply sufficient torque to ensure a secure, stable connection. Grounding the pole is unnecessary if the transformer base is grounded. The Contractor shall

have the option of routing cable for signal heads and detection equipment through the pole before the pole is erected, or providing a means for installing cable without splices or damage after the pole is erected. After the bolts have been secured and tightened, the Contractor shall install the removable ornamental pole top finial and the 4 ornamental cast leaf bolt covers where specified in the Contract Documents.

- B. MEASURE AND PAYMENT** - The unit of measure for Steel Traffic Signal Pole will be each. The payment for Steel Traffic Signal Pole will be paid at the Contract unit price for each pole complete in place. The price will include all labor, equipment, tools, material, and incidentals to complete the Work specified herein.

### **613.19 ROUND STEEL MONOTUBE POLES WITH ROUND STEEL MONOTUBE ARM**

- A. DESCRIPTION** - The Contractor shall furnish a round steel monotube pole with a round steel monotube arm consistent with the dimensions specified in Contract Documents and Plans, and satisfying the technical Specifications described on the applicable Standard Drawing. The pole and the arm are to be fabricated from 11-gauge steel meeting ASTM A 595 GR A with a yield point of not less than 55,000 psi. The pole and the arm are to be hot-dip galvanized to the requirements of either ASTM A 123 or ASTM A 153. The final galvanized coating will be free of any debris or flux ash.

All holes necessary to allow for cable entry into signal heads, pedestrian and vehicle detection equipment or any other traffic feature shall be drilled and finished smooth prior to the erection of the pole onto the foundation. All holes must be made prior to the entry of any cable into the pole, and burrs must be removed and made smooth to avoid snagging and subsequently damaging electrical cable as it is pulled through the hole.

The Contractor shall erect the pole on a leveled and true foundation with the holes in the base coinciding with the anchor bolts protruding from the foundation. The monotube mast arm shall be oriented perpendicular to the face of the adjacent curb or at a specific angle as shown on the Plans or directed by the Engineer. The Contractor shall supply sufficient torque to ensure a secure, stable connection between the pole base and the anchor bolts protruding from the foundation. The pole shall feature a 0.5 inch-13 tapped lug in the frame to accept the ground wire coming from the ground rod in the nearest manhole or handbox. The Contractor shall have the option of routing cable for signal heads and detection equipment through the pole and arm before they are erected, or providing a means for installing electrical cable without splices or damage after the pole is erected. After the bolts have been secured and tightened, the Contractor shall install the removable end cap at the end of the monotube arm and the cast aluminum pole top at the top of the monotube pole with stainless steel set screws. The Contractor shall apply a bead of sealant around the base of the pole to prevent moisture and debris from entering the pole between the top of the foundation and the bottom of the pole. The Contractor shall be responsible for the removal and disposal of all debris from the Work Site at the conclusion of the job.

- B. MEASURE AND PAYMENT** - The unit of measure for the Round Steel Monotube Pole with Steel Monotube Arm will be each. The payment for Round Steel Monotube Pole with Steel Monotube Arm will be paid at the Contract unit price for each pole/arm assembly complete in place. The price will include all labor, equipment, tools, materials, clean up and incidentals to complete the Work specified herein.

### **613.20 WOOD POLE 35 FEET TALL OR LESS**

- A.** The Contractor shall furnish and install a wood pole equal to 35 feet in length at the location specified in the Plans. A minimum of 20 percent of the pole height shall be buried in the ground. The Contractor shall comply with installation instructions as shown in the applicable Standard Drawings to include the installation of the pole and all required anchor guy supports to ensure pole stability.

The pole shall be set plumb and true and in line within an existing line of poles. The Engineer will direct the actual location of the wood pole. All poles set within existing pole lines shall have proper protection from coming in contact with energized power lines or other overhead lines which may be in the immediate area.

The backfill around the pole shall be installed in 6 inch layers and compacted before the next layer is installed. A mound of Earth at least 6 inches above grade is to be left around the base of the pole to allow for settlement.

The wood pole shall be 35 feet in length, made from Southern Pine or Douglas Fir, and comply with the technical Specifications to include treatment in 825.06. The wood pole shall be identical in diameter, materials and workmanship to include treatment to those currently deployed throughout Washington, D.C. by the PEPCO.

Work under this Pay Item includes the procurement and installation of the wood pole and all supporting hardware to include grounding, guy wire anchors and a metal label affixed to the pole designating pole owner and pole number. The Contractor shall be



responsible for the removal from the job Site and the disposal of all trash and debris generated at the Work Site as a result of this Work.

- B. MEASURE AND PAYMENT** - The unit of measure will be each wood pole installed. Payment will be made at the Contract unit price for each wood pole installed. Payment will include all labor, equipment, tools, materials and all incidentals necessary to complete the Work specified herein.

#### **613.21 TRAFFIC SIGNAL CLAMP ON MAST ARM 8 FEET TO 15 FEET LONG**

- A. DESCRIPTION** - The Work consists of providing Traffic Signal Mast Arms for traffic signal poles of the clamp-on type in the length specified in the Contract Documents with removable caps and clamps conforming to 825.21 and 825.23 and the Standard Drawings.

The Contractor shall drill a hole in the pole at the point where the mast arm is to be mounted. The location of the hole is a function of the height of the bottom of the signal head to be installed on the mast arm above the pavement. The height above the pavement may be determined from the Standard Drawings. The hole shall be approximately 2 inches in diameter and of such size that the mast arm completely covers the entire hole. The edges of the hole shall be machined to remove burrs that may snag the cable.

The installation of the mast arm onto the pole shall be undertaken after all required cable has been pulled through the hole drilled into the pole. The Contractor shall route electrical cables through the interior of the mast arm and out of the hole(s) previously cut in the mast arm for the mast arm mount signal bracket(s). Being careful not to crimp any of the cable, the Contractor shall affix the mast arm to the pole using the clamp. The Contractor shall line up the hole in the clamp with the hole in the pole and make the attachment using the high strength galvanized connecting bolts. The bolts shall be tightened per manufacturer's specification to ensure a secure, tight installation. The Contractor shall apply a continuous bead of waterproof sealant at all edges of the hole.

- B. MEASURE AND PAYMENT** - The unit of measure for Traffic Signal Mast Arm will be each. The payment for Traffic Signal Mast Arm will be paid at the Contract unit price for each mast arm complete in place. The payment will include all labor, equipment, tools, material and incidentals to complete the Work specified herein.

#### **613.22 TRAFFIC SIGNAL LIGHT EMITTING DIODE (LED) MODULE**

- A. DESCRIPTION** - The Work consists of providing LED Signal Modules for traffic signals, warning flashers and pedestrian signals at locations specified in the Contract Documents. The LED Signal Modules shall conform to Section 825 and be installed according to the manufacturer's recommendations. After receiving the Engineer's approval of catalog cuts, the Contractor shall procure LED modules conforming to the technical Specifications contained in 825.09 and 825.14.

The Contractor shall be responsible for safekeeping and storage of the module at the Contractor's facility following receipt of the materials from the vendor. Payment to the Contractor by the city shall be authorized only after the module has been delivered to and remains within the District of Columbia.

- B. MEASURE AND PAYMENT** - Each individual LED module will be measured and paid at the Contract unit price.

#### **613.23 VEHICULAR OR PEDESTRIAN TRAFFIC SIGNAL HEAD ON ANY POLE**

- A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure vehicle and/or pedestrian signal head housings conforming to 825.10 and 825.11 and upper and lower mounting brackets and hardware, as described herein.. The Work to be performed is as follows:

The Contractor shall procure materials described above.

The Contractor shall drill a hole in the pole at the point where the upper signal head mounting bracket is to be installed. The hole shall be approximately 1 inch in diameter, and edges shall be machined to remove burrs which may snag cable.

The Contractor shall prepare the signal head for attachment to the pole prior to arriving in the field at the intersection. The Contractor shall construct each signal head as described in the traffic signal sequence of operation. The appropriate LED modules shall be inserted and affixed into the housing and wired to the signal head terminal block, in accordance with manufacturer's instructions. Tunnel visors may be attached at this time or after the signal head is erected.

Pole mounted 1, 2, 3, 4 and 5 section signal heads shall feature sections mounted vertically one about the other. Connections between signal head sections shall be watertight and contain an opening through which cable can pass.

Pole mounted signal heads shall be outfitted with upper and lower mounting brackets. This assembly shall feature serrated locking washers at the signal head to prevent misalignment. This assembly shall be attached to the signal head and to the pole such that a watertight barrier results. This shall be accomplished through the use of washers and/or sealing compound at the pole. The assembly shall consist of 1-1/2 inch diameter steel tubes (nipples) threaded to fit into the pole plate and into the 90 degree ell leading to the signal head. The other end of the assembly shall be affixed to a universal pole plate into which the 1-1/2 inch diameter steep nipple can be screwed. The universal pole plate may be constructed from cast aluminum and shall be structured to accept 1 inch wide stainless steel banding strapping above and below the nipple where the plate sits next to the pole. The 1-1/2 inch steel nipple shall be of sufficient length and configuration to match the hardware arrangement of this signal display being replaced and to situate the signal head equidistant from the pole as the signal display being replaced.

The field cable protruding through the hole in the pole is to be carefully routed through the mounting hardware into the signal head and connected to the proper terminals in the terminal block of the signal head. The Contractor shall make the proper electrical connections of the field cable to the terminal block and ascertain that the connections are secure and consistent with the approved traffic signal sequence of operation. The field cable shall be fitted with terminal lugs for attachment to the terminal block.

The Contractor shall mount the signal head assembly to the pole after carefully aligning the universal pole plate to the pole without damaging or crimping field cable. Each new signal head will be mounted so that the bottom of the signal head is at a height above grade equal to the signal head being replaced. The universal pole plate shall be affixed to the pole utilizing 1 inch wide stainless steel banding strapping 2 points on each pole plate, 1 above and 1 below where the nipple screws into the pole plate. The mounting shall be accomplished with banding tools specifically intended for securing banding strapping and with standard tools.

The Contractor shall ensure a secure fit of the assembly and confirm that the signal head operates in compliance with the approved traffic signal sequence of operation.

- B. MEASURE AND PAYMENT** - Each individual traffic signal head installed will be paid at the Contract unit price. The price will include the signal head housing, the upper and lower mounting brackets, universal pole plate, all miscellaneous hardware including terminal lugs, tunnel visors, stainless steel banding materials, and all labor, equipment and materials. The price shall also include insertion, affixing and wiring of the LED module into the signal head. The cost of the LED module is not included in this Pay Item.

#### **613.24 OPTICALLY PROGRAMMABLE VEHICLE SIGNAL HEAD ON ANY POLE**

- A. GENERAL** - All provisions of 613.23, except those pertaining specifically to LED modules, shall pertain to this specification. The Contractor shall perform the following additional Work.

Optically programmable signal heads shall be mounted approximately 12 inches off the pole to permit the technician to open the rear door of the signal head. This shall be accomplished through the use of a 1-1/2 inch diameter steel mounting arm above and below the signal head of sufficient length to permit rear door access.

After the signal head is properly mounted and aimed to the satisfaction of the Engineer, the Contractor shall access the rear door of the signal head and affix tape to the rear lens to mask those parts of the intersection where the signal display is not to be seen. All signal sections of each optically programmable signal head shall be similarly masked in accordance with the specific direction of the Engineer, who will provide specific guidance relative to signal head visibility.

- B. MEASURE AND PAYMENT** - Each individual optically programmable traffic signal head installed will be paid at the Contract unit price. The price will include the signal head with lamps, reflectors and electrical terminal block, the upper and lower mounting brackets, universal pole plates, all miscellaneous hardware including terminal lugs, tunnel visors, stainless steel banding materials, programming tape and all labor, equipment and materials required to install aim, and optically program each signal head section, as described.

#### **613.25 VEHICULAR TRAFFIC SIGNAL HEAD ON ANY MAST ARM**

- A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure vehicle signal head housings, vehicle signal back plates and mast arm mount signal brackets conforming to 825.10. The Work to be performed is as follows:

The Contractor shall procure the materials described above.

The Contractor shall drill a hole in the mast arm at the point where the mast arm mount signal bracket is to be installed. The hole shall be approximately 1 inch in diameter, and edges shall be machined to remove burrs which may snag cable.

The Contractor shall prepare the signal head for attachment to the mast arm prior to arriving in the field at the intersection. The Contractor shall construct each signal head as described in the Plans. The appropriate LED modules shall be inserted and affixed into the housing and wired to the signal head terminal block, in accordance with manufacturer's instructions. Tunnel visors may be attached at this time or after the signal head is erected.

Mast arm mounted 1, 3 and 4 section traffic signal heads shall feature sections mounted one above the other. Mast arm mounted 5 section traffic signal heads shall feature 2 adjacent columns of 2 sections each mounted one above the other and 1 section mounted directly above the other 2 so that the total assembly is 3 sections tall and 2 sections wide and so that the center of the top section coincides with the line vertically dividing the 2 columns.

Mast arm mounted signal heads shall feature a back plate affixed to the signal head. Back plates are to be procured in accordance with 825.12. The back plate shall be secured to the signal head utilizing hardware shown in the technical Specifications and in accordance with the technical Specifications and in accordance with the manufacturer's instructions.

Mast arm mounted signal heads shall be mounted to the mast arm at the point where the field cable exits the mast arm with a standard bracket assembly, procured in accordance with technical Specifications contained in the Contract.

All mounting hardware shall be affixed to the signal head to form a watertight joint in compliance with the manufacturer's installation instructions.

The existing field cable protruding through the hole in the mast arm is to be carefully routed through the mounting hardware into the signal head completely within the assembly and connected to the proper terminal in the terminal block of the signal head. The field cable shall be fitted with terminal lugs for attachment to the terminal block. The Contractor shall make proper electrical connections of the field cable to the terminal block and ascertain that the connections are secure and consistent with the approved traffic signal sequence of operation.

The Contractor shall mount the signal head assembly to the mast arm after carefully aligning the mast arm mount signal bracket to the pole without damaging or crimping field cable. Each new signal head shall be mounted so that the bottom of the signal head is a height above grade equivalent to the signal head being replaced. The Contractor shall tighten the stainless steel bands on the signal brackets to the mast arm to ensure a tight, secure fit utilizing specific banding tools and/or standard tools.

The Contractor shall make adjustments after the assembly is affixed to the mast arm to ensure proper alignment of the signal head.

The Contractor shall ensure a secure fit of the assembly and confirm that the signal head operates in compliance with the approved traffic signal sequence of operation.

- B. MEASURE AND PAYMENT** - Each individual traffic signal head installed will be paid at the Contract unit price. The price will include the signal head housing, the complete mast arm mount signal bracket, the back plate, tunnel visor, terminal lugs, stainless steel banding materials, all miscellaneous hardware and all labor, equipment and materials. The price shall also include insertion, affixing and wiring of the LED module into the signal head. The cost of the LED module is not included in this Pay Item.

### **613.26 OPTICALLY PROGRAMMABLE VEHICLE SIGNAL HEAD ON ANY MAST ARM**

- A. GENERAL** - All provisions in 613.25, except those pertaining specifically to LED Modules, shall pertain to this specification. The Contractor shall perform the following additional Work.

The Contractor shall furnish and install Mast Arm Mount Signal Brackets specifically intended for use with optically programmable traffic signal heads to permit the technician to open the rear door of the signal head.

After the signal head is properly mounted and aimed to the satisfaction of the Engineer, the Contractor shall access the rear door of the signal head and affix tape to the rear lens masking those parts of the intersection where the signal display is not to be seen. All signal head sections of each optically programmable signal head shall be similarly masked in accordance with the specific direction of the Engineer, who will provide specific guidance relative to signal head visibility.

- B. MEASURE AND PAYMENT** - Each individually optically programmable traffic signal head installed will be paid at the Contract unit price. The price will include the signal head with lamps, reflectors and electrical terminal block, the complete mast arm mount signal bracket, the back plate, tunnel visors, terminal lugs, stainless steel bonding materials, programming tape, all miscellaneous

hardware and all labor, equipment and materials required to install, aim and optically program each signal head section, as described herein.

### **613.27 BACK PLATE ON POLE MOUNTED VEHICLE SIGNAL HEAD**

**A. GENERAL** - The Work to be performed is as follows:

1. The Contractor shall identify the vehicle signal head to be retrofitted with a back plate and disconnect the appropriate electrical cables from the terminal block of the controller cabinet.
2. The Contractor shall disconnect the electrical cables from the terminal block of the vehicle signal head and carefully remove the vehicle signal head from the pole by cutting the stainless steel banding connecting the upper and lower mounting brackets to the pole. The cable shall be carefully pulled through the mounting bracket to avoid damage to the insulation or conductors.
3. With the upper and lower mounting brackets attached to the vehicular signal head, the Contractor shall affix the back plates to the vehicular signal head using stainless steel screws or tab inserts furnished by the manufacturer of the back plate.
4. After the back plate is secured to the signal head, the Contractor shall re-mount the signal head, back plate, upper and lower mounting bracket assembly to the pole using new stainless steel banding material. The Contractor shall carefully route the electrical cable through the mounting bracket to the terminal block of the signal head.
5. The Contractor shall make electrical connections to the terminal block of the signal head and to the terminal block of the controller. Electrical connections shall be made after the signal head is firmly secured to the pole. The Contractor shall align the signal head to face traffic and confirm that the signal head operates in compliance with the approved traffic signal sequence of operation.

**B. MEASURE AND PAYMENT** – Each individual back plate installed will be paid at the Contract unit price. The price shall include the back plates, materials to affix the back plate to the vehicle signal head, stainless steel banding materials, and all labor, equipment and materials. The price shall also include the cost to connect and disconnect electrical cable.

### **613.28 OPTICALLY PROGRAMMABLE PEDESTRIAN SIGNAL HEAD ON ANY POLE**

**A. GENERAL** - All provisions of 613.23, except those pertaining specifically to LED modules, shall pertain to this specification. The Contractor shall perform the following additional Work.

Programmable signal heads shall be mounted approximately 12 inches off the pole to permit the technician to open the rear door of the signal head. This shall be accomplished through the use of a 1-1/2 inch diameter steel mounting arm above and below the signal head of sufficient length to permit near door access.

After the signal head is properly mounted and aimed to the satisfaction of the Engineer, the Contractor shall access the rear door of signal head and affix tape to the near lens to mask those parts of the intersection where the signal display is not to be seen. All signal sections of each programmable signal head shall be similarly masked in accordance with the specific direction of the Engineer, who will provide specific guidance relative to signal head visibility.

**B. MEASURE AND PAYMENT** - Each programmable pedestrian signal head installed will be paid at the Contract unit price. The price will include the signal head with lamps, reflectors and electrical terminal block, the upper and lower mounting brackets, universal pole plates, all miscellaneous hardware including terminal lugs, tunnel visors, stainless steel banding materials, programming tape and all labor, equipment and materials required to install, aim, and optically program each signal head section as described herein.

### **613.29 LIGHT EMITTING DIODE (LED) ELECTRONIC SIGN**

**A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure signs conforming to 825.24

The Contractor shall be responsible for the safekeeping and storage of each sign at the Contractor's facility following receipt of the materials from the vendor. Payment to the Contractor by the city may be authorized only after the sign has been delivered to and remains within the District of Columbia. The following LED signs are used in the District of Columbia.

- 18" x 24" ONE WAY RIGHT ARROW

- 18" x 24" ONE WAY LEFT ARROW
- 30" x 30" NO LEFT TURN
- 30" X 30" DO NOT ENTER
- 30" X 30" WRONG WAY
- 30" X 30" USE ALL LANES
- 36" X 36" USE X LANES
- 36" X 36" X LANES AHEAD / USE X LANES
- 36" X 36" BEGIN X LANES

**B. MEASURE AND PAYMENT** - Each individual sign furnished will be measured and paid at the Contract unit price. The price will include the upper and lower mounting brackets, universal pole plate, all miscellaneous hardware including terminal lugs, tunnel visors, stainless steel banding materials, and all labor, equipment and materials.

### **613.30 LIGHT EMITTING DIODE (LED) ELECTRONIC SIGN ON ANY POLE**

After receiving the Engineer's approval of catalog cuts, the Contractor shall procure Light Emitting Diode (LED) Electronic signs conforming to 825.24, and upper and lower mounting brackets and hardware, as described herein. The Work described herein is closely associated with that described in 613.15. The Work is to be performed as follows:

The Contractor shall procure materials described above.

The Contractor shall drill a hole in the pole at the point where the upper sign mounting bracket is to be installed. The hole shall be approximately 1 inch in diameter, and edges shall be machined to remove burrs, which may snag cable.

The Contractor shall prepare the sign for attachment to the pole prior to arriving in the field at the intersection. Tunnel visors may be attached at this time or after the sign is erected.

Pole mounted signs shall be outfitted with upper and lower mounting brackets. This assembly shall feature serrated locking washers at the sign to prevent misalignment. This assembly shall be attached to the sign and to the pole such that a watertight barrier results. This shall be accomplished through the use of washers and/or sealing compound at the pole. The assembly shall consist of 1-1/2 inch diameter steel tubes (nipples) threaded to fit into the pole plate and into the 90 degree ell leading to the sign. The other end of the assembly shall be affixed to a universal pole plate into which the 1-1/2 inch diameter steel nipple can be screwed. The universal pole plate may be constructed from cast aluminum and shall be structured to accept 1 inch wide stainless steel banding strapping above and below the nipple where the plate sits next to the pole. The 1-1/2 inch steel nipple shall be of sufficient length and configuration to match the hardware arrangement of the sign being replaced and to situate the sign equidistant from the pole as the sign being replaced.

The field cable protruding through the hole in the pole is to be carefully routed through the mounting hardware into the sign and connected through the mounting hardware into the sign and connected to the proper terminals in the terminal block of the sign. The Contractor shall make the proper electrical connections of the field cable to the terminal block and ascertain that the connections are secure and consistent with the approved traffic signal sequence of operation. The field cable shall be fitted with terminal lugs for attachment to the terminal block.

The Contractor shall mount the signs to the pole after carefully aligning the universal pole plate to the pole without damaging or crimping field cable. Each new sign will be mounted so that the bottom of the sign is at a height about grade equal to the sign being replaced. The universal pole plate shall be affixed to the pole utilizing 1 inch wide stainless steel banding trapping to points on each pole plate, 1 above and 1 below where the nipple screws into the pole plate. The mounting shall be accomplished with banding tools specifically intended for securing banding strapping and with standard tools.

The Contractors shall ensure a secure fit of the assembly and confirm that the sign operates in compliance with the approved traffic signal sequence of operation.

### **613.31 PEDESTRIAN PUSH BUTTON**

**A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure pedestrian push buttons conforming to 825.15.

The Contractor shall furnish a pedestrian push button with a large mushroom shaped plunger that satisfies the minimum requirements of the Americans with Disabilities Act (ADA). The pedestrian push button must withstand severe impacts without deforming, and cannot be made to stick in the "on" position. The push button must be pressure activated requiring no more than 1 to 3 pounds of force. Visual LED confirmation of actuation is required. The push button shall be operational using the District of Columbia's standard 4 Conductor, 18AWG, Shielded Stranded Cable between the push button and the traffic signal controller.

The Contractor shall drill a hole in the pole at the point where the pedestrian push button is to be mounted. The height of the hole above ground level shall be consistent with the requirements of the Americans with Disabilities Act (ADA) and as shown on the Project Plans.

The hole shall be no more than 1 inch in diameter and of such size that the pedestrian push button completely covers the entire hole. The edges shall be machined to remove burrs which may snag the cable.

The Contractor shall make electrical connections at the terminal block of the pedestrian push button. Appropriate conductor(s) from the 4 conductor 18 AWG lead in cable and a No. 6 bare copper ground cable shall be connected to the pedestrian push button. The ground wire shall be attached to the ground rod in the pole foundation.

After the cable is attached, the pedestrian push button shall be affixed to the metal pole utilizing 3 quarter inch wide stainless steel banding strapping at 2 points on each pedestrian push button, 1 above and 1 below the plunger. The Contractor shall apply a continuous bead of waterproof sealant around the push button at the pole to preclude the flow of moisture and debris to the back of the push button.

- B. MEASURE AND PAYMENT** - Each individual pedestrian push button will be paid at the Contract unit price. The price will include the pedestrian push button, mounting and grounding materials and all labor, equipment and materials required to prepare the pole, make electrical connections, and affix the pedestrian push button to the pole.

### 613.32 ACCESSIBLE PEDESTRIAN SIGNAL (APS) SYSTEM

- A. GENERAL** - The Contractor shall furnish all labor, materials and equipment necessary to install an Accessible Pedestrian Signal (APS) System at signalized intersections. The APS System shall include a pole mounted push button wired directly to a control unit mounted in the pedestrian signal head serviced by that particular unit. The APS pedestrian push button is wired to the traffic signal controller using 4 Conductor, 18 AWG shielded, stranded electrical cable. The District of Columbia's traffic signal system features the Type 170E controller with the Model 336S and Model 336SS cabinets. The control unit must be located in the pedestrian signal head rather than the cabinet because there is not enough room in the cabinet to house this device.

Section 825.08 contains an APS Installation Materials List and the product technical specification within an operations manual. The pole mounted pedestrian push button assembly shall feature a locator tone with a variable volume automatically set by ambient noise. The verbal message to the pedestrian shall emanate from the push button assembly. The Contractor shall procure 1 configuration for each 100 APS push button assemblies ordered. The manufacturer shall program the verbal message to the Department satisfaction. The Contractor shall coordinate the precise wording of the verbal message for pedestrians with the manufacturer.

The Contractor shall be responsible for delivering a fully operational system at each signalized intersection. The Contractor shall also submit to the Department all warranty documents and operating manuals for the products.

- B. MEASURE AND PAYMENT** - Each individual APS pole mounted unit and associated control unit will be paid at the Contract unit price. The price shall include the unit, mounting hardware, programming, electrical cable between the pole mounted push button and the control unit, and all labor, equipment and materials required to install the equipment, make all electrical connections, adjust sound levels and operating patterns and clean up the Work Site to the satisfaction of the Engineer.

### 613.33 RAPID FLASHING BEACONS FOR VISION IMPAIRED CITIZENS AT CROSSWALKS

- A. GENERAL** - Rectangular Rapid Flash Beacons (RRFB) shall be installed by the Contractor at locations specified within the Contract Documents, to serve as warning beacons to supplement standard pedestrian crossing and school crossing warning signs at crossing of uncontrolled intersections.

**B. SPECIFICATIONS**

1. The RRFB shall consist of 2 rapidly and alternately flashed rectangular yellow indicators having LED-array based pulsing light

sources, each a minimum of 5 inches wide by 2 inches high.

2. The RRFB shall have a high-intensity LED indicator that flashes rapidly in a flickering flash pattern at a rate of at least once per second.
3. The light intensity of the yellow indicators shall meet the minimum Specifications of the most recent edition of the Society of Automotive Engineers standard J595 (Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance and Service Vehicles).

#### C. PLACEMENT

1. The RRFB shall be located no more than 12 inches outside the nearest edge of the standard crossing sign it is supplementing and shall be mounted immediately between the static crossing sign and the sign's supplemental arrow plaque.
2. An RRFB shall be used to complement a standard Pedestrian or School Crossing warning sign located at or immediately adjacent to a marked crosswalk
3. An RRFB shall not be used for crosswalks across approaches controlled by Yield signs, Stop signs or traffic signals.
4. In the event sight distance approaching the crosswalk at which the RRFB is used is less than deemed necessary by the Engineer, an additional RRFB may be installed on that approach in advance of the crosswalk, as a warning beacon to supplement a standard Pedestrian or School Crossing warning sign with an "Ahead" plaque..
5. For any approach on which RRFBs are used, 2 standard Pedestrian or School Crossing warning signs shall be installed at the crosswalk, 1 on the right-hand side of the Roadway and 1 on the left-hand side of the Roadway. On a divided highway the left-hand side assembly should be installed in the median, if practical, rather than on the far left side of the highway.
6. An RRFB shall not be installed independent of the crossing signs for the approach the RRFB faces. The RRFB shall be installed on the same support as the associated Pedestrian or School Crossing signs.
7. The outside edges of the RRFB, including its housing, shall not project beyond the outside edges of the associated Pedestrian or School Crossing sign.

#### D. OPERATION

1. The RRFB shall be normally dark, shall initiate operation only upon pedestrian actuation, and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
2. All RRFBs associated with a crosswalk shall, when activated, simultaneously commence operation of their alternating rapid flashing indicators and shall cease operation simultaneously.
3. If pedestrian push button are used to activate RRFBs, a pedestrian instruction sign with the legend "Push Button to Turn on Warning Lights" should be mounted adjacent to or integral with each pedestrian push button.
4. The duration of a predetermined period of operation of the RRFBs following each actuation should be based on the MUTCD procedures for timing of pedestrian clearance times for pedestrian signals.

- E. MEASURE AND PAYMENT** - The unit of measure for installation of RRFBs shall be each, including all labor and materials required to install and activate the RRFB.

Payment shall be made per unit in accordance with provisions of the Contract Documents.

Fiber for telecommunications and power cable shall not be paid separately. Installation of new fiber or power cable trunk lines shall be paid under the applicable Pay Item. Installation of fiber and cable from trunk line to RRFB shall be included in the cost of the RRFB.

### 613.34 INDUCTIVE LOOP DETECTORS

- A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure loop detection cable, loop detector slot sealant and waterproof, encapsulating splice kits conforming to the technical Specifications contained herein and in Sections 613.15 G and 613.15.I, Section 825.20 and the applicable Standard Drawings.

The Contractor shall furnish all labor, equipment and materials for the installation of inductive loop detector(s). Specific loop detectors locations and dimensions are shown on individual Project Plans. The Contractor shall utilize the applicable Standard

Drawings as the guideline to be followed for typical loop detector installation. The following documents the scope of work to be performed.

The Contractor shall be familiar with the installation procedures and materials to be utilized, and shall visit the Site in advance of actual installation. He shall plan and schedule daily operations as to accomplish all secondary tasks prior to commencing actual installation at a particular Site. He shall complete the installation of all loops the same day.

Work shall consist of furnishing and installing loops, conduits and splices between loop detectors and lead-in cables, unless the Contractor can protect the unfinished loops and/or saw cuts from traffic. The Contractor shall furnish all required materials for the Work and shall perform tests on the system satisfactorily, as detailed herein.

The Contractor shall notify the Engineer when the loops are to be installed. The placement of loop wires, the Megger test, and the sealing of the loops shall not be performed except in the presence of the Engineer or Electrical Inspector.

1. **Loop layout** – The Contractor shall lay out all vehicle loops and lead lines using spray paint, with or without template. No saw cutting of the pavement shall be done until the loop layout has been verified by the Engineer or Inspector. Loop locations as shown on the Plans must be maintained.
2. **Loop installation** – The saw cut for the lead-in to the handbox shall be made as close as possible to the curb without marring the curb. The pavement chase from the saw cut end to the curb shall be made with a punch or drill and not by excavating methods.

One 3/4 inch conduit for each loop lead shall be installed under the pavement from end of the saw cut to the hand box. The part of the curb above the pavement shall not be drilled or cut for conduit installation. A bronze bushing shall be installed on the conduit stub out to prevent damage to loop lead-in wires.

The conduit shall be installed in a direct line with the saw cut so that the wires entering the conduit shall not need to be bent. The cover over the conduit shall be of the same material that is used to seal the saw cut.

Self-propelled concrete cutting equipment shall be utilized. The machine shall have the capability of utilizing either a local or tank-supplied water source of adequate pressure to act as a blade coolant, lubricant, and slot cleaner. The diamond blades to be utilized for the saw cut shall provide a clean, well-defined 5/16-inch width saw cut without damaging the adjacent area. The saw cut depth shall be 1-3/4 inches. The saw cuts shall be overlapped to provide full depth at all corners. All saw cuts requiring a right angle turnoff shall be cut at a diagonal to prevent sharp wire bends.

All cuts must be wired and sealed on the same day on which they are made. Loop installations shall not be made when the pavement is wet.

Vehicular traffic shall not pass over an open cut unless the cut is covered by a protective panel.

Immediately after the cutting operation, and just prior to the installation of the wire, the saw cuts shall be checked for the presence of jagged edges or protrusions; cleaned of all cutting dust, grit, oil and other contaminants, flushed by means of water stream; and cleared of water by means of an air stream. The blown air from the compressor shall be free of oil and water.

Care should be taken during the cleaning of the cuts to avoid blowing debris at passing pedestrians and motorists. It is imperative that the saw cut be clean and free of water before the wire installation proceeds.

Loop wires shall be installed from the handbox thru the turn in the loop cuts and back to the hand box in 1 continuous length, without in-line splices. The loop lead-in wires shall be twisted to provide a minimum of 5 turns per foot from loop to pull box.

A minimum of 30 feet of lead-in pair slack shall be coiled and left in the pull box for each loop. The wires for each detector shall be color coded for ease of identification of the separate loops.

The wire shall be type THHN #14 AWG minimum, stranded single conductor. All wire installations must be made without kinks, curls or other damage to the wire or its insulation. The Contractor shall replace any damaged wires at his/her expense.

The wire shall be installed as far down in the cut as possible. A blunt object, similar to a wooden paint stirrer, shall be used to seat the loop wire. In no case shall a screwdriver or other sharp tool be used for this purpose. The wire shall be held in place in the cut during installation by means of hold down strips. The "hold-down" strips shall be approximately 2 inches in length and placed approximately every 2 feet. These strips shall be left in the cuts during pouring of the sealant. The strips shall be polyethylene foam sealant backers similar to Dow Chemical Company's Ethafoam SB, or approved equal.



Prior to pouring the sealant, the loop detector shall be checked for continuity and resistance. In addition, the integrity of the installation shall be checked by applying a 500 volts Megger between each end of the loop lead-in and the nearest reliable electrical ground (e.g., streetlight, fire hydrant, etc.). In the event that no available ground exists, a suitable ground shall be established for the measurement (e.g., driven metal spike). The Megger reading shall be in excess of 100 megohms under any condition. Using a loop detector test kit set at a frequency of 50 KHz, the inductance of the loop detector shall read between 60 and 500 Micro henries. The continuity of the inductance loop assembly is to be tested by connecting each end of the loop detector to the meter and reading the resistance of the assembly in ohms. A low resistance (less than 2 ohms) is desired. This is indicative of a continuous loop detector assembly with no breaks or points of high resistance in the wire. A resistance value greater than 5 ohms shall be deemed unacceptable. Unacceptable test results shall require the removal of the existing loop detector and the installation of a replacement loop detector. All loop detector tests shall be performed in the presence of a District of Columbia electrical Inspector.

The Contractor shall record the location and Megger readings, and indicate satisfactory compliance with continuity check. Reading and test equipment data shall be submitted for the record.

The Contractor shall utilize loop detector slot sealant specified in 825.20. The sealant shall not react with the cable insulation or adjacent pavement so as to create deterioration to these products.

The sealant shall be poured over the wire, half filling both the loop and lead in cuts. A check shall be made for air bubbles or material pile up and then the cuts are filled to Roadway level. Excess sealant shall be removed by means of a "Squeegee". In all cases, there shall be neither a trough nor a mound formed.

The sealant, when poured into a saw cut, shall completely surround the wires, displace all air therein, and completely fill the area of the cut, except for that portion filled with the wire hold down material.

The Contractor shall allow sufficient time for the sealant to harden in accordance with the manufacturer's instructions (minimum of two (2) hours) before allowing traffic to move over the area unless it is covered by a protective panel. The Engineer will determine when the hardening is acceptable.

The Contractor shall complete the loop detector installation by splicing in the handbox the loop detector cable with the loop detector lead-in cable. The splice kit used by the Contractor shall create a waterproof splice totally encapsulating all conductors. The Contractor shall maintain at least 3 feet of slack cable in both wires after splicing is completed.

Before leaving the Site, the Contractor shall repeat the entire resistance and continuity test specified above. The report should be given to the Engineer for comparison with the first report, and shall show no appreciable change.

- B. MEASURE AND PAYMENT** - The unit of measure shall be the number of linear feet of saw cut excluding diagonal cuts to facilitate wire installation, but including lead-in cuts to the face of curb. The actual number of linear feet measured will be paid at the Contract unit price. Payment shall include all labor, materials and equipment required by the Contractor to complete the job described herein.

### 613.35 MICROWAVE VEHICLE DETECTOR

- A. GENERAL** - After receiving the Engineer's approval of catalog cuts, the Contractor shall procure microwave vehicle detectors and the microwave detector isolation module with 12 VAC output conforming to 825.19. The Contractor will furnish 1 TCPS-1 card and 1 TCPS-2 card for each microwave detector assembly provided. The TCPS-1 card is used when there is only 1 detector on the signal phase and the TCPS-2 card must be used when there are 2 detectors on the same phase to eliminate intermittent detection.

The Contractor shall drill a hole in the pole at the point designated on the Plans where the microwave vehicle detector is to be mounted. Typically, microwave detectors are mounted as high as possible on the designated pole. The hole shall be approximately 1 inch in diameter and of such size that the microwave vehicle detector completely covers the entire hole. The edges shall be machined to remove burrs which may snag the cable. The cable coming out of the pole shall feature a drip loop to preclude the possibility of moisture re-entering the inside of the pole. The Contractor shall also affix a rubber grommet or a bead of sealant to completely close this hole after the bracket is attached.

The Contractor shall pull the 4 conductor 18 AWG lead-in cable through the hole and make electrical connections with the appropriate conductors to the terminal block of the microwave vehicle detector.

After the cable is attached, the microwave vehicle detector shall be affixed to the metal pole utilizing 1 inch wide stainless steel

banding strapping at 2 points on the microwave vehicle detector, 1 above and 1 below the device. The Contractor shall apply a continuous bead of waterproof sealant around the microwave vehicle detector at the pole to preclude the flow of moisture and debris to the back of the detector.

The Contractor shall aim the microwave vehicle detector to point in the precisely desired direction, as instructed by the Engineer. After proper orientation is obtained, the unit shall be secured to maintain the desired orientation according to manufacturer's Specifications.

The Contractor shall install the Microwave Detector Isolation Module with 12 AC Output into the appropriate rack on the controller cabinet and make proper electrical connections.

The Contractor shall ensure that the pole mounted detector and the isolation module perform satisfactorily. After the traffic signal is energized and placed into service, the Contractor shall troubleshoot the system and fine tune the detector to produce the desired level of detection, as directed by the Engineer.

- B. MEASURE AND PAYMENT** - Each individual microwave vehicle detector with the microwave detector isolation module with 12 VAC output will be paid at the Contract unit price. The price will include the equipment, pole mounting hardware, and all labor, equipment and materials required to install the equipment, make electrical connections and fine tune the detector to the satisfaction of the Engineer.

### 613.36 MAGNETIC SENSOR DETECTORS

- A. GENERAL** - This Work shall consist of furnishing and installing a 2-way wireless, battery-powered magnetometer vehicle detector unit, as specified in 825.29 and as approved by the Engineer. This Work shall include all necessary hardware to install the units within any roadway surface (asphalt or concrete) and to convey the data to either an Access Point (AP) or Repeater (RP) (paid for separately).

#### **B. SPECIFICATIONS**

- 1. Sensor placement** - Each sensor shall be installed in the Roadway using the following procedure:

- a. Core drilling the asphalt or concrete pavement to provide a 4-inch diameter hole, a minimum of 2.5-inches deep, or as deep as 8-inches, as shown on plan sheets. Add a 1/4 inch layer of sand to cover the bottom of the hole.
- b. The sensor shall be placed on top of this layer of sand, within a protective plastic housing in the correct orientation as clearly marked on the sensor and as approved by the manufacturer.
- c. The sensor shall be fully encapsulated with the epoxy to the lip of the cored hole.

Each installation of a 2-way Wireless Battery-Powered Magnetometer vehicle detection system (VDS) shall consist of 1 or more sensors installed in the center of each traffic lane, avoiding sources of magnetic noise such as underground power cables, manholes, underground metallic junction boxes and vaults, overhead high tension power cables, light rail or subway tracks, and power generation stations and sub-stations. Any sensors placed over a Metro subway line, shall be specially calibrated to account for this potential disturbance to the sensor. Upon calibration, the sensor shall operate as per the manufacturer's Specifications.

The sensors shall be located as specified by the intersection Plans. For count applications, sensors shall be placed in areas with minimum stop-and-go traffic flow.

- 2. Speed** - At least 2 sensors are required in each lane to determine speed and direction separated according to the distances as shown in the Plans.
- 3. Detection data** - If detection data is relayed to a central software system or central server, each installation of the 2-way Wireless Battery-Powered Magnetometer VDS shall provide at least the following measurements, as required by the application:
  - a. Vehicle flow rate (count) per lane over a specified time interval.
  - b. Lane occupancy (percent) over a specified time interval.
  - c. Vehicle speed per lane (mph or kph) and
  - d. Classification.

4. The time interval for measurements shall be configurable to include at least the following intervals: ten (10) seconds, thirty (30) seconds, one (1) minute, five (5) minutes, fifteen (15) minutes, one (1) hour and twenty-four (24) hours.
5. All sensor components shall have a minimum of a 2-year warranty that includes product defects in materials and workmanship under normal use from the date of acceptance. If a hardware defect arises the manufacturer shall exchange the product with a product that is new or which has been manufactured from new or serviceable used parts and is at least functionally equivalent to the original product. A replacement product or part, including a user-installable part that has been installed in accordance with instructions provided by the manufacturer, assumes the remaining warranty of the original product or ninety (90) Calendar Days from the date of replacement or repair, whichever provides longer coverage.

During the warranty period, technical support shall be available from the supplier via telephone within twenty-four (24) hours of the time a call is made by a user, where this support shall be provided by factory-authorized personnel or factory-authorized installers

- C. MEASURE AND PAYMENT** - Each sensor shall be paid for at the Contract unit price of each. The price shall include the cost of the sensor and all required labor equipment and materials to install the sensor in the field and render the traffic VDS operational. This Work includes all coring, sensor setting, epoxy fill, sensor calibration, testing, and furnishing documentation to complete the Work.

### 613.37 SENSOR REPEATER ON ANY POLE OR STRUCTURE

- A. GENERAL** - This Work shall consist of furnishing and installing a wireless, battery-powered sensor repeater onto a wooden pole, bridge structure, or a metal overhead lighting pole, traffic signal pole, or mast arm, as specified and as approved by the Engineer. This Work shall include all necessary hardware (including manufactures pole extension hardware) and electrical connections to install the units on an existing metal overhead lighting pole, traffic signal pole, or mast arm and to convey the data from a magnetic sensor detector to a traffic counter control cabinet, via an Access Point (paid for separately). This Work also includes the trimming of any tree limbs or branches to provide a clear line of sight between the sensor repeater and the access point or another sensor repeater or sensors.
- B. SPECIFICATIONS**
1. **Repeaters (RP)** - A repeater shall support at least 10 sensors.
  2. A repeater shall be battery-powered (ten (10) year battery life) by a field replaceable battery and shall operate at temperatures from -37° F /-38.3° C to +176° F / +80° C.
  3. All RP components shall be contained within a single housing that conform to NEMA Type 4X and IEC IP67 standards.
  4. The Contractor shall provide all materials required to successfully install the repeater units onto an existing metal traffic signal pole, lighting pole and mast arm, as per the manufacturer's recommendations. The Contractor shall also provide a weatherproof permanent name plate identification tag on every Repeater with their corresponding 8 digit number, as illustrated on the plan sheets. The identification tag shall be approved by the Department prior to installation by the Contractor.
  5. All sensor repeater components shall have a minimum of a two (2) year warranty that includes product defects in materials and workmanship under normal use from the date of acceptance. If a hardware defect arises the manufacturer shall exchange the product with a product that is new or which has been manufactured from new or serviceable used parts and is at least functionally equivalent to the original product. A replacement product or part, including a user-installable part that has been installed in accordance with instructions provided by the manufacturer, assumes the remaining warranty of the original product or 90 Calendar Days from the date of replacement or repair, whichever provides longer coverage.
  6. During the warranty period, technical support shall be available from the supplier via telephone within 24 hours of the time a call is made by a user, where this support shall be provided by factory-authorized personnel or factory-authorized installers
- C. INSTALLATION COORDINATION** - The Contractor shall coordinate the installation of all Repeaters onto a metal overhead lighting pole, traffic signal pole, or mast arm with the appropriate authority (PEPCO or the Department) before any work begins. Failure to properly coordinate with PEPCO or the Department, which lead to Project delays, is the sole responsibility of the Contractor. The Department is not responsible for utility coordination between the Contractor and the utility company.

- D. MEASURE AND PAYMENT** - Each sensor repeater shall be paid for at the Contract unit price of each. The price shall include the cost of the repeater and all required labor equipment and materials to install the repeater in the field (on an existing metal overhead lighting pole, traffic signal pole, or mast arm) and render the traffic VDS operational. This Work includes all mounting hardware, wiring, repeater calibration, testing, and furnishing documentation to complete the Work.

### 613.38 SENSOR ACCESS POINT ON ANY POLE

- A. GENERAL** - This Work shall consist of the Contractor furnishing and installing a sensor access point onto a metal overhead lighting pole, traffic signal pole, or mast arm, as specified and as approved by the Engineer. This Work shall include all necessary hardware (including manufactures pole extension hardware) and electrical connections to install the units on an existing metal overhead lighting pole, traffic signal pole, or mast arm, pole and to run Category-5e (CAT-5e) cable to convey the data from the access point to a traffic counter control cabinet. This Work also includes the trimming of any tree limbs or branches to provide a clear line of sight between the sensor repeater and the access point or another sensor repeater or sensors.

#### B. SPECIFICATIONS

1. **Access point (AP)** - An AP shall support the relay of sensor detection data through several interfaces as required by the application
    - a. As an option, detection data shall be communicated over TCP/IP via an integrated 10/100BaseT Ethernet interface.
    - b. The AP shall be capable of simultaneously communicating detection data via the contact closure interface, optional Ethernet interface, and optional cellular data modem interface.
    - c. Each sensor, AP shall be capable of accepting software and firmware upgrades.
    - d. The Wireless Battery-Powered Magnetometer VDS shall provide software operating on conventional notebook/portable PCs to support configuration of a sensor, configuration of an AP, configuration of an RP, and to store and retrieve detection data.
    - e. An AP shall support at least 48 sensors and shall be factory-configurable to support at least 2 different power options: Isolated nominal 48 VDC (36-58 VDC) input, consuming a maximum of 3W and providing 1500 V isolation and 5 kV surge protection; via a non-isolated nominal 12 VDC (10-15 VDC) input, consuming a maximum of 2W. The Contractor has the option of using a Power over Ethernet (PoE) injector. The specific PoE shall be submitted to the Department for approval before being utilized.
    - f. An AP shall operate at temperatures from -37 °F / -38.3 °C to +176 °F / +80 °C and shall be contained within a single housing that conforms to NEMA Type 4X and IEC IP67 standards.
    - g. The Contractor shall provide all materials required to successfully install the Access Point units onto an existing metal traffic signal pole, lighting pole and mast arm, as per the manufacturer's recommendations. The Contractor shall provide a weatherproof permanent name plate identification tag on every Access Point and Repeater Provide with their corresponding 8 digit number, as illustrated on the plan sheets. The identification tag shall be approved by the Department prior to installation by the Contractor.
    - h. All sensor AP components shall have a minimum of a two (2) year warranty that includes product defects in materials and workmanship under normal use from the date of acceptance. If a hardware defect arises the manufacturer shall exchange the product with a product that is new or which has been manufactured from new or serviceable used parts and is at least functionally equivalent to the original product. A replacement product or part, including a user-installable part that has been installed in accordance with instructions provided by the manufacturer, assumes the remaining warranty of the original product or 90 Calendar Days from the date of replacement or repair, whichever provides longer coverage.
    - i. During the warranty period, technical support shall be available from the supplier via telephone within 24 hours of the time a call is made by a user, where this support shall be provided by factory-authorized personnel or factory-authorized installers.
- C. INSTALLATION COORDINATION** - The Contractor shall coordinate the installation of all Access Points onto a metal overhead lighting pole, traffic signal pole, or mast arm with the appropriate authority (PEPCO or the Department) before any work begins.

Failure to properly coordinate with PEPCO or the Department, which lead to Project delays, is the sole responsibility of the Contractor. The Department is not responsible for utility coordination between the Contractor and the utility company.

- D. MEASURE AND PAYMENT** - Each Access Point shall be paid for at the Contract unit price of each. The price shall include the cost of the access point and all required labor equipment and materials to install the access point in the field (on an existing metal overhead lighting pole, traffic signal pole, or mast arm) and render the traffic VDS operational. This Work includes all mounting hardware, wiring, electrical and data connection to the communication modem within the controller cabinet, calibration, testing, and furnishing documentation to complete the Work.

### 613.39 VIDEO TRAFFIC FLOW DETECTION SYSTEM (VTFDS)

- A. GENERAL** - The Work to be performed under this section consists of furnishing, installing and wiring of the complete Video Traffic Flow Detection System (VTFDS) at the locations shown on the Plans and in accordance with the conditions set forth. The Work also includes testing, training, warranties, and guarantees as designated in the Specifications.

1. The VTFDS shall have the following general high level requirements
    - a. The system shall be non-intrusive.
    - b. The system shall use video image processing technology.
    - c. The system shall at a minimum collect volume, classification (3 or 4 types), speed, and occupancy.
    - d. A single system shall be capable of continuously collecting data for up to 6 lanes of traffic.
    - e. The camera shall be mounted on an overhead Structure directly over the travel lanes.
    - f. The collected data shall be stored in the field for at least 30 continuous days.
    - g. The system shall enable data collection through the Departments traffic signal communication network.
  2. The VTFDS shall consist of
    - a. A self-contained Video Traffic Sensor, camera lens, mounting equipment, all other associated hardware
    - b. 4-inch diameter GRS conduit, 4-foot extension pole.
    - c. Video Detection System Processor
    - d. Video Detection System Processor Software for installation and subsequent maintenance tasks
    - e. VTFDS Central Software
    - f. VTFDS Central Hardware
- B. MATERIALS** - All the materials shall contain all of the components described in the subsequent material Specifications. All necessary incidental components, cables, and hardware, shall be supplied to accomplish a fully operational VTFDS installation. All equipment and component parts furnished shall be new, and shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.
1. **Video Camera Sensor** - As a minimum, meet the following requirements for each camera installation. Use a camera sensor that is compatible with the video detection system processor and meets the following requirements:
    - a. *Lens* - Equip the video camera sensor with an eight-48 mm motor driven variable focal length lens
    - b. *Input Power* - 120 VAC, 60 Hz. Size power conductors from the power source to the camera input so that no more than a 3 percent drop is experienced (NEC 210-19a., FPN No.4). Include a provision at the rear of the camera enclosure for waterproof connection of power and video signal cables.
    - c. *Electromagnetic Interference (EMI)* – Apply FCC Part 15, Subpart J, Class A device requirements for the video camera sensor and associated connected equipment in their installed condition. .

- d. *Video Camera Sensor Enclosure* - Install the video camera sensor in a light colored enclosure to limit solar heating. Meet NEMA 250 Type 4 enclosure for the enclosure and pressurize the enclosure at least 5 psi  $\pm$  1 psi) to prevent sand, dirt, dust, salt, and water from entering. Provide a sun shield visor on the front of the enclosure which is sufficiently adjustable to divert water away from the video camera sensor lens and also prevent direct sunlight from entering the iris when mounted in its installed location. Install the sun shield so that it does not impede operation or performance accuracy of the video camera sensor or require removal of the video camera sensor enclosure for adjustment. Use an enclosure that allows the video camera sensor horizon to be rotated in the field during installation.
- e. *Weight* - 10 lbs maximum with mount, shield, and camera.
- f. *Mounting* - Ensure that video camera sensor assembly and associated enclosure and sun shield are capable of being mounted without special tools, fixtures, or holding devices. The video camera sensor horizon shall be adjustable without removing the camera, mounting bracket and enclosure, or sun shield.

## 2. Video Detection System Processor

- a. *Mounting* - Ensure that the video detection system processor is rack mountable in the Department 336SS Controller Cabinet.
- b. *Electrical* - Power the video detection system processor by 120 VAC, 60 HZ, single phase, and draw a maximum of 1.0A. Size power conductors from the power source for the video detection system processor input so that no more than 3 percent voltage drop is experienced (NEC 210-19a., FPN N0.4). The video detection system processor shall have transient protection that meets the requirements of NEMA TS1-1994 and NEMA TS2-2003. Power to the video detection system processor shall be from the cabinet equipment outlet.

Communicate to the traffic control center for downloading traffic data stored in non-volatile memory, via Spread Spectrum wireless communications to the Departments traffic signal communications network.

Ensure that the video detection system processor software is stored in non-volatile memory within the video detection system processor. Perform software updates through dial up port.

The video detection system processor front panel shall include a visual display of the status of each video input and the status of the video detection system processor in general. Indicators shall display, at a minimum, the status of video detection system processor communications, the status of the video detection system processor and whether or not video camera sensor is actively detecting.

Include an embedded HTTP server in the video detection system processor. The embedded HTTP server shall allow a remote user with a standard web browser to gain remote access, collect data, control, and configure the VTFDS. The server shall include multilevel password protection for a minimum of 10 users. The VTFDS shall also keep an access log that records MTFDS user and time of access.

Provide 2 RS-170A black and white composite video inputs on the video detection system processor such that signals from up to 2 video camera sensors or other synchronous or non- synchronous video sources can be processed in real time. Use BNC connectors on the front or back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

- c. *Remote Data Collection and Storage* - Detection Parameters: Provide a video detection system processor that independently computes the following traffic parameter data in each lane of detection:
  - i. Volume
  - ii. Speed
  - iii. Occupancy
  - iv. Vehicle classification (3 or 4 types)
  - v. Interval Duration - Provide a video detection system processor capable of computing and storing all traffic parameters by lanes in user selectable time intervals of one (1) minute, five (5) minutes, ten (10) minutes, fifteen (15) minutes, thirty (30) minutes, and sixty (60) minutes.

- vi. Memory - Store all traffic parameter data in non-volatile memory within the video detection system processor. This data shall be capable of being retrieved through a HTTP server or through a dial up connections. The memory shall have the capacity to store data for 30 continuous days.
  - vii. Data Retrieval - Transfer traffic parameter data from the video detection system processor's non volatile memory to the Department administrative building through a dial up connection.
- d. *Detector Configuration*
- i. Storage Format - Store collected traffic parameter data that is retrieved from the video detection system processor in readily accessible ASCII format.
  - ii. Data Display Format - Allow for displaying the collected traffic parameter data in the numeric format. Image Capture: Allow still image capture (snapshot) from all of the video detection system processor's active video inputs and provide for downloading the image for display or storage as a picture file. Capture and transmit the still image in JPEG format to transmit to the TMC.
  - iii. Communications - Perform communications to video detection system processor for detector configuration through the dial up communication.
3. **Cabinet Equipment**
- a. *Wiring, Conductors and Terminal Blocks* - Use terminal blocks and strips with voltage and current ratings greater than the voltage and current ratings or the wires that are terminated on the blocks or strips. Use Quick-clamp type wire terminals (Conch QC-1 or approved equivalent) optionally on TB 10. TB 10 shall have at least 8 terminal positions. Do not use compression-type or tubular clamp terminal blocks except for service entrance block SE. Do not use spade lug terminals for any terminal block.
  - b. *Surge Protection* - Provide full I/O surge protection, with additional devices to protect the equipment and cables from surges and over-voltages.
4. **Functional Requirements** - As a minimum, provide these features and capabilities that directly affect the overall operational performance.
- a. *Functional Detections* - Provide a VTFDS that performs the following functions:
    - i. Vehicle counting
    - ii. Vehicle speed
    - iii. Vehicle classification
    - iv. Per vehicle data acquisition
    - v. Per lane data acquisition
  - b. *Functional Output Parameters* - Provide a VTFDS that outputs at least the following detections parameters on a per lane basis: Volume, speed, occupancy, and vehicle classification.
  - c. *Video Detection System Processor Equipment and Software* - Provide video detection system processor equipment that gives an operator the capability to define multiple detection zones within each individual camera sensor's field of video at the video detection system processor via the configuration software. Provide flexibility in definition of the zones and response and processing time of each zone.
5. **VTFDS Firmware** - The Contractor shall provide VTFDS system firmware compatible for integration with the Department's current ATMS central software with functionalities and capabilities as identified in these Specifications.
- a. *VTFDS Central Hardware* - The system software will be installed in the hardware provided as part of other Pay Item as identified in these Specifications.
  - b. *Environmental*

- i. Video Detection System Processor - Provide a video detection system processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA TS-1 19944.
- ii. Video Camera Sensor - Operating ambient temperature range: -30<sup>0</sup>F to 140<sup>0</sup>F. Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interface with the operation of the video camera sensor electronics, or cause interference with the video signal.
- iii. Humidity - 5 – 95% per NEMA TS1-19944
- iv. Vibrations - Provide a video camera sensor and enclosure that maintains its functional capability and physical integrity when subjected to a vibration of 5 to 30 Hz up to 0.5 gravity applied to each of 3 mutually perpendicular axes (NEMA TS1-1994)
- v. Shock - Ensure the video camera sensor and enclosure can withstand a 10G + 1 G shock. Neither permanent physical deformation nor inoperability of the video camera sensor and enclosure can be sustained as a result from this shock level.
- vi. Acoustic Noise - Provide a video camera sensor that can withstand 150 dB for three (3) minutes continuously with no reduction in function or accuracy.

### C. CONSTRUCTION

1. **Installation** - Install all video camera sensors, video detection system processors, and equipment at the locations specified in the Plans. Install all rack mounted equipment with 1 rack unit space between adjacent equipment. Make all necessary adjustments and modifications to the total VTFDS system prior to obtaining the Department recommendation for system acceptance.
2. **Functional Output Protocol** - TFDS software from the the Department administrative building shall be able to open up connection to receive polled data from the TFDS. Ensure that TFDS can process polling requests to maintain a minimum 30 seconds polling cycle.
3. **Camera Sensor Operating Locations** - Adjust the video camera sensor lens to match the width of the road and minimize lane vehicle occlusion. Mount the camera at the top of the specified structure for that location as shown on the Plans.
4. **Cabinet Equipment** - Install the cabinet equipment including wiring, conductors and terminal blocks, surge protectors, and other components as per provisions as identified for the NEMA Type 336S Classification/Count Cabinet.
5. **Cables, Conduit, and Power Service** - Furnish and install electrical cables used for the detector control, communications signaling and power supply as shown in the Detail Drawings. Do not splice any cable, shield or conductor used. Identify all conductors for all cables by color and number. Identify the conductor function in as-built documentation (see next section). Terminate cable used for video signaling in BNC connectors. After terminating and dressing the cables in the cabinet, neatly coil and store a minimum of 2 feet of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back unused conductors over their outer jackets and individually tape them.

Provide electrical cables for the detector, communications signaling and power supply between the cabinet and the devices as required below and install them in accordance with manufacturer's instructions.

Beginning at individual video camera sensors, carry video signal from the camera to the pole-mounted junction/splice cabinet via coaxial cable to the video detection system processor located in the field cabinet. Transmit the vehicle traffic data from the video detection system processor to the traffic control center via the dial up communications.

Install cabling inside new hollow metal or concrete support poles unless otherwise specified. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and changing against the pole device or bracket. Form a drip loop at the weather head and route cabling to minimize water entry into the cable connector.

6. **As-Built Drawings** - Provide As-built drawings as identified in these Specifications. Place all documentation in a weatherproof holder in the cabinet.
7. **Training** - Provide Training as identified in these Specifications.



**D. MEASURE AND PAYMENT** - Video Traffic Flow Detection System (VTFDS) will be measured and paid for at the Contract unit price per each system. Each system may contain 1 or more cameras. The payments will be full compensations for furnishing, installing the detector in a manufacturers and the Department approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from the Department's TMC and furnishing documentation to complete the Work including the following:

1. Camera Sensor, Sensor lens, and mounting assembly with all associated hardware
2. All weather heads, vertical conduit risers, and conduit hardware on the VTFDS support pole for power service, grounding, communication and control.
3. All hardware and material necessary to provide electrical power services to the VTFDS field location as shown in the Plans.
4. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any VTFDS component.
5. **VTFDS Central System Software** - The central hardware and modem shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate Pay Item. However, the Contractor is responsible under this item to the complete installation, setup and configuration, and acceptance of the VTFDS.

All the items will be paid for only after the complete installation, setup and configuration, testing, and acceptance of the VTFDS.

#### 613.40 MICROWAVE TRAFFIC FLOW DETECTION SYSTEM (MTFDS)

**A. GENERAL** - This Work shall consist of furnishing and installing side-fired, radar based vehicle detectors, as specified and as approved by the Engineer. This Work shall include all necessary hardware and electrical connections to install the units on a traffic pole (paid for separately) and to convey the data to a traffic counter control cabinet (paid for separately).

1. All component parts shall be designed, manufactured, tested, and installed in compliance with the following codes and standards:
  - National Fire Protections Association (NFPA 20, 70, 75, & 780)
  - Underwriters Laboratories (UL 1283 and UL 1499)
  - International Standard Organization (ISO) – The Manufacturers shall be certified ISO 9001 for manufacturing design and service.
  - Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
2. Side-fired radar-based vehicle detectors shall be easy to install and remove, and shall be fully programmable to support a variety of applications. In general:
  - a. All Equipment and component parts furnished shall be new, be of the latest design and manufacture, and be in an operable condition at the time of delivery and installation.
  - b. All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturers recommendations and standard practices.
  - c. The design shall be such as to prevent reversed assemble or improper installation of connectors, fasteners, etc.
  - d. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments and maintenance.
  - e. The designed Mean Time Between Failures (MTBF) of the MTFDS unit, operating continuously in their application, shall be 10 years or longer.
3. **Area of Coverage** - The MTFDS's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall be as follows:

TABLE 613.40

Elevation Beam Width	45 degrees
Azimuth Beam Width	15 degrees
Range	10 to 200 feet

4. The MTFDS shall be a true presence detector which can provide presence, volume, lane occupancy, speed information and a minimum of 3 vehicle classifications on up to 6 discreet detection zones. The Contractor shall furnish and install the unit which captures the maximum number of vehicle classes available in the market at the time of purchase.
  - a. The information from the detector(s) shall be conveyed via spread spectrum radio available to existing controller via contact closure pairs and to other systems via serial communications lines.
  - b. The minimum number of detection zones shall be 6. The range limits of each zone shall be user defines in 7 feet resolution.
    - i. The detector shall identify vehicles presence within each detection zone with a 95 percent accuracy or greater, independent of the vehicle's direction of travel through the detection zone.
    - ii. The maximum permissible error shall be 5 percent in the detection of the direction and magnitude of radial speed and 10 percent in the case of transverse speed.

#### B. ELECTRICAL REQUIREMENTS -

1. **Equipment Cabinet** - Shall be a Type 332, or Pole-Mounted NEMA TS-2 Size 4 or 5 Cabinet, as shown on the Plans.
2. **Communications** - RF Wireless Modem to the nearest Traffic Signal Control cabinet.
3. **Input Power**
  - a. 12 – 24 VAC/DC
  - b. 95 – 135 VAC at 60Hz.
  - c. Power Consumption - 6 Watts
4. **Other Power Sources** - Power shall be obtained from the power distribution assembly, or from a 15-20 amp branch circuit from an existing cabinet, or from a solar power assembly as shown on the Plans.
5. **MTFDS Interface** - The interface at the MTFDS shall consists of a single MS connector which shall provide:
  - a. Power to the unit
  - b. Output contact closure wire pairs for each of the required detection zones, and
  - c. Serial communication lines for programming, testing or modem interface at 9600 Baud rate. The data format of the serial port shall be standard binary NRZ 8 bits data, 1 stop bit, no parity.
6. **Cable** - A UV-resistant cable of multiple twisted pairs of stranded AWG 20 wires with a common shield rated at 300V with a temperature rating of 105 degrees Celsius shall be used to provide a connection between the MTFDS and the cabinet equipment.

#### C. ENVIRONMENTAL - Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any of the following environmental conditions:

1. Ambient temperature range or -37 to +74 degrees Celsius
2. Relative humidity from 5 to 95 percent, non-condensing
3. Except as mat be otherwise stated herein for a particular item, no item, component, or sub-assembly shall emit a noise level exceeding the peak level of 55 dBa when measured at a distances of 1 meter away from its surface.
4. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcomes adverse effects due to temperature in the specified environmental range.

**D. INSTALLATION** - The MTFDS shall be mounted in the side-fired configuration, as directed by the Engineer.

It shall be mounted on poles or sign structures at the specified locations, using the supplied mounting brackets. The brackets shall be attached with approved 3/4 inch wide, .025 inch thick, stainless steel bands or to a concrete wall/bridge using 2 stainless steel expansion bolts of sufficient length and diameter to support 100 pounds.

The Contractor shall install the detector unity on a pole at a height of between 17-23 feet above the road surface, or as per manufacturer's recommendation, so that the masking of vehicles is minimized and that all detection zones are contained within the specified evaluation angle as suggested by the manufacturers.

The MTFDS detection zones shall be setup using the provided software and Notebook PC.

**E. MECHANICAL** - The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 MPH, dust and airborne particles, and exposure to moisture (NEMA type 3R enclosure)

The mounting assembly shall have all painted steel, stainless steel, or aluminum construction, and shall support a load of 20 pounds.

The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be titled in both axes then locked into place.

The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent.

The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test Ea), NEMA TS-1 (Section 2.1.13).

**F. CIRCUITRY PROTECTION** - All conduit connections to the MTFDS enclosure shall be watertight and allow for adjustment of the MTFDS for optimum viewing. Methods and materials used shall be approved by the Engineer, prior to installation of the signs.

Where a cable or wire passes through a hole or runs along a surface at any point through or on a completed assembly, such holes and/or surfaces shall be deburred and void of any sharp edges that may damage the cable or wire passing through or along the surface. All deburred holes shall be equipped with a rubber or plastic grommet.

The Contractor shall install all connections between the microwave unit and the controller cabinet in accordance with the recommendations of the MTFDS manufacturer.

All terminal blocks and strips located within the control cabinets shall be accessible to the extent that it shall not be necessary to remove any equipment from the housing to make an inspection or connection.

All wires shall be cut to their proper length before assembly. No wire shall be doubled back to make up for unnecessary slack. However, sufficient slack shall be provided such that any wire end can be cut back, re-stripped and connected at least twice.

All electrical connections in the MTFDS enclosures and cabinets shall have sufficient clearance between each terminal and the housing so as to prevent a leakage path or physical contact under stress. The lay of the interconnect cables between components shall be such that when the housing door is closed, it will not press against the cables or force the cables against various components inside the housing.

The ground side of service shall be carried throughout all MTFDS enclosures and control cabinets without a break. All equipment grounds shall run directly and independently to the ground bus. The grounding strip shall be connected directly to the housing wall.

**G. LABELING** - A block diagram of all components illustrating all connectors and connections used to interconnect the components, wiring diagrams and schematic drawings of all circuits shall be inserted in a re-sealable weather-resistant pocket that is permanently mounted on the inside of an accessible door in the ground-mounted controller cabinet.

The component name and model number shall be inscribed using a permanent label or laminoid name plate in a position adjacent to the location of each major or replaceable component on the inside of the cabinet and enclosure.

All devices, components, cables and wires shall be indelibly identified on permanently attached labels designed for use in the intended environment using labels approved by the Engineer, and inscribed in accordance with the approved schematic Shop Drawings showing the component layout.

All internal connectors and wire terminations shall be labeled with sufficient information to locate its connection point without recourse to any other documentation located outside the controller cabinet or enclosure.

- H. MEASURE AND PAYMENT** - Microwave Traffic Flow Detection System (MTFDS) will be measured and paid for at the Contract unit price per each. The payments will be full compensations for furnishing, installing the detector on a pole (paid for separately), configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from the Department's TMC and furnishing documentation to complete the Work.

#### **613.41 INFRARED TRAFFIC FLOW DETECTION SYSTEM (ITFDS)**

- A. GENERAL** - Work under this item will consist of furnishing, and installing an infrared non-intrusive traffic flow detection system at locations denoted on the plan set. The system shall consist of all mounting equipment, conduit, cabling, and power and communications equipment for a fully functional infrared detection station. The data from this device will be conveyed to a traffic count control cabinet. This data will be conveyed, via the existing Department traffic signal system, to a data base located at the TMC.

- B. MATERIAL** - At a minimum, the Contractor shall provide an infrared non intrusive traffic flow detection system with the following functionality:

##### **1. Data Collection and Storage Requirements**

- a. The system shall provide the following information:
  - i. Speed (Mph)
  - ii. Volume
  - iii. Occupancy
  - iv. Lane of Travel
  - v. Vehicle Classification description
  - vi. Vehicle Classification - 13 classifications
  - vii. End-to-end axle separation
- b. A single system shall be capable of continuously counting vehicle axle classification for multilane highways up to 4 lanes of traffic in each direction for a total of 8 lanes.
- c. The system shall have a detection range of 10 to 330 feet.
- d. The system shall have user-definable detection zones, which are programmable with an external personal computer or a handheld palm.
- e. The system shall be able to collect and store the collected data in fifteen (15) minute increments for a minimum of thirty (30) days. Data collection duration shall be configurable from one (1) minute to fifteen (15) minutes.
- f. The system shall have an internal memory to store data for thirty (30) continuous days.
- g. Accuracy: Between 90 percent to 100 percent for vehicle volume and classification, per lane

##### **2. Installation Requirements**

- a. The system shall be non intrusive, mounted on the ground (either on the curbside or in concrete barrier) by the roadside providing a low profile. The system shall be enclosed in a durable, NEMA 4X rated enclosure as to not allow water or other corrosive materials interfere with the operations of the units. When the units are installed in curb or barrier applications, the enclosure shall not impede the operations of vehicles or pedestrians by creating an unsafe situation.
- b. The Contractor shall verify that the infrared beams are leveled, as per the manufacturer's recommendations, to promote 95 percent accuracy in volumes speed and classification.
- c. The system shall be deployable for permanent application.
- d. The system shall not obstruct the vehicle or pedestrian traffic.
- e. The system shall be secured against vandalism.

- f. The system shall be safe for operation and maintenance,

### 3. Power Requirements

- a. The system shall be able to accept power via the following options:
  - i. 12 VDC internal power using cell batteries
  - ii. 12 VDC external power using a single 12 V battery
  - iii. 12 VDC solar power with battery
  - iv. AC 110V power stepped down to 12 VDC. The DC Power Supply shall be a UL Listed Class 2 Power Supply.
  - v. When a DC Power Supply, it shall be a UL Listed Class 2 Power Supply and it shall plugged into a surge protected power strip.
- b. The system shall be able to operate with 12 VDC internal batteries for up to seven (7) days or one hundred sixty-eight (168) hours without replacements.
- c. The system shall be able to operate with 12 VDC external batteries for up to 20 days without replacement.
- d. The system shall be able to operate with a single power supply of 4 W
- e. Dissipate power surge of not more than 6 KV – 10,000 amps.
- f. Provide surge protection to protect the device.

### 4. Communication Requirements

- a. The system shall be able to transmit the daily data from the traffic counter control cabinet to a traffic signal control cabinet via spread spectrum wireless communications. From the traffic signal control cabinet, the data will be conveyed through the Department's traffic signal network to a central controlling server and software at the Department administration building through a CDMA or a hard line telephone modem.
  - b. The system shall be suitable for polled operation using multi-point EIA-232 communication at 9600 bits per second.
  - c. The system shall meet FCC Part 15 requirements for interface.
5. **ITFDS Software** - The Contractor shall provide ITFDS software to configure the system, as well as to access and manipulate data from the ITFDS.
6. **ITFDS Hardware** - The system software will be installed in the hardware provided as part of other Pay Item as defined in these Specifications.
- a. *Environmental Requirements*
    - i. The system shall operate within the temperature range of -40 to +185 degrees Fahrenheit.
    - ii. Operating humidity range: 5 percent to 95 percent relative humidity, non-condensing.
    - iii. The system shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture.

## C. CONSTRUCTION

1. **Installation** - Construct and install all the equipment necessary for a fully functional ITFDS, in accordance with the requirements of the Plans, the manufacturer, applicable codes, regulations, and applicable Standards. All conduits, cables, wires, clamps required for a complete installation shall be associated with these items. Field verify the suitability of the proposed locations, and device installation with ITFDS manufacturer. Provide manufacturer recommendations for location revisions to the Engineer for review and approval.
2. **Functional Output Protocol** - ITFDS software from the Department administrative building shall be able to open up connection to receive polled data from the ITFDS. Ensure that ITFDS can process polling requests to maintain a minimum 30 seconds polling cycle.

3. **Testing** - Complete testing according to a Test Plan approved by the Engineer
4. **Warranty and Maintenance** - Provide warranty and Maintenance as per the Contract Documents.
5. **Training** - Provide Training as per the Contract Documents.

**D. MEASURE AND PAYMENT** - Infrared Traffic Flow Detection System (ITFDS) will be measured and paid for at the Contract unit price per each. The payments will be full compensations for furnishing, installing the detector in a manufacturers and the Department approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from the Department's TMC, training, and furnishing documentation to complete the Work including the following:

1. All the hardware and material necessary including unit enclosure and mounting assembly to provide a fully functional ITFDS.
2. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any ITFDS component.
3. ITFDS Software
4. All hardware and material necessary to provide electrical power services to the ITFDS field location as shown in the Plans.

The central hardware and RF modem, if applicable shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate Pay Item. However, the Contractor is responsible under this item to ensure that the ITFDS work including complete installation, setup and configuration, and acceptance of the ITFDS.

#### **613.42 ACOUSTIC TRAFFIC FLOW DETECTION SYSTEM (ATFDS)**

**A. GENERAL** - The Work to be performed under this section consists of procuring, furnishing, installing and wiring of the complete Acoustic Traffic Flow Detection System (ATFDS) at the locations shown on the Plans and in accordance with the conditions set forth. The Work also includes testing, training, warranties, and guarantees as designated in the Specifications.

1. The ATFDS shall have the following general high level requirements:
  - a. The system shall be non-intrusive.
  - b. The system shall use acoustic technology.
  - c. The system shall at a minimum collect classification (3 or 4 types), volume, speed, and occupancy.
  - d. A single system shall be capable of continuously collecting data for up to 5 lanes of traffic.
  - e. The detector shall be mountable from a side-fired location
  - f. The collected data shall be stored in the field equipment for at least 30 continuous days.
  - g. The system shall enable data collection through a spread spectrum wireless communication modem to the Department traffic signal network.
2. The ATFDS shall consist of:
  - a. A self-contained Roadway Traffic Sensor which detects and monitors Roadway traffic.
  - b. Cabinet termination circuit card
  - c. Mounting Bracket
  - d. Sensor lead-in cable
  - e. PC Monitoring and Set-Up software, for installation and subsequent maintenance tasks.
  - f. ATFDS Software

The pole for mounting the sensor and the cabinet, the hardware for installing software, and power and communication to the field cabinet will be considered as separate items.

All Acoustic Vehicle Detector Assembly sites shall be capable of allowing the straightforward integration of up to 4 additional Roadway Traffic Sensors in the future.

- B. MATERIALS** - All the materials shall contain all of the components described in the subsequent material Specifications. All necessary incidental components, cables, and hardware, shall be supplied to accomplish a fully operational ATFDS installation. All equipment and component parts furnished shall be new, be of the latest design, and manufacture. All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.

**1. Roadway Traffic Sensor**

- a. Functional Requirements** - The Roadway Traffic Sensor shall be mountable from a side fire location or overhead Structure, and shall comply with the following functional Specifications:
- i.** The unit shall be able to monitor a minimum of 5 discrete detection zones.
  - ii.** Zone width and location can vary, as per the Roadway's requirements, and shall be user definable.
  - iii.** The Roadway Traffic Sensor shall be capable of detecting vehicles in a far zone that is a minimum of 70 feet (near edge of zone) from the Roadway Traffic Sensor.
  - iv.** The Roadway Traffic Sensor shall be capable of detecting vehicles that are as close as 2 feet from the near travel lane.
  - v.** The unit shall operate in all prevalent traffic conditions, from zero to 80 mph. Over this range the unit shall be accurate to:
    - Volume - 5 percent of Actual Count (up to 4 lanes from the sensor), 6 percent of Actual count (in the 5th lane)
    - Occupancy- Within 10 percent
    - The unit shall be capable of storing data for 30 continuous days.
    - The unit shall retain all changeable parameters and settings upon loss and subsequent restoration of power.
- b. Power Requirements**
- i.** The unit shall operate on 12 - 24 VDC dissipating 6W, derived from either a 12 VDC solar power assembly, or from a DC Power Supply. The DC Power Supply shall be a UL Listed Class 2 Power Supply; that is, a 120 VAC to 12 VDC adapter. Include a provision at the rear of the enclosure for waterproof connection of power and communication cables.
  - ii.** When a DC Power Supply is used, plug it into a surge protected power strip. Both items are considered incidental to the ATFDS.
  - iii.** Power shall be obtained from connections to a terminal block on the Cabinet Termination Circuit Card located within Field Cabinet.
  - iv.** The Sensor Lead-In Cable connecting the unit to the Cabinet Termination Circuit Card shall supply power utilizing conductors whose minimum thickness is #22 AWG.
  - v.** Each unit shall be able to recover automatically after a power failure.
- c. Communication Interface** - The Roadway Traffic Sensor shall communicate to the field cabinet via RS-422 protocol.
- d. Enclosure** - The enclosure shall be a weatherproof cabinet of cast aluminum, stainless steel, or polycarbonate meeting as a minimum the NEMA requirements for a 336SS Type enclosure.
- e. Electromagnetic Interference (EMI)** - The unit and associated connected equipment in their installed condition shall comply with FCC Part 15 for interference.
- f. Weight** - The unit shall not exceed 10 lbs.

- g. Environmental Requirements** - This equipment shall meet all its specified requirements during and after being subjected to any combination of the following conditions:
- i.** The ambient temperature range shall be between -20° C and + 75° C.
  - ii.** The storage temperature range shall be between -25° C and +85° C.
  - iii.** Humidity: 5% to 95% per NEMA TS1 1989 (R1994), Section 2.1.5.2.
  - iv.** Vibration – fulfill NEMA TS2-2.1.9, or equivalent, as approved by the Engineer.
  - v.** Shock – fulfill NEMA TS2-2.1.10, or equivalent, as approved by the Engineer.

The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range. The unit shall not require programming changes to compensate for different environmental conditions encountered from season to season.

## 2. Cabinet Termination Circuit Card

- a. Functional Requirements** - The Cabinet Termination Circuit Card shall be a mountable card located within the field equipment cabinet that connects to the Roadway Traffic Sensor via the combination of Sensor Lead-In Cable and Home Run Cable. The Cabinet Termination Circuit Card shall comply with the following functional Specifications:
- i.** The Cabinet Circuit Termination Card shall allow for a terminal block that shall be plugged into the Card subsequent to having been connected appropriately to the Roadway Traffic Sensor with the Sensor Lead-In Cable and Home Run Cable.
  - ii.** The Cabinet Circuit Termination Card shall provide electronic circuitry capable of converting traffic data streams sent from the Roadway Traffic Sensor via RS-422 protocol to RS-232 protocol suitable for input to a Terminal Server that is also located within the field equipment cabinet.
- b. Power Requirements**
- i.** The terminal block plugged into the Cabinet Termination Circuit Card serves as “the source” for the Roadway Traffic Sensor; however, the Cabinet Circuit Termination Card supplies the terminal block with power from a separate DC source within the cabinet.
  - ii.** Power shall be obtained by plugging a terminal block connector that connects from the DC Power Source (within the Cabinet) into the Cabinet Termination Circuit Card.
  - iii.** The Cabinet Termination Circuit Card shall provide a single stage of solid-state surge protection, and an additional stage of gas tube surge protection for all data and power lines. Surge protection shall comply with IEEE Standard 587-1980 Category C.

- 3. Mounting Bracket** - The Roadway Traffic Sensor shall be supplied with a mounting bracket. The basic mounting bracket for the Roadway Traffic Sensor shall consist of a 51 mm diameter aluminum tube and a cast aluminum flange. The flange shall be matched to the structure the Roadway Traffic Sensor is mounted upon (e.g. curved to fit structures of differing diameters, or flat to fit rectangular structures or concrete walls). The flange shall be attached to the structure via stainless steel strapping or bolts. The aluminum tube shall screw into the flange, and be locked in place with set screw. The Roadway Traffic sensor itself slides over the tube before its stainless steel straps are tightened.
- 4. Sensor Lead-In Cable** - A single composite interface cable (Sensor Lead-In Cable), of no less than 50 feet length and Home Run Cable of no less than 200 feet length, shall be provided with each Roadway traffic Sensor. This Sensor Lead-In Cable shall provide DC power to the top-of-pole sensor as well as the RS-422 data lines required to interface to the Cabinet Termination Circuit Card. The Sensor Lead-In Cable shall contain a minimum of 6 pairs of stranded #22 AWG conductors – with foil shield running the length of the cable and ground strand in cable.
- 5. PC Monitoring and Setup Software** - A PC based diagnostic software package shall be provided that can be utilized to set up the Roadway Traffic Sensor and monitor operation to verify the performance and settings of the Roadway Traffic Sensor. The



Monitor and Setup software is designed to run under Windows. The software shall permit the Contractor to establish the detection zones and make all fine tuning adjustments necessary to ensure the accuracy and sanctity of the detection zones. The software shall also display presence, in real-time, within the programmed detector zones and shall report the accumulated data over the user-defined reporting interval for all programmed zones including volume, average occupancy, and average speed.

6. **ATFDS Central Software** - The Contractor shall provide ATFDS system software with functionalities and capabilities as identified in these Specifications.
7. **ATFDS Central Hardware** - The system software will be installed in the hardware provided as part of other Pay Item as defined in these Specifications.

### C. CONSTRUCTION

1. **Installation** - Furnish and install the Sensor as specified in the Contract Documents and adjust the Sensor and configure the lane detection zones.

Mount the Cabinet Termination Circuit Card inside the field cabinet to terminate the Sensor Lead-In Cable and convert RS-422 to RS-232.

Connect the sensor to the field cabinet via hard-wired Sensor Lead-In Cable and Home Run Cable with combined maximum run of 1500 feet. Sensor Lead-In Cable shall be connected to Home Run Cable at Junction Box located at the base of the pole on which the Sensor is mounted.

Connect all the cables as necessary within the cabinet to make the ATFDS functional.

2. **Functional Output Protocol** - ATFDS software from the Department administrative building shall be able to connect to receive polled data from the ATFDS. Ensure that ATFDS can process polling requests to maintain a minimum of 30 seconds polling cycle.
3. **Cabinet Equipment** - Install the cabinet equipment including wiring, conductors and terminal blocks, surge protectors, and other components as per provisions as identified for the NEMA Type 336S Classification/Count Cabinet. (Paid for separately)
4. **Testing** - Complete testing as described in a Test Plan approved by the Engineer
5. **Warranty and Maintenance** - Provide warranty and Maintenance as per the Contract Documents.
6. **Training** - Provide Training as per the Contract Documents.

- D. **MEASURE AND PAYMENT** - Acoustic Traffic Flow Detection System (ATFDS) will be measured and paid for at the Contract unit price per each. The payments will be full compensations for furnishing, installing the detector in a manufacturers and the Department approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from the Department's TMC and furnishing documentation to complete the Work including the following:

1. Roadway traffic sensor, and mounting assembly with all associated hardware
2. All hardware and material necessary to provide electrical power services to the ATFDS field location as shown in the Plans.
3. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any ATFDS component.
4. ATFDS Software

The central hardware, the pole and its foundation for mounting the ATFDS and modem shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate Pay Item. However, the Contractor is responsible under this item the complete installation, setup and configuration, and acceptance of the ATFDS.

All the items will be paid for only after the complete installation, setup and configuration, testing, and acceptance of the ATFDS.

### 613.43 CLASS X PIEZOELECTRIC SENSORS (X')

- A. GENERAL** - The Contractor shall develop a test and a range of electronic values to determine if the piezos installed are operating properly. The piezoelectric sensor placed in the Roadway shall be physically small by design. Sensor element housing prior to installation shall be less than ½ inch in diameter, preferably smaller. Dynamic output voltage of piezos installed during this Contract shall have a minimum of 300 millivolts of output voltage for all vehicle axles during the warranty period but should be significantly higher if possible. The piezo dynamic signal voltage will be measured according to standards outlined in these Specifications. The active sensor contact area should be less than 1/10 of the voltage magnitude of the true dynamic signal when compared to peak to peak voltages of the Bow Wave. Piezo output voltages shall not change significantly due to weather and temperature changes.

Static DC offset baseline voltages of the new piezo electric sensor shall not exceed  $\pm 100$  millivolts during the life of the warranty with all external components disconnected. The resistance between the shield and the center conductor of the piezo element shall have greater than 20 Megaohms of resistance during the warranty period. Resistance measured between the piezo shield and ground shall be greater than 20 Megaohms of resistance during the warranty period.

The installation support holder used for positioning the piezo sensor during installation shall be made of a material that will permanently bond with the grout material and develop a 100 percent encapsulated seal around the piezo electric sensor that will not crack or degrade over time. The use of plastic support holders during grouting operations will not be allowed. The installation depth of the piezo element shall be the depth recommended by the manufacturer, and the final installed height shall be exact without any variations across the length of the sensor.

For the typical installation, the first piezoelectric sensors shall be installed 3 feet from the back edge of the first loop and 1 foot from the front edge of the second loop and the second piezoelectric sensor shall be installed 1 foot from the back edge of the second loop and 3 feet from the front edge of the third loop. Both sensors shall be located from the left edge of the lane towards the middle, so that the left tire of vehicles will strike the sensor. If the AVC selected by the Contractor specifies a different type of layout, the Contractor must notify the Engineer so that he may make the final decision as to the spatial installation. All installed Class II piezoelectric sensors shall be a minimum of 8 feet in length. The length of all Class I piezoelectric sensors shall be as shown on the Plans. For each newly installed piezoelectric sensor, the Contractor shall provide the Engineer with the following:

1. Factory performance measures for each piezoelectric sensor.
2. Monitor traffic during normal operations for at least 30 minutes and capture 5 oscilloscope printout readings for each piezoelectric sensors that demonstrate the typical output signal for a typical sub compact, standard car, full size pickup, dump truck and a Class 9 truck. Vehicles monitored need to be traveling in the normal tire path. If vehicles are tracking in a different area because service vehicles are parked on the side of the Roadway, the service shall be moved out of the area to allow for normal traffic flow.
3. Results of a the Department approved drop test for each piezoelectric sensor (see test method in equipment section).
4. Sensor serial numbers.

When installing piezoelectric sensors, care shall be taken to insure coaxial lead-in cables installed in the Roadway are protected from road movement and cracking. When the splice area of the piezo electric sensor falls in an area of the Roadway that will not assure total protection to the sensor connection, the sensor shall be moved to a better location. Class II piezos shall normally be located on the left side of the lane, if vehicle tires track in areas outside this area the sensor shall be moved to a more ideal location. When pavement conditions or lack of a paved shoulder require the piezo to be reversed in the case of a full length piezo, it is recommended that the piezo placement be reversed and the lead-in cable run parallel with the sensor or the sensor moved. Under no circumstances will the connector between the piezo and the piezo lead wire be located in a pavement seam. The coaxial cable shall be inserted into tubing such as polybutylene, polyurethane or similar material that has been approved for use. A small 3 inch gap between the piezo and tubing will be sealed during the piezo grout pouring stage of the installation to prevent moisture from entering the sensor components. Duct tape shall be wrapped around end of the connection joint to prevent the grout material from traveling between the coaxial cable and tubing. The coaxial cable must be held in place with backer rod every 12 inches to prevent the conduit from floating up while the epoxy sealant is curing. Epoxy loop sealant shall totally encapsulate the coaxial cable conduit.

Static readings from the piezosensor will be recorded and submitted to the Engineer. These values will include capacitance, DC voltage offset, resistance and dissipation.

New sensors will require a finishing surface height procedure that is approved by the piezo, ATR, and grout manufacturer. The Engineer reserves the right to revise all installation guidelines.

Installation of piezoelectric sensors and the mixing of the piezo grout require the talents of the skilled craftsman and shall not be performed by an apprentice workman. The Engineer may request that individuals without the appropriate skills be removed from tasks that are beyond their skill levels.

- B. MEASURE AND PAYMENT** - Furnishing and installing polymer piezo sensors shall be measured and paid for by the unit each for the size indicated as specified in this specification.

#### **613.44 LEAD-IN CABLE FOR PIEZO P X (X FEET)**

- A. GENERAL** - Work under this item consists of providing a lead-in cable from the pull box/handbox nearest the piezo to the traffic counter cabinet to complete the circuit of the instrument.

- B. MATERIALS** - Lead-in cable shall be comprised of the following materials:

Piezo detector lead shall consist of 2 THHN/THWN conductors twisted and covered with a polyvinyl chloride outer jacket. The lead-in cable shall conform to UL subject 1277. The cable shall be rated for 600 volts.

The conductor shall be bare soft annealed copper wire, 7 wire (Class B) stranding conforming to ASTM B 3 and B 8.

The insulation shall be high dielectric polyvinyl chloride covered with an insulation armor of nylon conforming to UL 83 for type THHN/THWN insulation. The insulated conductors shall be twisted with a minimum of 3 turns per foot and covered with a helically or longitudinally applied suitable binding tape is optional.

Surface Printing: Ink Printed, "14 AWG No. Conductors - THHN/THWN".

- C. MEASURE AND PAYMENT** - Furnishing, installing, piezo lead-in cable shall be measured and paid for at the Contract unit price per each item as specified in this specification.

#### **613.45 SIDE-FIRED REMOTE TRAFFIC MICROWAVE SENSOR (RTMS)**

- A. GENERAL** - This Work shall consist of furnishing and installing side-fired, radar based vehicle detectors, as specified and as directed by the Engineer. This Work shall include all necessary hardware and electrical connections.

- B. MATERIALS** - All component parts shall be designed, manufactured, tested, and installed in compliance with the following codes and standards:

National Fire Protections Association (NFPA 20, 70, 75, & 780)

Underwriters Laboratories (UL 1283 and UL 1499)

International Standard Organization (ISO) – The Manufacturers shall be certified ISO 9001 for manufacturing design and service.

Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)

Side-fired radar-based vehicle detectors shall be easy to install and remove, and shall be fully programmable to support a variety of applications. In general:

1. All Equipment and component parts furnished shall be new, be of the latest design and manufacture, and be in an operable condition at the time of delivery and installation.
2. All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturers recommendations and standard practices.
3. The design shall be such as to prevent reversed assemble or improper installation of connectors, fasteners, etc.
4. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments and maintenance.
5. The designed Mean Time Between Failures (MTBF) of the RTMS unit, operating continuously in their application, shall be 10 years or longer.

- C. **AREA OF COVERAGE** - The RTMS's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall be as follows:

**TABLE 613.45**

Elevation Beam Width	45 degrees
Azimuth Beam Width	15 degrees
Range	10 to 200 feet

The RTMS shall be a true presence detector which can provide presence, volume, lane occupancy and speed information on up to 6 discreet detection zones.

1. The information shall be available to existing controllers via contact closure pairs and to other systems via serial communications lines.
2. The minimum number of detection zones defined shall be 6. The range limits of each zone shall be user defined in 7 ft. resolution.
  - a. The detector shall identify vehicle presence within each detection zone with a 95 percent accuracy or greater, independent of the vehicle's direction of travel through the detection zone.
  - b. The maximum permissible error shall be 5 percent in the detection of the direction and magnitude of radial speed and 10 percent in the case of transverse speed.

**D. ELECTRICAL REQUIREMENTS**

1. **Equipment Cabinet** - Shall be a Type 332, or Pole-Mounted NEMA TS-2 Size 4 or 5 Cabinet, as shown on the Plans.
2. **Communications** - 2 standard Hayes-Compatible, 9600 baud shelf-mount communications modems shall be provided with each RTMS and installed as directed by the Department at the Transportation Management Center.
3. **Input Power**
  - a. 12 – 24 VAC/DC
  - b. 95 – 135 VAC at 60Hz
  - c. Power Consumption - 6 Watts
4. **Distribution Panel (120/240 VAC Source Only)**
  - a. Single-phase, 3-wire, UL Listed with cover
  - b. 30-Amp. Fixed Mains
  - c. 2 15-Amp. Circuits with Type QO Breakers (each phase – 4 circuits, total)
  - d. Individual duplex grounded outlets in standard steel boxes with steel covers for each circuit
  - e. Surge suppression equipment shall be provided
5. **Other Power Source** - Power shall be obtained from the power distribution assembly, or from a 15-20 amp branch circuit from an existing cabinet, as shown on the Plans.
  - a. No Distribution Panel
  - b. Single 30-Amp Surge unit
6. **RTMS Interface** - The interface at the RTMS shall consists of a single MS connector which shall provide:
  - a. Power to the unit
  - b. Output contact closure wire pairs for each of the required detection zone
  - c. Serial communication lines for programming, testing or modem interface at 9600 Baud rate. The data format of the serial port shall be standard binary NRZ 8 bits data, 1 stop bit, no parity.

7. **Cable** - A UV-resistant cable of multiple twisted pairs of stranded AWG 20 wires with a common shield rated at 300V with a temperature rating of 105 degrees C (Beldin #9516 or approved equal) shall be used to provide a connection between the RTMS and the cabinet equipment.
- E. ENVIRONMENTAL** - Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any of the following environmental conditions:
1. Ambient temperature range of -37 to +74 degrees C
  2. Relative humidity from 5 to 95 percent, non-condensing
  3. Except as may be otherwise stated herein for a particular item, no item, component, or sub-assembly shall emit a noise level exceeding the peak level of 55 dBA when measured at a distances of 1 meter away from its surface.
  4. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcomes adverse effects due to temperature in the specified environmental range.
- F. INSTALLATION** - The RTMS shall be mounted in the side-fired configuration, as directed by the Engineer.
1. It shall be mounted on poles or sign structures at the specified locations, using the supplied mounting brackets.  
The brackets shall be attached with approved ¾ inch wide, 0.025 inch thick, stainless steel bands or to a concrete wall/bridge using 2 stainless steel expansion bolts of sufficient length and diameter to support 100 pounds.
  2. The Contractor shall install the detector unit on a pole at a height of 17-23 feet above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified evaluation angle as suggested by the manufacturers.
  3. The RTMS detection zones shall be setup using the provided software and Notebook PC.
- G. MECHANICAL** - The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 MPH, dust and airborne particles, and exposure to moisture (NEMA type 3R enclosure)
1. The overall dimensions of the box, including fittings, shall not exceed 8-inches x 10-inches x 6-inches.
  2. The total weight of the microwave radar detector assembly shall not exceed 5 pounds.
  3. The mounting assembly shall have all painted steel, stainless steel, or aluminum construction, and shall support a load of 20 pounds.
  4. The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be titled in both axes then locked into place.
  5. The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent.
  6. The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test Ea), NEMA TS-1 (Section 2.1.13).
- H. MEASURE AND PAYMENT** - Side-Fired Vehicle Detectors (RTMS) will be measured and paid for at the Contract unit price per each. Payment will be full compensation for furnishing, placing, maintaining, and removal from the Project Site as directed by the Engineer and for all material, technical applications, labor, equipment, tools, and incidentals necessary to complete the Work.

#### 613.46 IN-ROAD LIGHTING

- A. GENERAL** - This Work shall consist of furnishing and installing in-road lighting at pedestrian cross walks as specified in the Contract Documents and as directed by the Engineer. A complete system at any one crosswalk requires the control equipment and in-pavement lights.
- B. MATERIALS**
- Loop Sealant, as approved by the District Department of Transportation

- 1. In-road Warning Signals** - In-road Warning Signals shall be comprised of an in-roadway light assembly with a snowplow protection base plate. It is noted that multiple light assemblies constitute a complete system for each individual crosswalk. The number of light assemblies is dependent upon the curb to curb length of the crosswalk. The engineering design will document the number of in-pavement lights required for a specific crosswalk.

Each in-roadway light assembly shall use 12 amber light emitting diodes designed to emit light in a unidirectional manner that will be clearly visible to the motorist, and not visible to the pedestrians in the crosswalk.

The snow plow protection base plate shall be 14 inches diameter, and 1.875 inches high at its highest point with a pocket to hold the in-road light assembly. It shall be designed to be inset into the Roadway and to protect the in-road light assembly from snowplow damage.

- 2. Power and Control Equipment** - Power and Control Equipment shall be comprised of power and control equipment housed in a NEMA 3R cabinet and bollard activation unit. Each crosswalk shall require 1 power and control equipment unit and a pair of bollards at each crosswalk terminus.

The Power and Control Equipment shall be capable of being connected to a 120 volt power supply. It shall contain all the equipment necessary to monitor the bollard activation units and to activate the in-road Warning Signals to flash for a preset time. The preset timer for the warning signals shall be field adjustable from 11 to 44 seconds. The Power and Control equipment shall also record the number of times the in-road warning lights are activated.

A separate 120 volt tap shall be supplied that is energized whenever the in-road Warning Signals are flashing. This tap will provide a steady 120 volt AC suitable for operating a relay to control a hazard identification beacon.

A NEMA 3R, lockable enclosure of a suitable size shall be furnished to contain the Power and Control unit. The cabinet shall be formed of anodized aluminum, and have a natural finish.

The Bollard activation unit shall consist of 4 bollards arranged in pairs. Each pair shall be capable of detecting when a pedestrian passes between them, and with the power control equipment, determining if the pedestrian is entering or exiting the crosswalk. The Bollards shall be 42 inches high with an 8.5 inches diameter. The body of the bollard shall be formed of extruded aluminum.

## C. CONSTRUCTION

- 1. In-road Warning Signals** - In-road warning signals shall be installed so that the LED's are clearly visible to the oncoming traffic, but so that no part of the assembly projects more than 0.5 inches above the road. The installation shall not allow water to pool around the in-road warning signal. The snow plow protection base plate shall be secured to the road using an epoxy, and in a manner approved by the manufacturer. The in-roadway light assembly shall be fastened to the snowplow protection base plate with socket head stainless steel bolts.
- 2. Power and Control Equipment** - Power and control equipment shall activate the in-road warning signals for a preset time only when a pedestrian passes between a pair of bollards entering the crosswalk. The in-road warning signals shall not be activated by pedestrian exiting the crosswalk. If another pedestrian enters the crosswalk after the in-road warning signals have been activated, the preset time interval shall be restarted. Bollards shall be mounted to concrete pads as recommended by the manufacturer.
- 3. Bench Testing Manufacturers Certification** - The Power and Control Equipment and in-road Warning Signals to be supplied shall be preassembled at the factory before delivery and tested to insure correct operation of the system and correct color of the in-road warning signals. A written certification of this bench test shall be provided by the manufacturer with the equipment.

## D. MEASURE AND PAYMENT

- 1. In-road Warning Signals** – In-road Warning Signals shall be measured and paid for at the contact unit price per each. Payment shall be full compensation for furnishing and installing the in-road light assembly, the snowplow protection base plate, the saw cut necessary for installation of the in-road warning signals, cabling from the warning signal to the bollard activation units, epoxy, loop sealant, excavation of the road for installation of the snowplow protection base plate, and for all labor, tools, materials, and incidentals necessary to complete this Work.

2. **Power and Control Equipment** – Power and Control Equipment shall be measured and paid for at the Contract unit price per each. The payment shall be full compensation for furnishing and installing Power and Control Equipment, enclosure cabinet, activation bollards, conduit and cables connecting the power control equipment, activation bollards, concrete for mounting the bollards, and for all labor, tools, materials, and incidentals necessary to complete this Work.
3. **Bench Testing and Manufacturers Certification** - Bench Testing and Manufacturers Certification shall not be measured and paid for, but shall be incidental to other Contract items.

#### 613.47 TRAFFIC SIGNAL CONTROLLER AND CABINET

- A. GENERAL** - The Contractor shall furnish and install all required equipment in accordance with the provisions of the technical Specifications and in compliance with the procedures outlined in this section. Individual Plans specific to each intersection will specify the type and physical orientation of the cabinet.

The Contractor shall furnish all necessary labor, equipment, and materials to procure and install the controller and cabinet. Individuals tasked with wiring the cabinet must possess at least IMSA Level 2 certification and experience in working with all types of traffic signal controllers in operation in the District of Columbia. No other Contractor employee will be permitted access to the cabinet or electronic components within the cabinet.

The Department shall arrange for the deployment of an appropriate number of Traffic Control Officers (TCOs) from the Traffic Operations Administration to safely manage the flow of traffic when a new traffic signal operation is being installed by the Contractor. The Contractor shall provide 10 days advance notice to the Engineer to request the assistance of Traffic Control Officers.

- B. PROCUREMENT, ACCEPTANCE AND PROGRAMMING** - The Contractor shall accept delivery of the controller, cabinet and component parts from the vendor and deliver everything to the Traffic Operations Administration, Field Operations Division. District of Columbia technicians will inspect the delivered items and inform the Contractor of any deficiencies before the Department accepts delivery of the controller.

District of Columbia technicians shall program the controller to operate the approved traffic signal sequence of operation required for the specific intersection. The technician shall remove all unused component parts from the controller and place them in inventory. The technicians will allow the programmed controller and cabinet assembly to operate properly without malfunction in the Shop area for 72 consecutive hours before proclaiming the equipment suitable for field installation.

The Contractor will be notified to pick up the programmed controller and cabinet after the signal operation is properly programmed and the controller has run in the Shop area. The Contractor will pick up the controller cabinet assembly from the Field Operations Division and deliver the equipment to the field job Site for installation.

- C. FIELD INSTALLATION PROCEDURES** - The Contractor shall set the controller cabinet assembly on the permanent foundation ensuring that the foundation anchor bolts penetrate the designated holes in the base of the cabinet. The Contractor shall ensure that the front and rear cabinet doors are oriented properly in accordance with instructions on the Project Plans. The Contractor shall level the cabinet, if necessary, using stainless steel shims placed where appropriate between the base of the cabinet and the foundation. The Contractor shall utilize stainless steel washers and bolts to affix the leveled cabinet securely to the foundation. All 4 bolts shall be tightened to ensure a secure and stable fit on the concrete foundation.

The Contractor shall pull all cables through the conduits into the controller cabinet allowing a minimum of 10 feet of slack cable inside the cabinet. The Contractor shall attach an identifying, waterproof tag onto each cable identifying the specific field equipment being serviced by that particular cable run. The Contractor shall furnish and install a new No. 6 bare solid copper ground cable from the appropriate terminal in the controller cabinet to the ground rod extending above the top of the controller cabinet foundation.

The Contractor shall schedule and ensure the completion of the installation of secondary electrical service cable into the controller cabinet by PEPCO, following the procedures outlined in Section 613.06. The Contractor shall maintain constant communications with counterparts in PEPCO to ensure that PEPCO officials are apprised of the Project schedule for the purpose of avoiding Project delays attributable to secondary electrical service installation.

The Contractor shall terminate all traffic signal, electronic sign, school flasher, vehicular and pedestrian detector lead-in, closed circuit television, and communications cables at their appropriate place on the terminal block of the controller cabinet. The Contractor shall cut the cables pulled into the controller cabinet at the appropriate length, strip the conductors, and affix terminal lugs at the end of the conductors. All cables shall be dressed and arranged using cable ties in a neat, orderly manner in accordance

with accepted industry standards.

The Contractor shall apply a generous quantity of duct seal into each conduit entering the cabinet to help regulate cabinet humidity and to impede the flow of moisture or other matter between the cabinet and the underground conduit/manhole network. The duct seal shall penetrate at least 4 inches into each conduit entering the cabinet and shall totally encapsulate the conduit and cables. The duct seal shall be installed after all cable is terminated and dressed.

The Contractor shall apply a generous bead of waterproof sealant inside and outside the controller cabinet at all points where the cabinet is in physical contact with the concrete controller cabinet foundation to preclude the flow of moisture and debris between the inside of the cabinet and the outside environment.

- D. MEASURE AND PAYMENT** - Each controller and cabinet assembly will be paid at the Contract unit price. Payment shall include the cost of the controller, cabinet and all peripheral electronic components and all required labor equipment and materials to install the cabinet in the field and render the traffic signal operational in accordance with the approved traffic signal sequence of operation. The cost associated with arranging and providing secondary electrical service to the cabinet is not included in this payment.

#### **613.48 336SS TRAFFIC SIGNAL CABINET WITH CLASSIFIER/COUNTER AND RADIO FREQUENCY MODEM**

- A. GENERAL** - The Contractor shall furnish and install all required equipment in accordance with the provisions of the technical Specifications and in compliance with the procedures outlined in this section and on the Project drawings. Individual Plans specific to each intersection will specify the type and physical orientation of the cabinet.

The Contractor shall furnish all necessary labor, equipment, and materials to procure and install the cabinet, classifier/counter and radio frequency (RF) modem. Individuals tasked with wiring the cabinet must possess at least IMSA Level 2 certification and experience in working with inductive loop and piezoelectric sensors, microwave detectors, acoustic detectors, video detectors and infrared detectors. No other Contractor employee will be permitted access to the cabinet or electronic components within the cabinet.

- B. SPECIFICATIONS** - This Section and Section 825 contain the technical Specifications for the Model 336SS Controller Cabinet, counter/classifiers and detectors, and all peripheral electronic components within the cabinet. The Contractor shall procure equipment in strict conformance with those Specifications. The Contractor must submit and the District must approve catalogs cuts from individual vendors before procurement is undertaken.

1. **336SS Controller Cabinet** – The controller cabinet shall conform to Section 825.01, 825.02, 825.03, 825.04 as well as to the appropriate the Department Standard Drawings.
2. The Contractor shall include rustproof mounting brackets, and all miscellaneous fittings, connectors, terminal strips, power switches, indicator lights. The cabinet shall be large enough to accommodate:
  - a. Power distribution assembly
  - b. Terminal block
  - c. Mounting rack
  - d. A 15-watt shatterproof fluorescent strip-light
  - e. Power strip
  - f. 2 Radio Frequency (RF) modems (RS232 to Wireless)
  - g. 2 RF modem antenna (Minimum 3 dB Gain)
  - h. One of the following per cabinet
    - i. 1 Traffic Counter/Classifier unit
    - ii. Video processing unit
    - iii. Infrared processing unit
    - iv. Microwave data storage unit



v. Acoustic data storage unit

The Contractor shall submit the layout of the cabinet to the Engineer for review and approval. The layout should be similar to the layout provided in the Project drawings. A rustproof lock shall be provided with 2 keys of the pattern approved by the Department.

The Contractor shall provide all accessory equipment necessary to mount and operate the traffic classifier/counter equipment to be stored within each cabinet, including a power distribution assembly, counter/classifier, RF modem, mounting hardware, cabinet wiring, and wiring harnesses. The Contractor shall provide a RF modem with power and antenna connection in each cabinet. The modem shall be as described in this Section of these Specifications and will be paid for under this Bid Item.

The Contractor shall provide full I/O surge protection, with additional devices to protect the equipment and cables from surges and over-voltages. The Contractor shall include detector cable terminals and power service connections.

The Contractor shall provide all mounting racks for all equipment.

Door locks and keying shall be electronic security locks that conform to 825.02

The Contractor shall provide surge protected power strip to accommodate all DC power supplies, or piezoelectric or loop sensor counting equipment for each station location.

A 15-watt shatterproof fluorescent strip-light fixture shall be provided mounted to the top front portion of the cabinet, as far forward as possible, in order to illuminate the front face equipment placed on the shelves. A door-actuated switch shall be installed to turn on the cabinet light when the door is opened, and to turn out the light when the door is closed.

The Contractor shall provide screened and louvered vents designed to keep out rain, insects, and rodents. The cabinet shall be equipped with intake vents with a 14 inch by 20 inch by 1 inch standard furnace-type vent filter. The filter tray shall be sized to adequately house and secure the filter in place. There shall be no obstructions on the interior face of the door to interfere with easy removal and replacement of the filter.

The equipment and terminal blocks shall be arranged within the cabinet such that they do not interfere with the entrance, tracing, and connection of electrical conductors or communication cables. All conductors and cables shall be neatly arranged in the cabinet and bundled in groups with cable ties, vinyl labels, or vinyl tape. The Contractor shall label all conductors and cables with indelible ink.

The Contractor shall permanently mark all parts with the Manufacturer's Name, Serial Number, and Model or Part Number.

A block diagram of all components illustrating all connectors and connections used to interconnect the components, wiring diagrams and schematic drawings of all circuits shall be inserted in a re-sealable weather-resistant pocket that is permanently mounted on the inside of an accessible door in the ground-mounted controller cabinet.

The component name and model number shall be inscribed using a permanent label or laminoid name plate in a position adjacent to the location of each major or replaceable component on the inside of the cabinet and enclosure.

All devices, components, cables and wires shall be indelibly identified on permanently attached labels designed for use in the intended environment using labels approved by the Engineer, and inscribed in accordance with the approved schematic Shop Drawings showing the component layout.

All internal connectors and wire terminations shall be labeled with sufficient information to locate its connection point without recourse to any other documentation located outside the controller cabinet or enclosure.

3. **Counter/Classifier** – At a minimum, the Contractor shall provide the classifier/counter with the following functionality:
  - a. Provide 1 counter/controller for every controller cabinet identified for the Project. Some sites will not require a counter/classifier; in this case, the Contractor shall deliver the counter/classifier to the COTR at the traffic counter branch at 1338 G Street SE. Sites that require more than 1 counter/classifiers will request additional counter/classifiers from the COTR. COTR will provide additional counter/classifiers from those extra units delivered by the Contractor.
  - b. Count 1 to 16 lanes
  - c. Classify 1 to 8 lanes using 13 classification bins
  - d. Input capabilities per counter

- i. Up to 16 presence inductive loop sensors
    - ii. Up to 8 piezo sensor inputs
  - e. Record Intervals
    - i. One (1) minute to twenty-four (24) hours
    - ii. Ability to program counter for different intervals throughout the day
  - f. 2 counting modes
    - i. Time interval count mode
    - ii. Time stamped count mode
  - g. 3 modes of classification (1 to 8 lanes)
    - i. Binning with default and user definable vehicle and speed
    - ii. Time stamped sensor events
    - iii. Individual vehicle records (RAW) containing lane number, time of day, speed, number of axles, axle spacing, and type of vehicle
  - h. *Memory* - Provide sufficient memory to store up to a week of data for each count location (minimum 1 MB RAM without TAM card)
  - i. 16 key watertight keyboard with complete alphabet and numbers on a liquid crystal display
  - j. Programmable from counter keyboard and display and IBM compatible PC
  - k. Data collection and download, command, control, and calibration locally by an IBM compatible PC and remotely through a telephone modem
  - l. English and metric unit capability for speed, distance and weight measurements
  - m. Hardwire power capability
  - n. Able to be mounted within the 336SS cabinet
  - o. Adjustable and automatic baud rates ranging from 300 to 19,600 kbs
  - p. *Environmental operating range* - -40° F to 165° F; 0-95 percent non-condensing relative humidity
4. **RF Modem** – At a minimum, the Contractor shall provide 900 MHz RF modems with the following functionality:
- a. The Contractor shall provide 2 RF modems (RS232 to Wireless) for every controller cabinet identified for the Project. Some sites will not require 2 RF modems (RS232 to Wireless); in this case, the Contractor shall deliver extra RF (RS232 to Wireless) modems to the COTR at the end of the Site installation.
  - b. *Performance*
    - i. Power Output: 1 mW – 1 Watt (0 - 20 dBm)
    - ii. Indoor/Urban Range: up to 3000 feet (900m)
    - iii. Outdoor/RF Line-of-sight Range: up to 40 miles (64 km)
    - iv. Receiver Sensitivity: -110 dBm (at 9600 bps)
    - v. RF Data Rate: 9.6 or 19.2 Kbps
    - vi. Interface Data Rate: up to 230.4 Kbps
  - c. *Networking*
    - i. Spread Spectrum Type - FHSS (Frequency Hopping Spread Spectrum)

- ii. Supported Network Topologies - Peer-to-peer, point-to-point, point-to-multipoint & multidrop
  - iii. Error Handling - Retries & acknowledgements
  - iv. Filtration Options - VID (Vendor ID Number), channels and addressing
  - v. Channel Capacity - 7 hop sequences share 25 frequencies
  - vi. Addressing - 65,000 network addresses available for each channel
  - vii. Encryption - 256-bit AES
  - d. *Power*
    - i. Supply Voltage: 7 - 28 V
    - ii. Transmit Current: 900 mA
    - iii. Receive Current: 110 mA
    - iv. Power-down Sleep Current: 17 mA
  - e. *General*
    - i. Frequency Band: 902 - 928 MHz
    - ii. Data Connection: DB-9
  - f. *Certifications*
    - i. FCC - OUR9XSTREAM
    - ii. IC - 4214A-9XSTREAM 4214A 12008
    - iii. Class 1 Division 2 - Approved
  - g. *Antenna*
    - i. Minimum Gain: 3dB
    - ii. Type - Yagi Directional
- C. PROCUREMENT, ACCEPTANCE AND PROGRAMMING** - The Contractor shall accept delivery of the counter/classifier, detectors, cabinet, and component parts from the vendor. Storage of the materials shall be in accordance with the Department Standard Specifications. All material will be stored in an approved location until delivered to the specific Site location.
- D. FIELD INSTALLATION PROCEDURES** - The Contractor shall set the controller cabinet assembly on the permanent foundation ensuring that the foundation anchor bolts penetrate the designated holes in the base of the cabinet. The Contractor shall ensure that the front and rear cabinet doors are oriented properly in accordance with instructions on the Project Plans. The Contractor shall level the cabinet, if necessary, using stainless steel shims placed where appropriate between the base of the cabinet and the foundation. The Contractor shall utilize stainless steel washers and bolts to affix the leveled cabinet securely to the foundation. All 4 bolts shall be tightened to ensure a secure and stable fit on the concrete foundation.

The Contractor shall pull all cables through the conduits into the controller cabinet allowing a minimum of 10 feet of slack cable inside the cabinet. The Contractor shall attach an identifying, waterproof tag onto each cable identifying the specific field equipment being serviced by that particular cable run. The Contractor shall furnish and install a new No. 6 bare solid copper ground cable from the appropriate terminal in the controller cabinet to the ground rod extending above the top of the controller cabinet foundation.

The Contractor shall schedule and ensure the completion of the installation of secondary electrical service cable into the controller cabinet by the Potomac Electric Power Company, following the procedures outlined in these Specifications. The Contractor shall maintain constant communications with counterparts in PEPCO to ensure that PEPCO officials are apprised of the Project schedule for the purpose of avoiding Project delays attributable to secondary electrical service installation.

The Contractor shall terminate all loop detector lead-in, piezoelectric lead-in, microwave detector, acoustic detector, infrared detector, closed circuit television, and communications cables at their appropriate place on the terminal block of the controller cabinet. The Contractor shall cut the cables pulled into the controller cabinet at the appropriate length, strip the conductors, and affix

terminal lugs at the end of the conductors. All cables shall be dressed arranged using cable ties in a neat, orderly manner in accordance with accepted industry standards.

The Contractor shall apply a generous quantity of duct seal into each conduit entering the cabinet to help regulate cabinet humidity and to impede the flow of moisture or other matter between the cabinet and the underground conduit/manhole network. The duct seal shall penetrate at least 4 inches into each conduit entering the cabinet and shall totally encapsulate the conduit and cables. The duct seal shall be installed after all cable is terminated and dressed.

The controller shall apply a generous bead of waterproof sealant inside and outside the controller cabinet at all points where the cabinet is in physical contact with the concrete controller cabinet foundation to preclude the flow of moisture and debris between the inside of the cabinet and the outside environment.

- E. MEASURE AND PAYMENT** - Each cabinet assembly will be paid for at the Contract unit price of each. Payment shall include the cost of the counter/classifier, cabinet, RF modem, modem antenna and all peripheral electronic components and mounting hardware and all required labor equipment and materials to install the cabinet in the field and render the traffic count station operational in accordance with the operation including testing, and furnishing documentation to complete the Work. The cost associated with arranging and providing secondary electrical service to the cabinet is not included in this payment.

#### **613.49 CLOSED CIRCUIT TELEVISION (CCTV) CAMERA SYSTEM**

- A. GENERAL** - The Contractor shall furnish all labor, materials and equipment necessary to install a fully operational Closed Circuit Television (CCTV) Camera System. A listing of materials comprising a complete CCTV Camera System is shown in 825.07 The CCTV Camera System shall be installed in accordance with Drawing Numbers 617.28, 617.29, and 617.30, as contained in the District Department of Transportation, Standard Drawings, 2005. The Contractor shall demonstrate proper operation of the system and deliver to the Department all pertinent warranty and operations manuals.
- B. MEASURE AND PAYMENT** - Each individual operational Closed Circuit Television (CCTV) Camera System will be paid at the Contract unit price. Payment shall include all labor, equipment, tools, materials, and incidentals needed to complete the Work, clean up the Work Site, and deliver a fully operational CCTV Camera System, as described herein.

#### **613.50 REMOVE ABANDONED STREET LIGHT OR TRAFFIC SIGNAL POLE FOUNDATION**

- A. GENERAL** - The Contractor shall supply all labor, equipment and materials necessary to remove the streetlight pole or traffic signal pole foundation.

The Contractor shall remove the foundation completely. The Contractor shall seal the conduit, remove the anchor bolts and cut off the ground wire or rod. If the foundation is located within a dirt Tree Space, the Contractor shall backfill the excavation with approved material to grade. Where the foundation is located in a paved area the Contractor shall backfill with approved pavement base material to within 6 inches of grade and install a temporary asphalt patch.

All material removed shall become the property of the Contractor and will be disposed of at no additional cost to the District.

- B. MEASURE AND PAYMENT** - The unit of measure will be each. Payment will be made at the Contract unit price for each foundation removed. Payment will include all labor, equipment, tools, materials and all incidentals, including clean up at the job Site, necessary to complete the Work specified herein.

#### **613.51 REMOVE ABANDONED TRAFFIC SIGNAL CONTROLLER CABINET FOUNDATION**

- A. GENERAL** - The Contractor shall supply all labor, equipment and materials necessary to remove the traffic signal controller cabinet foundation.

The Contractor shall remove the foundation completely. The Contractor shall seal the conduit, remove the anchor bolts, and cut off the ground wire and ground rod. If the foundation is located within a dirt Tree Space, the Contractor shall backfill the excavated area with approved topsoil material to grade. If the foundation is located within a paved area, the Contractors shall backfill with approved pavement base material to within 6 inches of grade and install a temporary asphalt patch.

All materials removed shall become the property of the Contractor and will be disposed of at no additional cost to the District of

Columbia.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Abandoned Traffic Signal Controller Cabinet Foundation will be each. Payment will be made at the Contract unit price for each foundation removed. Payment will include all labor, equipment, tools, materials and all incidentals, including clean up at the job Site, necessary to complete the Work specified herein.

### 613.52 REMOVE TRAFFIC SIGNAL POLES AND TRAFFIC SIGNAL EQUIPMENT

- A. GENERAL** - The Contractor shall furnish all labor, materials, and equipment necessary to remove metal traffic signal poles, transformer bases, mast arms, vehicle and pedestrian signal heads, pedestrian push buttons, microwave vehicle detectors, electronic signs, cables, and other equipment related to the traffic signal system. Work shall not begin until the replacement traffic signal is in service and operational, and until electrical service has been provided to the new signal controller. The Engineer must be satisfied that the new signal controller is operating the required traffic signal sequence of operation before old equipment can be removed.

The Contractor shall remove all existing traffic and pedestrian signal heads, pedestrian push buttons, microwave vehicle detectors and other devices hanging on the pole and return them to the District of Columbia. Care should be taken to avoid damaging these devices, as they can be reused. The Contractor shall also remove all mounting hardware except stainless steel banding and return them to the District of Columbia.

The Contractor shall remove the existing traffic signal poles and 8 foot long mast arms and return them to the District of Columbia. Poles and mast arms deemed, by the Engineer, to be reusable shall be cleaned and painted before storage.

Static metal signs shall be removed from poles only after the Contractor has installed new replacement signs on the new poles.

Traffic signal equipment mounted on street light poles will be removed under this specification.

The Contractor shall remove all electrical cable between the previous controller cabinet foundation and each signal device. All cable is to be removed and discarded by the Contractor.

The Contractor shall clean up the area and ensure that all remnants of the former traffic signal including miscellaneous hardware are removed from the Site.

- B. MEASURE AND PAYMENT** - The unit of measure will be the intersection. Payment will be made at the Contract unit price without regard for the amount of materials to be removed from the intersection. Payment will include all labor, equipment, tools, materials, and all incidentals, including clean up at the job Site and transportation of parts, necessary to complete the Work specified herein.

### 613.53 REMOVE TRAFFIC SIGNAL CONTROLLER AND CABINET

- A. GENERAL** - The Contractor shall furnish all labor, materials, and equipment necessary to remove the controller and cabinet from the intersection. Work will not be begun until the replacement controller is in service and operational and until power has been disconnected to the controller. No Work will be performed until the Engineer is satisfied that the replacement controller is satisfactorily operating the traffic signal sequence of operation.

The Contractor shall carefully disconnect all field and communications cables from the cabinet, taking care to avoid damage to any part of the cabinet. Set screws in the terminal block shall be tightened. The Contractor shall disconnect the foundation bolts and lift the complete cabinet off the foundation and onto a vehicle suitable for transporting the cabinet safely and securely back to the District of Columbia. The Contractor shall transport the entire cabinet to a facility designated by the Engineer.

The Contractor shall clean up the area around the old cabinet foundation to ensure that all remnants of the old controller and cabinet including miscellaneous wire and hardware are removed from the Site.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Traffic Signal Controller and Cabinet will be each. Payment will be made at the Contract unit price for each controller and cabinet removed. Payment will include all labor, equipment, tools, materials and incidentals, including clean up at the job Site and transportation of the cabinet, necessary to complete the Work specified herein.

### 613.54 REMOVE EXISTING SIGNAL HEAD

- A. GENERAL** - The Contractor shall be required to remove signal heads conforming to one of the following characteristics:

1. 1 Section pedestrian signal heads featuring the DON'T WALK and the WALK message in the same section.
2. 3, 4, or 5 Section vehicle signal heads featuring 1 or more sections with 8 inch diameter lenses.

3. 3, 4, or 5 Section vehicle signal heads with all lenses 12 inches, but the signal head is determined to be damaged beyond repair and incapable of accepting an LED Module. Potentially damaged signal heads will be identified by the Contractor and verified by the District of Columbia Inspector before removal and subsequent replacement is undertaken.
4. 3, 4 or 5 Section vehicle signal heads with all lenses 12 inch featuring 1 or more indications for a left turn or right turn movement considered redundant to the primary left turn signal so as to achieve compliance with the Manual on Uniform Traffic Control Devices by displaying only 1 indication for the non-primary movement. The District will identify these for the Contractor prior to issuance of the Notice to Proceed.
5. 1 Section yellow beacons used for flashing warning signals with 8 inch lenses.
6. 1 Section yellow beacons used for flashing warning devices with 12 inch lenses, damaged beyond repair and incapable of accepting an LED Module or identified for replacement.

The Contractor shall disconnect internal wiring at the terminal block of the signal head after identifying the function of each conductor to ease subsequent reinstallation. The end of each conductor shall be taped to avoid accidental contact with a metallic surface during the removal and reinstallation processes. On pole mounted signal heads, the Contractor shall cut the banding material or disassemble the mounting brackets to detach the signal head, upper and lower mounting brackets, universal pole plate and banding material/brackets from the pole. On mast arm mounted signal heads, the Contractor shall cut the banding material and detach the bracket, banding material, and signal head from the mast arm. The Contractor shall route the existing cable carefully through and free of the signal head assembly. At the conclusion of the removal process, only the cable shall remain protruding through the hole in the pole or mast arm.

For the purpose of this Pay Item, no distinction shall be made by number of signal sections in the signal head, mounting arrangement or type of mount. All materials removed from the pole or mast arm shall be discarded by the Contractor.

Under no circumstances will a Contractor perform any work on optically programmable vehicular or pedestrian signal heads.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Existing Signal Head will be each. Payment will be made at the Contract unit price per each signal head removed and payment will include all labor, equipment, tools, materials and all incidentals necessary to complete the Work.

### **613.55 RELOCATE ANY SIZE VEHICULAR OR PEDESTRIAN SIGNAL HEAD FROM ONE POLE TO ANOTHER POLE**

- A. GENERAL** - The Contractor shall disconnect the electrical cable from the terminal block of the vehicular or pedestrian signal head to be relocated after the Department technician has disconnected the cables for those signal heads in the controller cabinet. The Contractor shall carefully pull the electrical cable from the signal head to be relocated into the base of the existing pole foundation. The Contractor shall cut the stainless steel bands affixing the vehicular or pedestrian signal head and the upper and lower pole mounting assembly and remove the entire assembly from the pole.

As directed in the Plans, the Contractor shall furnish and/or install electrical cable between the traffic signal controller and a hole in the other pole where the cable is to pass through the signal head mounting assembly into the relocated signal head. This electrical cable may take the form of new cable, existing cable routed from the original pole, or new cable spliced for temporary installations only onto the existing electrical cable to the proposed pole.

The entire assembly featuring the vehicular or the pedestrian signal head and the upper and lower mounting brackets is to be affixed to the new pole using new stainless steel mounting bands after the electrical cable has been routed through the pole and the mounting hardware to the terminal block of the relocated vehicular or pedestrian signal head. After the Contractor connects the cable to the proper terminal block in the signal head, the Department technician shall reconnect the cables in the traffic signal controller.

The procedures outlined in this Section shall pertain when a vehicular or pedestrian signal head is being relocated from an existing pole to a new pole, from an existing pole to a temporary pole mounted on a temporary portable concrete base, or from a temporary pole mounted on a temporary, portable concrete base to a new pole. The existing vehicular or pedestrian signal heads shall be mounted at the same height above the ground as they were when mounted on the pole at its previous location. The orientation of the relocated vehicular or pedestrian signal heads shall be as shown on engineering Plans. All damage to vehicular and pedestrian signal heads, electrical cables, or mounting hardware during this process shall be repaired or replaced as directed by the Engineer at no additional cost to the District of Columbia. Work shall be deemed complete when the relocated vehicular or pedestrian signal head

operates in accordance with the approved traffic signal sequence of operation for that intersection.

- B. MEASURE AND PAYMENT** - The unit of measure to relocate an existing vehicular or pedestrian signal head will be each. The price shall include the cost of relocating the vehicular or pedestrian signal head and upper and lower mounting brackets, installing new stainless steel mounting bands and brackets, making electrical connections at the terminal block of the signal head, and removing debris from the Work Site. Payment shall be made at the Contract unit price for each relocated signal head and will include all labor, equipment, tools, materials and incidentals needed to complete the Work.

#### **613.56 RELOCATE ANY STEEL TRAFFIC SIGNAL POLE FROM ONE FOUNDATION TO ANOTHER**

- A. GENERAL** - The Contractor shall disconnect the electrical cable from the terminal block of all traffic signal devices including vehicle signal heads, pedestrian signal heads, pedestrian push buttons, Accessible Pedestrian Signals (APS), electronic signs, and pole mounted vehicle detectors attached to the pole after the Department technician has disconnected these cables from the traffic signal controller cabinet. The Contractor shall carefully pull all electrical cable through the pole to the base of the pole. The Contractor shall subsequently disconnect the existing pole from the foundation by removing the nuts and the washers from the anchor bolts in the foundation. Existing traffic signal devices may remain on the pole or be removed, as directed in the engineering Plans.

The Contractor shall remove the pole from its existing foundation and install the pole on top of the new foundation. If the existing pole is mounted on a steel transformer base, the pole and the transformer base shall be moved as a unit. A new transformer base shall be provided on the new foundation under a separate Pay Item if the steel pole to be relocated was mounted directly onto the initial foundation.

As directed in the Plans, the Contractor shall furnish and/or install electrical cable to each of the traffic signal devices mounted on the pole at its original location. The Contractor shall affix the pole assembly to the foundation by tightening the nuts and washers to the anchor bolts. After the Contractor connects the cables to the terminal blocks of the pole mounted traffic signal devices, the Department technician shall reconnect the cables in the traffic signal controller cabinet. The Contractor will subsequently ground the pole assembly to the ground rod in the foundation using ground cable and ground clamps.

The procedures outlined in this Section shall pertain to a pole/transformer base assembly being relocated from an existing permanent foundation to a proposed permanent foundation, from an existing permanent foundation to another existing permanent foundation at the same intersection, from an existing permanent foundation to a proposed temporary portable concrete base, or from a temporary, portable concrete base to an existing or a proposed permanent pole foundation. If the pole being relocated contains existing pole mounted traffic signal devices, the Contractor must ensure that the orientation of these devices shall be as shown on the engineering Plans. All damage to poles, traffic signal devices, mounting hardware, foundations, and electrical cable during this process shall be repaired or replaced as directed by the Engineer at no additional cost to the District of Columbia. Work shall be deemed complete when the pole assembly is relocated to its new foundation and the pole mounted traffic signal devices operate in accordance with the existing traffic signal sequence of operation.

- B. MEASURE AND PAYMENT** - The unit of measure to relocate an existing pole from one foundation to another will be each. The price shall include the cost of relocating the pole, ground clamps and ground wire, making electrical connections at the terminal block of the traffic signal devices on the relocated pole, and removing debris from the Work Site. Payment will be made at the Contract unit price for each relocated pole and will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

#### **613.57 MAINTAIN EXISTING TRAFFIC SIGNALS DURING CONSTRUCTION**

- A. GENERAL** - When traffic signal work is being performed at 1 or more existing signalized intersections as part of a roadway or bridge rehabilitation or reconstruction project, the Contractor shall establish a 24 hours per day, seven (7) days per week traffic signal malfunction response unit capable of responding to selected, reported traffic signal malfunctions at the signalized intersections under their construction authority. The Department expects the Contractor to maintain a close working relationship with the Department Field Operations Division and with the Department City-Wide Traffic Signal Maintenance Contractor. The Contractor shall establish communication with these units at the pre-construction meeting and they shall notify both units when their work has been completed and accepted by the Department. The Contractor shall meet with designated the Department Field Operations Division personnel before the Contract Notice to Proceed letter is issued to list deficiencies with all traffic signals within the Contract limits for the Department to order and effect all needed repairs before traffic signal work is begun by the Contractor.

Work assignments will typically be made by the dispatcher for the Department Traffic Signal Maintenance Contractor. The Contractor will perform no work within the traffic signal controller cabinet; assistance will be provided as needed by the Department Field Operations Division or by the Department City-Wide Traffic Signal Construction Contractor when controller cabinet access is required for the Contractor to complete their assigned maintenance task. The Contractor will be responsible for responding to individual malfunctions within a defined time period, and they shall provide a detailed report of work performed and actions taken for inclusion into the Department Traffic Signal Malfunction Log. The Contractor will be given a copy of the sample reporting form at the pre-construction meeting or at the Walk Through with Field Operations Division personnel.

**B. TRAFFIC SIGNAL COMPLAINTS** - The Department Traffic Signal Maintenance Contractor is required to respond to all traffic signal complaints upon notification by the Department. The Department Traffic Signal Maintenance Contractor shall dispatch traffic signal malfunction reports to the Contractor for signalized intersections within their work zone. The Contractor shall be on call 24 hours per day, seven (7) days per week including holidays to perform traffic signal repairs, and they shall dispatch qualified personnel with the proper materials and equipment to respond in a timely manner and take needed remedial action. The Contractor shall arrive at the Site within the established time constraints and remain on the Site until all repairs are completed. Emergency malfunctions shall require immediate response by the Contractor. The Contractor shall maintain records in a format established by the Department to document all traffic signal repairs and submit weekly reports to the Department through the Department Traffic Signal Maintenance Contractor. These reports shall include as a minimum the nature and the cause of the malfunction, the condition of the traffic signal upon arrival, materials used, time dispatched, time begun, time completed, and other pertinent information. The Contractor may be required to report and work with the Department City-Wide Traffic Signal Maintenance Contractor when that Contractor responds to a traffic signal controller or cabinet malfunction on the job Site and the remedy to that issue requires 1 or more repairs to the signalized intersection under construction. Maintenance repairs shall be deemed complete when the traffic signal is operating in compliance with the approved traffic signal sequence of operation at the conclusion of all repairs.

**C. COMPLAINTS AND COMPLAINT RESPONSE TIMES** - The Contractor shall be expected to respond to the following traffic signal malfunctions within one (1) hour between 6:00 AM and 7:00 PM, Monday through Friday except Holidays, and within two (2) hours all other times:

- Traffic Signal Pole Down
- Traffic Signal Pole Loose
- Traffic Signal Pole Leaning
- Temporary Traffic Signal Pole Down
- Temporary Traffic Signal Pole Damaged
- Electrical Traffic Signal Cables (All Types) Open, Shorted, Grounded, Cut or Damaged
- Electrical Traffic Signal Cables (All Types) Hanging with Exposed Conductors
- Electrical PVC Underground and Above Ground Conduit (All Sizes) Damaged
- Electrical GRS Underground and Above Ground Conduit (All Sizes) Damaged
- Messenger Cable Defective or Damaged
- Brackets or Hangers Loose and Damaged
- Vehicular and/or Pedestrian Signals All Out (1 or More Signal Head Out)
- Vehicular and/or Pedestrian Signals Stuck (Not Cycling)
- Vehicular and/or Pedestrian Signals Turned or Twisted (Out of Alignment)
- Conflicting Vehicular and/or Pedestrian Signals
- Vehicular or Pedestrian Signal Head Damaged
- Vehicular and/or Pedestrian Head Door Open
- Vehicular and/or Pedestrian Signal Head LED Module Out
- Traffic Signal on Flash



- Traffic Signal All Out (All Displays Dark)
- Detector Head Loose (All Types)
- Detector Head Damaged (All Types)
- Detector Not Operating (All Types)
- Detector Steady Call (All Types)
- Detector No Call (All Types)
- Defective or Damaged Inductive Loop Detector
- Defective or Damaged Pedestrian Push Button
- Defective or Damaged Accessible Pedestrian Signal (APS) Unit
- Electronic Variable Message Sign All Out
- Electronic Variable Message Sign Lamp Out
- Loose or Damaged Electronic Variable Message Sign
- Handbox For Loop Detector and/or Communications Cable Access Damaged
- The Department Manhole (3 foot X 3 foot) Damaged
- The Department Manhole (4 foot X 4 foot) Damaged

The Contractor shall be expected to respond to the following traffic signal malfunction reports within one (1) hour between 6:00 AM and 7:00 PM, Monday through Friday except Holidays and within 24 hours all other times:

- Traffic Signal Pole Damaged
- Missing or Damaged Visor for Vehicular or Pedestrian Signal Head

The Contractor shall be expected to respond to the following traffic signal malfunction reports within 24 hours:

- Missing or Damaged Transformer Base Door
- Electrical Cable Exposed in the Base of the Pole or the Transformer Base
- Inoperative Closed Circuit Television (CCTV) Traffic Camera
- Defective or Damaged Closed Circuit Television (CCTV) Traffic Camera

- D. MEASURE AND PAYMENT** - The unit of measure to maintain an existing traffic signal in an active work zone will be by the intersection. The Contractor will provide a lump sum unit price for each signalized intersection within the Contract limits. Payment shall be made at the Contract unit price for each intersection maintained during the life of the Contract and will include all labor, equipment, tools, materials, incidentals, and clean up needed to complete the Work.

### 613.58 SOLAR POWER SYSTEM

- A. GENERAL** - Furnish and install a solar power system as denoted on the plan set or in the Specifications for either the microwave or acoustic traffic counting system. The solar power system with inverter option will include inverter in addition to other items as detailed below.

- B. MATERIAL** - At a minimum, the Contractor shall provide the solar power system with the following functionality:

The system shall have the capacity of producing electricity directly from the Sun i.e., Solar Power. The solar system shall provide power to run 1 or 2 detector unit(s).

The system shall provide stored power for full operations for a minimum of five (5) sun-less days. The system shall fully restore battery charge in eight (8) hours of sunshine.

The system shall include complete equipment including all individual units, array combiner box, cables, fuses, switches, circuit breakers, and meters for reliable operation of the detector.

The system shall have solar power assemblies made up of the following interconnected components, each with a specific function.

**1. Solar Array Panel**

- a. Solar array shall consist of 1 or more Photovoltaic modules, which generate DC electricity from the sunlight and convert it into usable electric energy.
- b. The size of the array panel shall be designed based upon the power requirement for the system, geographical location of the detector sites and storage capability of the solar battery bank.
- c. The modules shall be connected in series and/or parallel to provide the required voltage and current levels.
- d. The arrays shall be mounted on the same pole with the detector, if applicable, at a downward angle of 34 degrees from horizontal.
- e. The photovoltaic arrays shall be arranged in rugged weatherproof steel or aluminum anodized frame, using code approved components and wired to US NEC Standards.
- f. The panels shall have high mechanical strength capable of withstanding extreme wind (110 mph), snow load, hailstorm/hailstones protected from airborne particles and exposure to moisture.
- g. Each solar array shall be refined and treated with special oxides to passivate the surface.
- h. The panels shall have an anti-reflective coating to optimize the cells optical properties for maximum absorption of Photons from the sunlight.
- i. The arrays shall have the capability of high light absorption, even at low light level or cloudy conditions.
- j. Each solar cell shall be laminated in ethylene-vinyl acetate (EVA) between multi-layer rear film and front glass.
- k. The arrays shall have an operating temperature range of -37 to +74 degrees C.
- l. The arrays shall have an operating humidity range of 5 percent to 95 percent relative humidity, non-condensing.
- m. The system shall avoid any power loss of any type or reason especially, during shadowing.
- n. The system shall have an output voltage of 12-24 VDC supplying a minimum of 6W, or by adding an Inverter, supply 120 VAC at 60 Hz.
- o. The solar array panel shall have a warranty of at least 15 years.
- p. Each solar panel shall have a typical maximum power ( $P_{max}$ ) of 120 Watts.

**2. Mounting Bracket**

- a. Provide stainless steel clamps or bands for mounting on metal poles, or provide stainless steel lag-bolt or through bolts for mounting on wood poles. Design must be submitted for review and approved by the manufacturer and the Engineer.
- b. The elevation adjustable angle shall be 25 to 65 degrees in 5 degrees increments.
- c. Provide heavy gauge steel pole clamps, strong back, and support arm to withstand self load, loads of all equipment, wind load, snow load and also associated moments and torsion.
- d. Provide components having rust-proof/rust-resistant properties against all weather conditions.

**3. Solar Charge Controller**

- a. A charge controller shall be provided for each solar array panel to maintain a battery at the proper charge level, and to protect from overcharging.
- b. The charge controller shall be 100 percent solid state unit completely sealed against any harsh environment conditions.
- c. The charge controller shall have the following features: lightning protection, reverse leakage protection blocking diode, low power consumption, simple rugged circuitry, No. 12 AWG terminal, charging light and Low Voltage Disconnect (LVD) activated light.
- d. The charge controller shall be a maintenance free unit.

- e. The charge controller shall have a temperature sensor capable of adjusting the charging thresholds according to battery temperature.
- f. The charge controller shall have a Low Voltage Disconnect (LVD) relay to protect battery from low voltage damage.
- g. The solar charge controller shall have an operating temperature range of -37 to +74 degrees C.
- h. The solar charge controller shall have an operating humidity range of 5 percent to 95 percent relative humidity, non-condensing.
- i. The solar charge controller shall have at least three (3) years of warranty.

#### 4. Battery Bank

- a. The Battery Bank shall contain 1 or more 12-Volt (minimum) deep cycle batteries, connected in series and/or parallel depending on voltage and current need for TFDS.
- b. Size and number of batteries shall be "sized" to match the System.
- c. The Battery shall be capable of storing and discharging energy, when and as required.
- d. Battery Bank System shall be approved by the manufacturer of the solar array panel.
  - i. The battery shall have a deep cell, sealed gel battery, with a minimum of five (5) days of autonomy.
  - ii. The Battery shall be maintenance free.
  - iii. The battery shall have an operating temperature range of -37 to +74 degrees C.
  - iv. The battery shall have an operating humidity range of 5 percent to 95 percent relative humidity, non-condensing.
  - v. The battery shall have a warranty period of at least three (3) years.

#### 5. Inverter

- a. When required by the System or when stated in these Specifications, the Solar Power Assembly shall include an Inverter capable of converting 12-24 VDC power from the solar array into 120 VAC power.
- b. The inverter shall have an automatic thermal protection.
  - i. The inverter shall have efficiency greater than 95 percent.
  - ii. The inverter shall have a low input voltage alarm.
  - iii. The inverter shall have dual AC Outlets.
  - iv. The inverter shall have plug in Protection.
  - v. The inverter shall have full Input and Output Protection.
  - vi. The inverter shall have reverse polarity protection.
  - vii. The inverter shall be capable of providing maximum continuous output power, as required for running the detector without any obstruction.
  - viii. The inverter shall have surge protection.
  - ix. The inverter shall be maintenance free.
  - x. The inverter shall have an operating temperature range of -37 to +74 degrees C.
  - xi. The inverter shall have an operating humidity range of 5 percent to 95 percent relative humidity, non-condensing.
  - xii. The inverter shall have a warranty of at least three (3) years.

All components must be approved by the Engineer before installation.

- C. **MEASURE AND PAYMENT** - Furnish and Install Solar Power System will be measured and paid for at the Contract unit price per each. Payment shall be full compensation for furnishing and installing, solar array panels, mounting bracket, solar charge

controller, battery bank, and inverter (if applicable), all associated cables and wiring, manuals, setup and testing for the equipment necessary to complete the Work

### 613.59 SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEM

- A. **GENERAL** - Furnish and install a Spread Spectrum Wireless Radio Frequency (RF) receiving modem within an existing Traffic Signal Controller Cabinet according to the Plans. Install the corresponding antenna to the nearest traffic signal pole. Antenna cable shall be run from existing traffic signal pole to the Traffic Signal Controller Cabinet utilizing existing conduit traffic signal cable conduit. Program the modem to receive signals from adjacent traffic counter cabinet signals spread spectrum wireless communication system as denoted on the plan set or in the Specifications and convert the signal into Ethernet ready protocol to be conveyed through the Department's Traffic Signal Communications Network.
- B. **MEASURE AND PAYMENT** - Each spread spectrum assembly will be measured and paid for at the Contract unit price per each. The payments will be full compensation for furnishing, installing the RF modem, modem antenna and all peripheral electronic components and mounting hardware and all required labor equipment and materials to install the modem in the field cabinet and antenna on the nearest adjacent traffic signal pole, including testing, and furnishing documentation to complete the Work.

### 613.60 ROADWAY WEATHER INFORMATION SYSTEM (RWIS)

- A. **GENERAL** - The Work to be performed under this section consists of procuring, furnishing, installing and wiring of the complete Road Weather Information System (RWIS), in compliance with 825.30, at the locations shown on the Plans and in accordance with the conditions set forth.
  - 1. The RWIS system shall have the following general high level requirements:
    - a. The system shall be specifically designed for monitoring and displaying pavement surface conditions, pavement temperature, freeze point temperature, chemical percent concentration, subsurface temperature, roadway video images, and atmospheric conditions from the location(s) as shown in the Contract Plans.
    - b. Both passive and active in-pavement sensors shall be installed at the RWIS Site(s) to monitor roadway surface status conditions including dry, wet, frost, chemical wet, and snow/ice warning.
    - c. Atmospheric/meteorological conditions monitored may include any of the following; air temperature, relative humidity, dew point, precipitation classification, visibility, barometric pressure, and/or wind/speed direction.
    - d. The system shall provide color still frame video images of the Roadway.
    - e. The information from the RWIS station shall be collected by, archived and displayed on the existing DOT RWIS server system.
- B. **MEASURE AND PAYMENT** - Roadway Weather Information System (RWIS) will be measured and paid for at the Contract unit price per each. Payment shall be full compensation for furnishing, installing the detector in a manufacturers and the Department approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from the Department's TMC and furnishing documentation to complete the Work.

### 613.61 DYNAMIC MESSAGE SIGN (DMS)

The contractor shall furnish and install DMS as described below.

#### 613.61.01 LED FULL MATRIX DMS

##### A. GENERAL

- 1. **DMS Type** – The DMS shall be of the following types:
  - a. *Type I* - shall be LED Full-Matrix DMS (27 x 145 pixels, 66 mm pitch), 30-degree viewing cone, capable of displaying at least 3 lines, each with 21 18-inch characters per line, flashing beacons where applicable, and walk-in housing for installation on major freeways and arterials. Maximum dimensions not to exceed 9ft H x 31ft W x 4ft D and 4,500 lbs.
  - b. *Type II* - shall be LED Full-Matrix DMS (27 x 105 pixels, 44 mm pitch), 30-degree viewing angle, capable of displaying 1, 2, or 3 lines, with 15 12-inch characters per line, cantilever or pedestal mounted, and front access for installation on city streets. Maximum dimensions not to exceed 6ft H x 18ft W x 2ft D and 2,000 lbs.

2. **Definition** – Full-Matrix is defined as a type of DMS without fixed lines, columns or characters and the entire display area contains equally spaced pixels. The DMS and controller shall have the ability to display characters using proportional spacing on the full-matrix configuration. Any graphic, symbol, character or font can be placed in any location within the display area of the DMS without regard to lines or columns.
3. **Test Certificate** – The DMS manufacturer shall submit a test certificate from an independent laboratory to certify compliance with the cone-of-vision requirement. The cone of vision shall be measured at the front of the sign in its final position with any component that could impede or otherwise affect the light output (such as the front face, mask, and polycarbonate) in place. An LED component manufacturer certificate shall not satisfy this requirement, since the test shall consider the mounting of display boards within the sign and the front face.
4. **Terminology** – Due to the varying definitions used in Dynamic Message Sign technology, this section defines specific terms as they apply to this specification.
  - a. *Sign* - The sign housing and its contents.
  - b. *Sign Controller* - Located in a cabinet (as detailed in this specification), the sign controller manages all aspects of the sign operation including: specifying the message to be displayed, diagnostics, and remote communications. Messages can be selected either remotely from the central controller, locally from a laptop computer or from the front panel of the sign controller.
  - c. *Central Controller* - The Microsoft Windows Server computer system and related software, which operates the system from a remote control site.
  - d. *Workstation* - The Microsoft Windows workstation computer and related software that operates as a remote client over a computer network to the central controller. A workstation operator can access the central controller and gain access to the functions of the central by using the appropriate access codes.
  - e. *LED (Light Emitting Diode)* - The DMS display lighting technology.
  - f. *Pixel* - Any of the small discrete elements that, when arranged in a pixel matrix, create a character. A pixel contains a cluster of LEDs.
  - g. *Pitch* - Distance measured from center to center of adjacent pixels within a matrix. This distance is measured both horizontally and vertically.
  - h. *Poll* - The central controller and laptop computer are said to “poll” a sign when they request the sign’s status information. The term is derived from the periodic status polling, which a central controller can perform, but is loosely used to refer to any status request.
  - i. *Message* - Text; the information displayed on the sign.
  - j. *Display* - The message seen by the motorist. A display may include more than 1 page of text (an alternating display). Any character or set of characters of a display may be flashed (a flashing display).
  - k. *Neutral State* - Sign is blank, or displaying a predefined message that is displayed regularly.
5. The Contractor shall register with the manufacturer(s) all equipment in the name of the Department. Photocopies of the registration forms shall be forwarded to the Engineer.
6. The Contractor shall store and handle all materials and equipment in a clean, dry location; free from construction dust, precipitation and excess moisture, so as not to degrade quality, serviceability or appearance.
7. The Contractor shall contact the DMS manufacturer for information on proper storing and installation of the DMS equipment.

## B. MATERIAL

### 1. General

- a. All materials furnished, assembled, fabricated or installed under this item shall be new and of the latest design and recent manufacture, corrosion resistant, and in strict accordance with this specification. No used or refurbished hardware is permitted. Furthermore, firmware and software shall be tested and in working order. Neither prototype firmware, nor

prototype software is permitted. Failure to meet all details and functionality detailed in this specification shall be grounds for rejection of the equipment.

- b. All parts shall be of high-quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.
- c. All external screws, nuts, and locking washers shall be stainless steel. Self-tapping screws shall not be used on the exterior of the sign. All nuts shall be nylon nuts or similar. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, aluminum or brass. All materials used in construction shall be resistant to fungal growth and moisture deterioration. All dissimilar metals shall be separated by an inert dielectric material.

## 2. Physical Characteristics

- a. The latest available techniques shall be utilized in equipment design and construction of the LED DMS with a minimum number of different parts, subassemblies, circuits, cards and modules to maximize standardization and commonality.
- b. The equipment shall be designed for ease of maintenance with all component parts readily accessible for inspection and maintenance. Test points for checking essential voltages shall be provided.
- c. All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician.
- d. Solid-state display elements and modules shall be provided. Mechanical or electromechanical elements or shutters shall not be used.
- e. The DMS, including the sign housing and all modules and assemblies, shall be designed and manufactured by company certified by ISO 9001 or equivalent formal Quality Systems, and shall comply with the provisions of NEMA Standard TS 4-2005, latest revision.
- f. The LED DMS shall be designed for a minimum life of 10 years.
- g. The signs shall be designed and constructed to present a clean and neat appearance. Poor workmanship will be cause for rejection of the sign.
- h. If cable attachments are used in the sign housing, the cables shall be securely clamped in a manner as approved by the Department. No adhesive attachments shall be allowed.
- i. The complete sign housing of the LED DMS shall be designed and manufactured in-house by the LED DMS Sign Manufacturer.
- j. The presence of power transients or electromagnetic fields, including those created by any components of the system, shall have no deleterious effect on the performance of the system. The system shall not conduct or radiate signals which will adversely affect other electrical or electronic equipment including, but not limited to, other control systems, data processing equipment, audio, radio, and industrial equipment.

## 3. Electrical Components

- a. All electronic equipment shall be of solid-state design and modular construction. Individual electronic modules shall provide easy service access and shall be field replaceable. The design shall be such as to prevent incorrect assembly or installation of connectors, fasteners, etc., where possible malfunction or personnel hazards might occur. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance
- b. All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods. All electronic assemblies shall meet or exceed IPC 610A workmanship standards.
- c. The sign and its sign controller shall be capable of operating with 240/120 VAC, 40 amp per leg, 60 hertz, single-phase power.
- d. The system shall be protected by transient voltage suppression devices, including MOVs, RIS and spark gap arrestor. Resettable surge protection shall be provided. Tripping of the surge protection shall prevent power from reaching any

components of the sign until the surge protection has been reset. Tripping of the surge protection shall cause the sign controller to call the TMC and report the error condition.

- e. Each DMS provided shall consist of internal wirings, terminal strips for interconnecting wire, duplex outlets for maintenance equipment, photo sensors, and heating strips.

#### **4. Housing Face**

- a. The housing face shall be of 3-piece construction, consisting of internal structural members, external face panels and lens panel assemblies.
- b. The interior structural members shall be fabricated from 6061-T6 or 6063-T6 aluminum alloy extrusions and shall:
  - i. Accommodate both display module mounting and air distribution.
  - ii. Retain the display modules in a manner to facilitate easy and rapid removal of each display module without disturbing adjacent display modules.
- c. There shall be no exposed fasteners or welds on the housing face.
- d. The external face panels shall be designed to minimize heat conduction between the exterior surfaces and the interior components.
- e. The external face panels shall be made of UV stabilized high-impact resistant polycarbonate material with a UV silk-screened mask that provides a high level of contrast and readability. The Panel shall absorb greater than 80 percent of UVA and UVB.
- f. The border and therefore, the external fascia perimeter panels shall be a minimum of 12 inches wide.
- g. The external face panels shall be thermally isolated from the rest of the sign housing.
- h. The housing face shall be finished with a matte black, licensed factory-applied KYNAR 500 Resin, fluoropolymer based coating system. Certification shall be provided from the licensed factory KYNAR 500 coater for all aluminum face materials. All other exterior and interior surfaces shall be a natural aluminum mill finish. Surfaces shall not be painted.
- i. The Lens Panel Assembly shall consist of a KYNAR 500 coated aluminum mask over a clear glazing and shall be modular in design, interchangeable with no misalignment with the LED pixels and sealed with a closed-cell resilient gasket.
- j. The lens panel shall be heated to prevent fogging and condensation.
- k. No manufacturer and/or vendor logos shall be allowed on the housing face. Logos, preapproved by the Engineer, may be allowed on the sides and/or rear of the sign housing.

#### **5. Walk-In Access DMS**

- a. The DMS housing shall be walk-in access containing 2 access doors, one on each side of the enclosure. Each door shall be mounted to the housing using a stainless-steel, continuous piano-style hinge so that it opens towards the outside front of the sign to shield maintenance personnel visibility from traffic.
- b. The walk-in housing access shall be from the side via a door with a minimum internal height of 6 feet-6 inches.
- c. The access door, when open at a 90-degree angle from the DMS housing front wall, shall not extend more than 38-inches from the housing. All doors shall contain a stop that retains the door in a 90-degree open position. When a door is open, the door and its stop shall not be damaged by an 80 mph wind.
- d. A document holder on the inside of door shall be provided for schematics, line diagrams, etc.
- e. The DMS housing doors shall be furnished with a door lock that is keyed to the Department standard lock. The latching/locking mechanism shall include a handle on the interior of the housing such that a person with no key and no tools cannot become entrapped inside the housing.
- f. Doors shall be provided with door switch(s) and control wiring connected to the sign controller for reporting door open/closed status.

- g.** A closed-cell neoprene gasket shall be used to seal out moisture and other contaminants when the door is closed.
- h.** A level interior walkway manufactured of anti-skid aluminum with a minimum width of 18 inches running the entire length of the sign shall be installed in the bottom of the sign housing.
- i.** The sign floor shall be designed to be slip resistant and to avoid water retention. The bottom panel of the housing shall be provided with a minimum of 4 drain holes, with snap-in, replaceable drain filter plug inserts, in each section formed by internal structural members.
- j.** The housing shall contain a floor system capable of safely supporting a weight of 1,000 pounds. Signs indicating the maximum weight shall be conspicuously displayed inside the housing.
- k.** The interior sign housing shall be a minimum of 2 feet 10 inches wide to allow adequate room inside the sign housing for maintenance personnel. There shall be 18 inches of clear area between all equipment along the entire length of the sign housing from the 18-inch walkway up to 6 feet above the 18-inch walkway.
- l.** The sign housing shall provide easy access to all internal components for maintenance and repair purposes.
- m.** A shelf or workbench shall be provided inside the enclosure for a notebook computer and related equipment.
- n.** The sign interior shall be equipped with fluorescent lights fitted with clear protective covers running the length of the housing. A sixty (60) minute mechanical rotary timer switch shall be easily accessible upon entering the housing. The light timer shall be clearly labeled "LIGHTS".
- o.** The DMS housing shall include a minimum of two 15 AMP, 120 VAC duplex electrical outlets, with ground fault circuit interrupters (GFI), for use by maintenance personnel. The 2 duplex outlets, one at each end, shall be located within the DMS housing.
- p.** A humidistat shall be provided that shall monitor the humidity from zero percent to 100 percent. The humidistat shall be sensed by the sign controller and shall provide continuous, automatic control to sense humidity rise exceeding a selected level with an adjustable range of 20-80 percent.
- q.** Provisions shall be made for natural ventilation inside the sign enclosure by means of screened and filtered air outlets at the top, rear of the enclosure. These outlets shall be suitably baffled or louvered to prevent the entry of wind-blown moisture and dust. The filters shall be of the permanent, washable type, and shall be easily removable for servicing.
- r.** A positive-pressure, filtered, forced-air ventilation system that cools both the display modules and the sign interior shall be provided. The forced-air ventilation system shall provide a minimum of 1 sign enclosure volume change per minute.
- s.** The ventilation system shall have 2 methods of control; an industrial-style thermostat, and a sixty (60) minute mechanical rotary timer switch. The thermostat shall operate with 1 internal temperature sensor and an additional temperature sensor to measure the ambient temperature outside the sign housing. Temperature sensors shall have an accuracy of  $\pm 1.5$  degrees Fahrenheit, and a range from  $-30^{\circ}$  F to  $+140^{\circ}$  F. The set point of the thermostat shall be adjustable from  $90^{\circ}$  F to  $130^{\circ}$  F. The blower timer shall be clearly labeled "BLOWER", in the same manner as the light switch, and shall be mounted directly adjacent to the light switch.
- t.** Enough baseboard heaters shall be provided to warm the interior of the walk-in housing to 30 degrees Fahrenheit above ambient. A sixty (60) minute mechanical rotary timer switch in the sign and remotely from the laptop and central computers shall control these heaters. The heater timer shall be clearly labeled "HEATER" in the same manner as the blower switch, and shall be mounted directly adjacent to the blower switch.
- u.** The LED modules and electronic equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the sign controller.
- v.** Each DMS shall be equipped with the secured fiberglass ladder of sufficient height to permit servicing all modules and components within the enclosure.
- w.** Each DMS shall have a set of tools necessary for performing preventive maintenance service on the walk-in enclosure. Tools shall be placed in the tool box and secured inside the sign.
- x.** Fall arrest anchor points shall be provided at the doors at both ends of the walk-in housing for workers to attach to when the door is opened.



## 6. Beacon Flasher System

- a. The enclosure shall contain four 12 inch, Amber LED signal heads and 8 inch tunnel visors, arranged as shown in the Plans. The signals installed shall have Fresnel-style, or “ball” diffusers.
- b. LED signal modules shall comply with all requirements of the most recent, formally-ratified version of the ITE Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules, with the exception of luminous intensity.
  - i. The on-axis (2.5 degree) luminous intensity shall be a minimum of 675 candelas, not to exceed 1,000 candelas.
  - ii. The manufacturer of LED signal heads supplied shall provide written certification of compliance with the ITE Specification, and the luminous intensity stated in item (1) above, in their catalog cut submittals.
  - iii. The manufacturer of LED signal heads supplied shall provide written certification that their LED signals are approved for use in flashing mode.
- c. The signal heads shall be wired to a 2-circuit NEMA flasher so that the flasher will activate alternate pairs of bulbs simultaneously. 1 cycle will light bulbs 1 and 3, and the next will light bulbs 2 and 4.
- d. Current sensing circuitry shall be provided to monitor operation of the signal modules, and log and remotely alert the system operator of signal failure.
- e. The entire flasher and signal head system shall be installed and pre-wired to the main sign connection terminal block by the sign manufacturer.
- f. The operation of the beacon flasher system shall be controlled by software command, at the discretion of the system operator. Upon issuing the command, the controller shall activate the NEMA flasher, which will then activate the signal heads as described above.
- g. Shop drawings for the complete beacon flasher system shall be submitted to the Engineer for approval along with the Shop Drawings for the walk-in enclosures before beginning fabrication of either system.

7. **Environmental** – The sign shall operate without malfunction and without any decrease in performance over an ambient temperature range of -30° F to +140° F and with a relative humidity of up to 95 percent non-condensing.

The DMS sign controller shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a 140° F threshold temperature.

## 8. DMS Sign Controller

- a. The controller shall meet NTCIP requirements and shall be provided with resident software stored in non-volatile memory. The sign controller shall be programmed to receive sign control commands from the central controller or laptop computer, transmit responses as requested to the central controller or laptop computer via the communication system, monitor sign and message status and control sign operation and message displays.
- b. The controller shall be a software-driven microprocessor-type DMS controller with printed circuit boards and front panel indicators.
- c. The controller shall continuously monitor the display of the sign independent of any external commands, and cause the signs to display all the appropriate characters
- d. The controller shall incorporate an audible tone that sounds about every 15 minutes when messages are displayed to alert the operators that a message or messages is/are running during an incident clearing activity, a stationary or roving work crew, etc. The sound will alert the operators to check on the message status so that they may update the message or blank out as needed.
- e. The controller shall accumulate data about the sign status (to be transmitted upon request), and receive commands from the central computer, maintenance laptop computer, and a local panel.
- f. The controller shall have the ability to control the brightness level, using the photo sensor controls in the DMS cabinet. The controller shall have the ability to achieve an “overbrightness” mode operation in fog or intense sunlight.

- g. The operator shall be able to select independent display times for alternating, flashing messages and blank-out time between messages in one-tenth (0.1) second increments. Upon terminating the display time for a message, the controller shall either blank the sign or place the sign in a neutral condition.
- h. A fail-safe mechanism shall be provided to automatically blank the sign upon encountering an error, or improper information display in the case of malfunction, or communication and/or power failure.
- i. The controller shall have power-up and auto-restart capabilities with automatic sign blanking when recovering from a power off condition. A watchdog circuit shall be utilized to provide automatic reset to the controller. The central controller shall be capable of remotely commanding a sign controller reset.
- j. The controller shall be 19-inch rack mounted in the DMS Controller Cabinet.
- k. The controller will communicate with the display modules via fiber-optic cable.
- l. The controller shall include a local/remote control switch and LED indicator, allowing a local operator to override central operations and take over local control of the sign. A timeout feature will force the controller to revert to central operations after a configurable timeout or inactivity period.
- m. A controller shall be provided that is able to read the internal temperature sensors, external ambient temperature sensor and the humidistat. The controller shall use these readings in an algorithm that turns on the heat at the appropriate times to reduce both frost on the face of the sign and condensation on the display modules and other display system circuitry.
- n. A temperature reading greater than a user selectable critical temperature shall cause the sign to go to blank and the sign controller shall report this error message to the central computer.
- o. The controller shall continuously measure all LED module power supply voltages. The controller will provide these voltage readings to the central controller or laptop computer when the central controller or laptop computer polls the sign controller.
- p. The controller shall be easily replaceable/interchangeable in case of any failures.
- q. The controller shall provide a library with a minimum of 50 permanent messages, consisting of 30 or fewer characters per line, stored in PROM. The controller shall also be able to accept a downloaded library from the central or laptop computer containing at least 25 changeable messages stored in non-volatile RAM. These messages may be displayed on the sign from the keypad on the front panel of the controller. The RAM shall be backed up by a long life battery allowing power outages of a minimum of 12 months without loss of data.
- r. The controller shall also be capable of displaying messages on the sign that are downloaded from the central controller or laptop computer, but are not located in the library stored in non-volatile memory of the sign controller.
- s. The full matrix display shall also be capable of displaying other sized characters and other number of lines depending on the height of the character utilized. The interline spacing shall be variable.
- t. *Central Communications* - Exchanges between the DMS sign controller and central controller shall be made only upon the central controller request inviting the DMS sign controller to send (select) or receive (poll) data. The 3 modes of operation shall be:
  - i. Central Mode: The central controller controls and monitors the sign.
  - ii. Local Mode: The sign controller LCD panel and keypad are used for direct sign operations and diagnostics.
  - iii. Remote Mode: A local laptop computer is used to control and monitor the sign.

The communications between the sign controller and the central controller or laptop computer shall comply with the NEMA National Transportation Communication for ITS Protocol (NTCIP) as detailed in this specification. Unless otherwise stated, the software shall comply with the versions of the relevant NTCIP standards that are current at the date of this document.
- u. *Communications Interfaces*
  - i. The controller will include separate RS-232/422/485 serial interface and an RJ45 Ethernet 10/100 Base T interface for communication with the central controller.

- ii. The controller will include a separate RS-232 serial interface for communication with the laptop computer. A minimum 6-foot long serial cable will be supplied to connect the laptop computer to the sign controller.
- iii. The controller will include an RJ-11 jack for connecting to a dial-up phone line.
- iv. The controller will contain 8 digital inputs, 4 analog inputs, and 4 digital outputs to support external alarm and contact closure monitoring.

#### 9. DMS Controller Wiring

- a. The communication and control cables between DMS controller and sign housing shall be fiber optic. The cables shall terminate in a fiber patch panel at both ends. Fiber patch cords, meeting the same Specifications of the fiber cable and 3 foot length, shall be used to connect local equipment to the patch panel.
- b. The fiber optic cable shall meet the following requirements.
  - i. A 6-fiber optic 62.5/125 cable shall meet the Specifications of Corning OM1 fiber type multimode, or equal, at a minimum. The duplex fiber optic cable shall have a nominal fiber OD of 2 x 4 mm and shall be orange in color. The fiber optic cable shall have a maximum attenuation of 3.75dB/km at 850 nm and 1.5 dB/km at 1300 nm. The fiber optic cable shall have a minimum gigabit Ethernet capability of 220 meters at 850 nm and 550 meters at 1300 nm. The fiber shall have a maximum tensile load capability of 48 lb-ft short term and 15 lb-ft long term with a minimum installed bend radius of 2.5 cm (1 inch). Maximum insertion loss shall be less than 0.4 dB with a maximum back reflection of less than -25 dB.
  - ii. The fiber optic cable shall be terminated with “ST” connectors on all ends within the fiber patch panel. The “ST” connectors shall be Corning Glass Insert Connectors (GIC) Anaerobic (95-101-52 SP multimode 62.5/125 um) or equal.

#### 10. DMS Sign Controller Software – Sign Controller software and firmware shall be NTCIP 1203 v.2 compliant and support the following minimum functions:

- a. Report errors and failures, including, but not limited to:
  - i. Power recovery
  - ii. Power Failure
  - iii. Pixel string failure
  - iv. Fan failure
  - v. Over user selectable critical temperature
  - vi. Power supply failure
- b. Message and status monitoring – The sign controller will respond to the central controller whenever it receives a request for status. The return message will be capable of providing the following information:
  - i. Actual message that is visibly displayed on the sign on an individual pixel basis
  - ii. Current sign illumination level
  - iii. Local Control Panel switch position (central or local)
  - iv. Error and failure reports
  - v. Temperature readings
  - vi. Power supply voltage levels
  - vii. Origin of display message transmission (laptop or central)
  - viii. Heater status
  - ix. Uninterruptible power supply status

- c. Severe error condition response - In dial-up mode, the sign controller will initiate a call to the central controller and report any severe error conditions. In multi-drop mode, the sign controller will report severe error conditions to the central controller during the next polling. In network communication mode (UDP/IP), the sign controller will automatically send the diagnostic information to the Traffic Management Center (TMC) to notify the technicians of any reported errors. Also email notification alarm can be setup to notify the Supervisor if the sign controller reported any severe error conditions.

The severe error conditions are:

- i. AC power failure
  - ii. AC power recovery
  - iii. Surge protection has tripped
  - iv. Temperature reading over a user selectable critical temperature
  - v. The sign housing and controller cabinet door is open
- d. *Display Control*
    - i. Display static, flashing, and alternating messages
    - ii. Supports amber monochrome alphanumeric characters and graphics messages
    - iii. Has the ability to control any size character, line, or full matrix DMS
    - iv. Scheduling is based on to-the-minute time-of-day, day-of-week, holiday or special days, one-time or recurring scenarios
    - v. Photo sensor override and manual brightness control
- e. *DMS Messaging*
    - i. Includes message-creating editing tool with preview
    - ii. Manages DMS font database
    - iii. Has the ability to create, save, and adjust message duration and priority settings
    - iv. Configures flash rates, scrolling and other message attributes
    - v. Can create and save banned words list (white and black lists)
    - vi. Spell checks messages before display and can edit 1 line (or word) of text without having to retype the entire message
    - vii. Supports multi-phase (3-phase minimum) messages
    - viii. Supports beacon activation by message
    - ix. Has the ability to create and save default messages for each DMS
- f. *Utilities and Diagnostics*
    - i. Has the ability to view status, errors, and any error codes of all DMS subsystems in real time and historical date/time stamped logs
    - ii. Has the ability to locate pixel failures and verify the error
    - iii. Has a built-in pre-programmed common pixel test patterns and diagnostics
    - iv. Has the ability to monitor the DMS environmental conditions based on DMS sensors
    - v. Has the ability to accept remote firmware upgrades
- g. *Security* - Has the ability to restrict each user's functional areas (read/write restrictions) with user accounts containing unique user names and passwords.

- C. CONSTRUCTION** - The installation of the DMS sign and all DMS controller cabinet connections shall be in accordance with DMS manufacturer guidelines, approved final design Plans and all applicable Department standards.

**D. TESTING**

**1. General**

- a. The testing of all equipment furnished and installed under this Contract shall be conducted by, and be the responsibility of, the Contractor.
- b. The Contractor shall make arrangements for the witnessing tests as requested by the Department. Full documentation of test results including problems experienced shall be prepared by the Contractor and submitted to the Department. Any equipment failing the tests shall be replaced or repaired and re-tested at the Contractor's expense.
- c. The Contractor shall submit a detailed and comprehensive Test Plan to the Department within 30 days of Notice to Proceed (NTP) for approval. The Test Plan shall identify all required testing levels for the specific equipment provided by the Contractor. The Test Plan shall identify the Contractor's test organization, including the roles and responsibilities of the quality assurance organization. Anticipated test dates and durations shall also be identified.
- d. Following completion of each test, the Contractor shall provide a written report detailing all test results and a proposed course of action for resolving any anomalies.

**2. Factory Acceptance Tests (FAT)**

- a. DMS, controller, and software requirements as stated herein shall be factory demonstrated by the DMS vendor/Contractor to the Department prior to shipment. 1 factory acceptance test per sign type will be required or as directed by the Department.
  - b. The Contractor shall submit factory test procedures to the Department for approval at least 14 days prior the FAT. The following items shall be tested as part of the FAT:
    - i. NEMA 4X waterproofing test.
    - ii. NTCIP Testing - The DMS vendor/Contractor shall be responsible for ensuring that the DMS equipment complies with the NTCIP Standards as specified herein and in conformance with NTCIP 9012 v0127 or later, Testing Guide for NTCIP Center-to-Field Communications.
    - iii. The DMS controller shall be tested for NTCIP conformance and specification compliance using a standard commercially-available test device such as the IDI Device Tester for NTCIP, SimpleSoft SimpleTester, Trevilon NTester, or equivalent. NTCIP testing will be performed as part of the FAT.
  - c. No equipment for which a demonstration test is required shall be shipped by the manufacturer without successful completion of FAT, receipt of documented test results and the Department's authorization to ship.
  - d. The Contractor shall notify the Engineer thirty (30) days in advance of factory tests.
  - e. Failure to conform to the requirements of any tests and these Specifications shall be counted as a complete failure, and the equipment shall be rejected. Rejected equipment/tests may be retested after all deviations have been corrected. After successful completion of all factory demonstration/acceptance tests, the DMS for this Contract will be accepted for shipment to the implementation Site. The Contractor shall provide the documentation to the Department of all test and demonstration results.
  - f. The approval of test procedures and the Department's acceptance of DMS tests shall not relieve the Contractor of his responsibility for providing a completely acceptable DMS operating system that meets the requirements as stated herein.
- 3. System Integration Test** - The system integration test shall demonstrate that all equipment is fully integrated and operational. This test shall verify that all equipment installed at each location is installed properly and that all functions conform with the Contract Documents. All Contractor-supplied software shall also be tested during the System Integration Test.
- 4. Test Documentation** – The Contractor shall submit to the Department for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the

approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

**E. DOCUMENTATION** - The following shall accompany all electrical and mechanical components supplied:

1. **Operator Manuals** – Operator Manuals shall be provided for all equipment and components supplied as part of the DMS. The manuals shall be comprehensive, easy to use and understand, and completely descriptive of the product.
2. **Maintenance Procedures Manuals**
  - a. A service manual containing detailed preventive and corrective maintenance procedures shall be provided for each different type or model of equipment. The manual shall cover as a minimum the proper method of adjusting and otherwise maintaining each item, a concise statement of the necessary operating functions in proper sequence, and a detailed description of the component function in relation to the various operation steps.
  - b. Systematic field and bench trouble shooting procedures shall be included, as shall normative waveforms and test voltages as applicable.
  - c. An equipment assembly pictorial drawing showing the physical location and identification of each component shall be provided for each different electronic assembly and each different subassembly of each assembly.
  - d. A detailed parts list shall be included. For each part, its circuit or pictorial identifications shall be shown, as shall all necessary rating information and a manufacturer and associated model or part number. The list shall also include cross-references to parts numbers of other manufacturers that make the same replacement part.
3. **As-Built Drawings**
  - a. A complete set of as-built Shop Drawings including equipment layout, assembly drawings, electrical schematic, wiring diagram and a logic diagram shall be provided for each different type or model of equipment supplied by the Contractor. A stage-by-stage explanation of the circuit theory shall be provided with the circuit wiring diagrams. All drawings shall be identified by DMS sign location.
  - b. Schematic wiring diagrams shall include all electrical components and electronic circuit board schematic diagrams of all electronic components supplied.
  - c. The as-built drawings shall provide a complete record of the final installation by location. The Contractor shall incorporate all design modifications, Change Orders and field installation changes.
4. **Media**
  - a. The Contractor shall provide 1 complete set of all Manuals, Drawings and other documentation in bounded paper format to be stored within each DMS sign enclosure.
  - b. The Contractor shall deliver 3 additional complete sets of all documentation, bound, loose-leaf copies of a booklet, 8-1/2 inches x 11 inches in size, and 1 reproducible electronic copy in .pdf format to the Engineer prior to DMS System Integration Testing.

#### **613.61.02 DMS TEST FIXTURE**

- A. GENERAL** - The DMS Test Fixture includes an appropriate quantity and type of all modules and electronics components from each DMS sign type necessary for bench testing and troubleshooting DMS system operation.
- B. MATERIAL** - As a minimum the following types of subassembly modules should be provided. The Contractor should follow recommendations of the DMS sign manufacturers as to the exact mix, type and quantity of components.
  1. DMS Sign Controller with software/firmware
  2. Display modules
  3. Single board computers and electronic driver boards to control display modules
  4. Power supplies, wiring harnesses, test stands and other miscellaneous items necessary to support a suitable test bench environment

- C. **MEASURE AND PAYMENT** - The LED Test Fixture will be measured and paid for at the Contract unit price each, which shall include all component assemblies, furnish and delivery to the Department location as designated by the Engineer, setup and final connections, and all other incidentals. The payment shall be full compensation for all materials, labor, equipment and all other incidentals necessary to complete this Work.

### 613.61.03 DMS CONTROLLER CABINET

- A. **GENERAL** - The DMS Controller Cabinet includes the physical cabinet housing and associated internal cabinet support subassemblies. Specific equipment necessary to support the DMS operation and communications are specified elsewhere.
- B. **CONSTRUCTION AND INSTALLATION** - Installation of the DMS cabinet and all utility and DMS sign connections shall be in accordance with the approved final design Plans and all applicable Department standards.

#### 1. DMS Controller Cabinet

- a. The Contractor shall install at each Site the DMS Controller Cabinet and all standard hardware items in the cabinet in accordance with the approved design Plans. Additional equipment shall be installed in the cabinet as specified elsewhere.
- b. The Controller Cabinet shall be installed on the DMS support in accordance with the attached installation drawings. The Contractor shall submit attachment details for the Controller Cabinet for review and approval by the Engineer prior to the installation of the Controller Cabinet.
- c. The Contractor shall plug all conduit entrances in the cabinet with duct seal to prevent rodent entries.

#### 2. Conduit

- a. The Contractor shall install new conduit from the DMS Controller Cabinet to the Dynamic Message Sign (DMS) and from the DMS Controller Cabinet to the utility service pedestal and meter.
- b. New electrical and fiber optic wire or cable shall be installed in new conduit or raceway by the Contractor as shown on Plans. Electrical cable and communications cable shall be installed in separate conduit or raceway.
- c. All conduit wire/cable pulls shall have a pull rope installed beside installed conductors.

#### 3. Wire & Cable

- a. **DMS Controller Cabinet to Service Pedestal** - The Contractor shall install the power cables from the service pedestal to the cabinet in conduit buried below grade entering the foundation and up through the vertical support to a handbox in accordance with the approved design Plans. The power and fiber communication cables supporting the DSM sign shall exit the cabinet through the same access hole and routed up the vertical sign support. Power and communications cables shall be routed in separate conduits where conduits are required as shown on the Plans.
- b. **DMS Controller Cabinet to Sign** - The Contractor shall install cables from the DMS to the Controller Cabinet through the vertical support as indicated on the approved design Plans.
- c. The Contractor shall install waterproof connectors where the cables enter into the cabinet. All cables shall be clearly marked or tagged. A minimum of 3 foot of cable shall be left coiled in the cabinet.
- d. **Panelboard (Breaker Box) enclosure**
  - i. Tag conductors with new sleeve tag using the sign number as the conductor label identification. Affix wire tag at panelboard and sign ends for each conductor.
  - ii. Refer to the Plans as a basis for specific sign / circuit assignment (wire tag) labels.
  - iii. New sign power wiring from panelboard circuit breaker shall be 12AWG.
- e. Wire insulation class shall be THHW minimum.
- f. **UPS** - The UPS discrete contact closure outputs shall be wired to the sign controller alarm inputs and appropriately configured to provide this capability.

4. **Electrical Power** – The Contractor shall connect installed equipment to the Power Distribution Panel within the cabinet as indicated in the approved design Plans. Prime operating power to each Site shall be supplied from nominal 240/120 VAC power.

All conductors entering and leaving the cabinet shall be protected by surge protectors and lightning arrestors to protect against damage resulting from voltage surges.

5. **Grounding** – The Contractor shall install #10 copper ground wire from the electrical panel in the cabinet to nearest ground rod as indicated on the design Plans. The ground wire shall be connected to the ground rod with 3/4 inch acorn ground rod clamps.

#### C. TESTING

1. **System Integration Test** – The system integration test shall demonstrate that all equipment is fully integrated and operational. This test shall verify that all equipment installed at each location is installed properly and that all functions are in conformance with the Contract Documents.
2. **Thirty (30) Day Field Operational Test** – All equipment shall be subject to the same thirty (30) day field operation test requirements as described in 613.61.01.D.
3. **Test Documentation** – The Contractor shall submit to the Department for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

#### D. DOCUMENTATION - The following shall accompany all electrical and mechanical components supplied:

1. **Operator Manuals** – Operator Manuals shall be provided for all equipment and components supplied as part of the cabinet. The manuals shall be comprehensive, easy to use and understand, and completely descriptive of the product.
2. **Maintenance Procedures Manuals**
  - a. A service manual containing detailed preventive and corrective maintenance procedures shall be provided for each different type or model of equipment. The manual shall cover as a minimum the proper method of adjusting and otherwise maintaining each item, a concise statement of the necessary operating functions in proper sequence, and a detailed description of the component function in relation to the various operation steps.
  - b. Systematic field and bench trouble shooting procedures shall be included, as shall normative waveforms and test voltages as applicable.
  - c. A detailed parts list shall be included. For each part, its circuit or pictorial identifications shall be shown, as shall all necessary rating information and a manufacturer and associated model or part number. The list shall also include cross-references to parts numbers of other manufacturers who make the same replacement part.
3. **As-Built Drawings**
  - a. A complete set of as-built Shop Drawings including equipment layout, assembly drawings, electrical schematic, wiring diagram and a logic diagram shall be provided for each cabinet. All connections, conduits, wiring, function and I/O information shall be detailed. A stage-by-stage explanation of the circuit theory shall be provided with the circuit wiring diagrams. All drawings shall be identified by cabinet location.
  - b. Schematics shall include a list of tests points detailing the nominal operating voltage, wave form and all pertinent information regarding the wave form at each test point.
  - c. The as-built drawings shall provide a complete record of the final installation by location. The Contractor shall incorporate all design modifications, Change Orders and field installation changes.

#### 613.61.04 DMS CENTRAL CONTROLLER

- A. **GENERAL** - A single central server computer installed in the Department Traffic Management Center, and as directed by the Engineer, will be used to provide remote management, monitoring, and control of all DMS signs. The server will be used to host the DMS Central Controller Software specified elsewhere.



- B. MATERIAL** - A rack-mounted server computer CPU of a brand that is fully compliant with District IT computing standards and meeting the following minimum Specifications:
1. The hardware, operating system, and any other commercial off-the-shelf components of the DMS Central Controller shall be fully compatible with the DMS Control Software specified elsewhere, and with existing District field communications, networking components, equipment rack mounting, and KVM (keyboard, video, and mouse) systems.
  2. **Design** - Server-class modular 1U chassis design to allow economical expansion and upgrade of components as newer technology becomes available, including hot-swappable dual power supply, and dual fan units.
  3. **Cabling** - includes KVM cabling to existing rack-mount KVM switch, dual power, and dual Cat 6 network patch cords.
  4. **CPU** - Intel Xeon 2.4GHz processor or above
  5. **Memory** - 4GB RAM
  6. **Removable Media** - DVD±RW
  7. **Hard Disk** - RAID 1 configuration with a minimum of three 150GB hot-swappable disks
  8. **Network** - Dual RJ45 Gigabit Ethernet network adapter
  9. **OS** - Windows 2008 R2 Server with sufficient CALS to support 4 simultaneous remote user connections
  10. **Display Graphics** - 1280 x 1024 high color 32 bit display or better
  11. **Software And Utilities** - any third party software or utilities (DMS Software Bid Item specified elsewhere) to provide a fully functioning server computer (i.e. database management system, data backup software, antivirus, web browser, operating system)
  12. **Mounting** - universal rack mount with slide out rails and cable management arm to allow full chassis access within the equipment rack
  13. **Documentation And Packaging** - all original packaging, documentation, CD/DVD, cables and other miscellaneous items shall be shall be delivered to the Engineer.
- C. INSTALLATION AND INTEGRATION** - The DMS Central Controller shall be installed into an existing EIA 19 inch equipment rack with a minimum 1U rack space provided. The following shall be performed:
1. Cabling to be installed and secured within existing rack cable management systems as directed by the Engineer.
  2. **System Configuration** - all necessary information to provide a fully functional system shall be programmed into the DMS Central Controller. The operating system, server application settings, and network parameters, such as user accounts, IP addresses, DMS device addresses, and client workstation information shall be provided by the Engineer.
  3. **Labeling** - The computer server name shall be labeled on the outside face of the computer and all cables supporting the server operation shall be labeled. Labeling shall be in a method consistent with District standards and as directed by the Engineer.
- D. TESTING**
1. **System Integration Test** – The system integration test shall demonstrate that all equipment is fully integrated and operational. Testing of the DMS Central Controller shall be performed after installation and configuration of the DMS Central Controller Software and shall include:
    - a. Verification of user account logon profiles
    - b. Verification of IP address, name resolution, and reachability of host devices, such as DMS signs and client workstations
    - c. Verification of Central Controller redundant component operation, such as power supply, hard disks, and network interface
  2. **Thirty (30) Day Field Operational Test** – All equipment shall be subject to the same thirty (30) day field operation test requirements as described in Section 613.61.01.D.

- 3. Test Documentation** – The Contractor shall submit to the Department for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

#### **613.61.05 DMS CENTRAL CONTROLLER SOFTWARE**

- A. GENERAL** - The central controller software server will be used to support remote management, monitoring, and control of all DMS signs. The software will be hosted in the Department Traffic Management Center on the Central Server Computer specified elsewhere.

- B. MATERIAL** - DMS Central Controller Software that complies with the latest version of NTCIP standards publications for communications with DMS sign field equipment, and meeting the following minimum Specifications:

##### **1. General Architecture**

- a. Have the ability to provide client-server architecture that any computer connected to the District network and equipped with the client version is able to connect to the central controller. Support a minimum of 4 simultaneous users.
- b. Have the ability to support unlimited signs at once from traffic management centers.
- c. Support Ethernet, serial connections, and modem pools.
- d. Have the ability to enable/disable ping, telnet, http on field controller.
- e. Have the ability to push firmware upgrades onto all field controllers.
- f. Support event logging and email alerts.
- g. The hardware, operating system, and any other commercial off-the-shelf components of the DMS Central Controller shall be fully compatible with the DMS Control Controller Software specified elsewhere, and with existing field communications, networking components, and equipment rack mounting and KVM systems.

- 2. NTCIP Compliant** - The software shall be able to be universally interface with all NTCIP-compliant DMS.

The software shall be able to support NTCIP 1203 v.2.

##### **3. Display Control**

- a. Have the ability to display DMS network in list or map view.
- b. Have the ability to view, group, and monitor multiple DMS in real time.
- c. Have the ability to control any size character, line, or full matrix DMS.
- d. Enable scheduling based on to-the-minute time-of-day, day-of-week, holiday or special days, one-time or recurring scenarios.
- e. Have a photo sensor override and manual brightness control.

##### **4. DMS Messaging**

- a. Include WYSIWYG graphical message creating editing tool with preview.
- b. Manage font database for each DMS.
- c. Have the ability to create, save, and adjust message duration and priority setting.
- d. Configure flash rates, scrolling and other message attributes.
- e. Have the ability to create and save banned words list (white and black lists).
- f. Spell check messages before display and have the ability to edit 1 line (or word) of text without having to retype the entire message.

- g. Support multi-phase (3-phase minimum) messages.
- h. Support beacon activation by message.
- i. Support amber monochrome alphanumeric characters and graphics messages.
- j. Have the ability to create and save default messages for each DMS.

**5. Utilities And Diagnostics**

- a. Have the ability to view status, errors, and any error codes of all DMS subsystems in real time and historical date/time stamped logs.
- b. Have the ability to locate pixel failures and verify the error.
- c. Have built-in pre-programmed common pixel test patterns and diagnostics.
- d. Have the ability to monitor the DMS environmental conditions based on DMS sensors.
- e. Verify NTCIP conformance parameters for each DMS.

**6. Security** – Have the ability to restrict each user’s functional areas (read/write restrictions) with user accounts containing unique user names and passwords.

Have the ability to centrally manage field controller user accounts and passwords.

**7. Operating System And Software Compatibility**

- a. *Client workstation* – Microsoft Windows XP/7 or later.
- b. *Server* – Microsoft Server 2008 R2 or later
- c. *Browser* – Microsoft Internet Explorer 8.0 or later

**C. INSTALLATION AND INTEGRATION** - Installation of the DMS Central Controller Software shall take place on the DMS Central Controller, installed and accepted under separate Bid Item, and up to 4 other non-project workstations as directed by the Engineer.

All necessary information to provide a fully-functional system shall be programmed into the DMS Central Controller Software, including but not limited to: user account information, DMS sign controller device configuration information, maps and lists of field devices, communication parameters, and other application settings. This will also include any client software installation and configuration for up to 4 workstation computers as directed by the Engineer.

**D. TESTING**

1. **System Integration Test** – The system integration test shall demonstrate that all equipment is fully integrated, operational, and meets all of the functionality as stated herein.
2. **Thirty (30) Day Field Operational Test** – All equipment shall be subject to the same thirty (30) day field operation test requirements as described in Section 613.61.01.S.
3. **Test Documentation** – The Contractor shall submit to the Department for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

**E. DOCUMENTATION** - A full installation copy of the DMS Central Controller Software, including support files, utilities, and any other required third party software, shall be supplied on DVD/CD-ROM and licensed for Department use.

2 paper copies of the manufacturer’s operation manual, plus an electronic copy shall be delivered to the Engineer prior to the installation of the DMS Central Controller Software.

### 613.61.06 NTCIP COMPLIANCE

**A. GENERAL** - The sign controller and central computer software shall comply with the National Transportation Communications for ITS Protocol (NTCIP) Standards when installed. The Contractor shall be responsible for furnishing DMS equipment that is compliant with NTCIP standards as defined below. The Department reserves the right to define conformance groups to be supported. The Contractor shall provide a detailed description of how the system shall conform to the following minimum NTCIP requirements at the time of bid.

**1. NTCIP References** – The DMS shall comply with all applicable NTCIP standards that are current at the date of this document, including all Recommended or Approved Amendments. Under this Contract, the Contractor shall ensure that each NTCIP component covered by these technical Specifications implements the most recent version of the standard at the development stage of “Recommended” or higher, including any and all Approved or Recommended Amendments to these standards. It is the responsibility of the Contractor to monitor NTCIP activities to discover any recent additional documents. The following is a list of these Standards:

- NTCIP 1101:1996 (V01.12) Simple Transportation Management Framework, December, 2001 with Amendment 1 v08
- NTCIP 2104:2003 (V01.11) Ethernet Sub network Profile, September, 2005
- NTCIP 2202:2001 (V01.05) Internet (TCP/IP and UDP/IP) Transport Profile, December, 2001
- NTCIP 2301:2001 (V01.08) Simple Transportation Management Framework Application Profile
- NTCIP1203 (V2.35a): Object Definitions for Dynamic Message Signs (DMS) Information Profile, March 2007
- NTCIP 1201:2005 (V02.32) Global Object (GO) Definitions - Version 02, Information Profile October 2005

**2. NTCIP Framework** – The software shall comply with NTCIP 1101 (NEMA TS 3.2, Amendment #1) the Simple Transportation Management Framework, and shall meet the requirements for Conformance Level 1 as clarified by amendment

**3. NTCIP Communications, Subnet Level** – Each NTCIP Component that communicates remotely shall conform to all mandatory NTCIP 2104 (Ethernet) subnet profile requirements. Each NTCIP component shall support the receipt of application data packets at any time.

NTCIP Components may support additional Subnet Profiles at the vendor’s option. At any one time, only 1 Subnet Profile shall be active on a given serial port of the NTCIP Component. If the NTCIP Component has a serial port that supports multiple Subnet Profiles, the NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

**4. Transport Level** – Each NTCIP Component shall comply with NTCIP 2202 (TCP/IP and UDP/IP). Each NTCIP component shall support the receipts of datagrams conforming to the DMS configured TCP/IP and UDP/IP Transport profiles. NTCIP Components may support additional Transport Profiles at the manufacturer’s option. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

**5. Application Level** – Each DMS controller shall comply with NTCIP 2301, (NEMA TS 3.AP-STMf), as a Managed Agent and shall meet the requirements for Conformance Level 1. SNMP shall be required and STMP shall not be required. An NTCIP Component may support additional Application Profiles at the manufacturer’s option. Responses shall use the sample Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

### B. DOCUMENTATION

1. The Contractor shall furnish a detailed description of how the system conforms to the stated NTCIP requirements and meets the functional requirements of the DMS system stated elsewhere.
2. 1 paper copy of the DMS Manufacturer’s protocol implementation conformance statement (PICS), plus an electronic copy shall be delivered to the Engineer prior to installation.
3. 1 electronic copy on DVD/CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format. MIBs shall be delivered to the Engineer prior to installation:

- a. The relevant version of each official NEMA Standard MIB Module referenced by the device functionality.
  - b. If the device does not support the full range of any given object within a NEMA Standard MIB Module, a manufacturer specific version of the official NEMA Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX field of the OBJECT-TYPE macro. The filename of this file shall be the same as the standard MIB filename with the extension “.man”.
  - c. Any and all manufacturer-specific objects supported by the device in a manufacturer-specific MIB with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- C. MEASURE AND PAYMENT** - The unit of measure shall be each DMS sign installed. The unit price shall include the sign and all necessary supporting materials and software required to produce a functioning DMS. The unit price shall include all necessary labor, equipment, materials and incidentals required to install and make fully operational the DMS sign, to remove and dispose construction debris from the Work Site, and to complete all Work described herein.

### 613.62 TRAFFIC SIGNAL CABLE REMOVAL

- A. Traffic signal cable which has been replaced with new cable and is no longer required for the operation of the traffic signal is to be removed and discarded by the Contractor. Existing electrical cable shall not be removed until its replacement cable has been installed and determined to be fully operational. The cables to be removed shall include, but not limited to; (1) 7 Conductor, 14 AWG Stranded Traffic Signal Cable, (2) 4 Conductor, 18AWG Shielded, Stranded Traffic Signal Cable, and (3) 19AWG Twisted Pair Communications Cable.
- B. The cable shall be removed from all manholes, hand boxes, pull boxes, foundations, and electrical conduits within the signalized intersection. An exception will be made in the case of a collapsed or obstructed electrical conduit through which electrical cable cannot physically be removed. In such instances, the Contractor shall cut the immovable cable at the point in the manhole, foundation, hand box or pull box where the cable enters the conduit. The cable within the collapsed or obstructed conduit will be abandoned in place. The Contractor shall not be paid for that cable which remains in a collapsed or obstructed conduit.
- C. Special attention is directed to the case where temporary traffic signal cable extends between the base of an existing foundation and traffic signal equipment mounted on a temporary portable concrete base to provide traffic control during construction. Typically, a new traffic signal pole foundation, pole, signal equipment, and cable are to be installed to replace that currently in service. Under no circumstances will the existing electrical cable, pole, foundation, signal equipment, or temporary portable concrete base be taken out of service and removed from the intersection and removed from the intersection until the replacement equipment is installed and fully operational. Permanent street cut repairs and roadway repairs including the new sidewalk shall not proceed until the existing foundation and the electrical cable coming from the foundation are removed. It shall be unacceptable to feature a temporary cable coming out of a final new sidewalk. A 3 foot square void in the new sidewalk shall be maintained until the temporary cable and the final original pole foundation are removed. The final sidewalk can be installed after the cable and the original foundation are removed.
- D. **MEASURE AND PAYMENT** - The unit of measure shall be linear feet of cable removed. Each linear foot of cable removed will be paid at the Contract unit price. The price shall include the proper disposal of the removed cable. The price shall include all labor, equipment, materials and incidentals required to remove and dispose of the cable, to clear associated debris from the Work Site, and to complete all Work described herein.

### 613.63 INITIAL ACCEPTANCE, GUARANTEE, AND FINAL ACCEPTANCE

- A. Initial acceptance of the Contractor’s Work will be given by the Engineer after inspection and verification that the Work as defined in the Contract Documents, Special Provisions, Technical Specifications and Project Plans has been satisfactorily completed. Initial acceptance can be granted as individual intersections are completed. Initial acceptance shall be neither be sought by the Contractor nor approved by the Engineer at least until all proposed signs and pavement markings are in place, the new controller is communicating with Central Control, all proposed signal hardware is erected, and the signal is properly operating the proposed traffic signal sequence of operation.
- B. After the Engineer has granted initial acceptance, each signalized intersection shall operate for thirty (30) consecutive Calendar Days without any type of failure of Contractor supplied equipment or software. A failure shall be defined as one that results in the

operational loss of 1 or more components of the traffic signal and communication system including cabling, controller software, cabinet components and all equipment furnished and installed by the Contractor.

The purpose of this requirement is to demonstrate that each signalized intersection is properly installed, is free from identified malfunctions, exhibits stable and reliable performance, and complies with all Contract Specifications and requirements. This thirty (30) day period shall apply to each and all intersections covered under this the Contract, and shall include emergency on-site maintenance or repair completed within 24 hours of notification by the Engineer. The Contractor shall perform on-site diagnosis and trouble-shooting and repair or replacement of failed materials or equipment, as requested by the Engineer.

Manufacturer's standard warranties that extend beyond the Contractor's warranty period shall automatically transfer to the District of Columbia government. The Contractor shall inform the manufacturer of this requirement prior to the purchase of the equipment, and provide to the Engineer a written agreement of compliance from the manufacturer.

Final acceptance of the Work will be given at the end of each intersection's thirty (30) day break-in period. All Work including completion of all required permanent street cut repairs must be completed to the satisfaction of the Engineer before final acceptance is given and the Contractor is relieved from maintenance responsibility.

- C. The Project CPM schedule for each intersection shall display as milestones projected initial and final acceptance dates.
- D. **MEASURE AND PAYMENT** - Warranties will not be measured, but the cost of warranties and incidentals shall be included in the Contract unit price to furnish and install materials and equipment specified in the Contract Documents. The payment shall be full compensation for all testing, labor, tools, materials, equipment and incidentals.

## 614 STREETLIGHTING AND MISCELLANEOUS ELECTRICAL WORK

### 614.01 DESCRIPTION

Streetlighting and miscellaneous electrical work shall consist of furnishing all labor, equipment, materials, installing all electrical equipment, conduits, manholes, handholes, pull boxes, junction boxes, wiring, transformers, luminaries or fixtures, streetlight poles, and all electrical facilities and incidentals as shown in the Contract Documents, and as specified herein for a complete working streetlight or electrical system. This work shall also include necessary excavation and backfill, disposal of discarded materials, and restoration of distributed facilities and surfaces in accordance with these Specifications.

Any subsection or component of this section will be superseded and replaced by the latest version of "Supplemental Streetlight Specifications" maintained by the Department.

Wherever the word "provide" is used, it shall mean "furnish and install complete in place and ready for use."

Definitions of electrical terms used in Roadway lighting shall be in accordance with Appendix F of the American National Standard Practice for Roadway Lighting ANSI D12.1. Exceptions are as follows:

- A. A luminaire shall include direct appurtenances such as a reflector, refractor, housing and supports that are integral with the housing, high intensity discharge (HID) ballasts, drivers and appurtenances for Light Emitting Diode (LED).
- B. A light pole, also called a lighting standard, shall be considered to include an anchor bolt or transformer base, shaft, bracket arm (if required), pole cable, and integral hardware to support luminaries.

Items for streetlight and miscellaneous electrical work equipment shall consist of products of the same manufacturer, as far as practicable. The system shall conform as to voltage, amperage, frequency, and type as specified by the references and requirements in 614.02 and the Contract Documents.

In order to provide the proposed lighting system, the Contractor shall coordinate with PEPCO independently for all service issues (new feed or removal), access to PEPCO assets (e.g., PEPCO manholes and conduits) or any additional needs. PEPCO will supply the power required for the locations outlined in the Contract Documents.

### 614.02 CODES AND STANDARDS

The material, equipment and installation shall conform to the following:

- American Society for Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- Certified Ballast Manufacturers
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Power Cable Engineers Association (IPCEA)
- National Electrical Code (NEC) - Latest Edition
- National Electrical Manufacturers Association (NEMA)
- Underwriters Laboratories, Inc. (UL)
- District of Columbia Electrical Code - Latest Edition
- National Electric Safety Code (NESC) - Latest Edition
- United States of America Standards Institute (USASI)
- Rules and Regulations of the Potomac Electric Power Company (PEPCO)
- American Association of State Highway and Transportation Officials (AASHTO)
- Illuminating Engineering Society of North America (IESNA)

- International Code Council (ICC)

Electrical contractors must be bonded in the District and their electricians must have District licenses. The Contractor's Master Electrician shall secure a permit approved by the Electrical Engineer, D.C. prior to starting any Project Work, and the Master Electrician shall be responsible for all Project electrical Work. The Contractor's Master Electrician shall be required to attend progress meetings once a month. The Project electrical Work shall at all times be inspected by electrical inspectors of the District Department of Transportation.

A licensed journeyman shall do all electrical works. Apprentice electricians are allowed to do electrical Work if they are accompanied and supervised by the licensed journeyman.

No Work shall be covered at any time prior to inspection.

The Contractor must have a complete set of approved Shop Drawings, catalog cuts, and Specifications available at the jobsite for inspection by the Engineer and the Department's electrical inspector.

### 614.03 MATERIALS

- A. GENERAL** - New first quality materials shall be furnished in conformance with 820. Material and equipment must be UL listed and labeled. All electrical equipments, wire, and other elements of the streetlight installations shall be of ample capacity to carry the required current without excessive heating or causing an excessive drop in voltage. Except otherwise specified herein, or in the Contract Documents, each individual streetlight equipment shall bear a nameplate or other type of indelible marking or brand that shall identify it as to type, catalog number, and manufacturer in a conspicuous way. This applies to hardware and miscellaneous materials.
- B. COORDINATION WITH OTHER TRADES** - It shall be the responsibility of the Contractor to coordinate the location of equipment, conduit, devices, fixtures, etc., furnished and installed under other sections and by other trades to the extent that interference among such items is avoided. Any relocation of items required as a result of the failure of the Contractor to coordinate his work with the work of other trades shall be at the expense of the Contractor, and incur no additional cost to the District.
- C. STANDARD PRODUCTS** - Unless otherwise indicated, materials furnished shall be standard products of a manufacturer regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design complying with the specification requirements.

Where materials, equipment, apparatus, or other products are specified by manufacturer, brand name, type, or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the bid. Specified materials shall be furnished unless changed by mutual agreement between the Contractor and the Engineer. Where 2 or more designations are listed, the choice shall be optional with the Contractor, subject to the approval of the District.

Should the Contractor propose to furnish materials and equipment other than those specified, as permitted by the "or approved equivalent" clauses, he shall submit a written request for any or all substitutions to the Engineer and must demonstrate that the equivalent product being submitted is equal to or exceeds all technical performance, and visual criteria of the original specified item. Where such substitutions alter the design or space requirements indicated in the Contract Documents, the Contractor shall include in his request all items of cost for the revised design and construction, including cost of all allied trades involved.

Acceptance of the proposed substitutions shall be subject to the approval of the Engineer. If requested by the Engineer, the Contractor shall submit for inspection samples of both the specified and the proposed substitute items.

In all cases where substitutions are permitted, the Contractor shall bear any extra cost of evaluating the quality of the materials and equipment to be installed.

- D. SAMPLES** - When samples are required, they shall be submitted to the Engineer for approval prior to the preconstruction meeting, but no later than eight (8) weeks after the Award of the Contract. A sample shall comprise of the entire item or representative section or portion thereof (as determined by the District), and shall be properly marked for identification, and be free of expense to the District. The District reserves the right to mutilate or destroy any sample submitted when considered necessary for testing purposes. Samples not mutilated or destroyed will be returned to the Contractor at the Contractor's expense when no longer needed by the Department. Sections 106.01, 106.02, and 106.03 shall apply to samples and materials used in conjunction with Electrical Work.



The Contractor shall submit the following:

1. The name and manufacturer of the equipment he proposes to furnish.
2. Such data and descriptive materials as may be necessary for the proper procedures and operational characteristics associated with maintenance.
3. All wiring or necessary diagrams and drawings for approval.
4. Any additional samples if deemed necessary.

- E. MATERIAL AND WORKMANSHIP** - Installation work shall be in accordance with the Contract Documents. Defective equipment or equipment damaged in the course of installation or test shall be replaced or repaired by the Contractor in a manner meeting the approval of the District without additional compensation.

The Contract Drawings indicate the extent and general arrangement of the conduit and wiring systems. If departures from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted within 2 business days to the District for approval. No departures shall be made without prior written approval.

The Contractor shall be responsible for all cutting and patching necessary for accomplishing the Work. All such modified areas shall be left in as good repair as prior to the beginning of this Work, at the expense of the Contractor and at no additional cost to the District. Cutting of structural members shall not be done without approval of the Engineer.

The Contractor shall comply with the materials and items of work specified in 820 and in the Contract Documents.

- F. GUARANTY** - The Contractor shall guarantee all electrical work to be in accordance with Contract requirements and free from defective or inferior materials, equipment, and workmanship for a period of two (2) years from Substantial Completion per 103.01 ARTICLE 12.

If, within the guaranty period, the Department finds that the guaranteed work needs to be repaired or changed because of the use of materials, equipment, or workmanship which are inferior, defective or not in accordance with the terms of the Contract, the Department shall inform the Contractor in writing and the Contractor shall promptly and without additional expense to the District: (1) Place in a satisfactory condition all such guaranteed work; (2) Make good all damage to equipment, the Site, the Structure, and/or related appurtenances, which is the result of such unsatisfactory guaranteed work; (3) Make good any work, materials, and equipment that are disturbed in fulfilling the guarantee.

Should the Contractor fail to proceed promptly in accordance with the guarantee, the District may cause such Work to be done by others and the Contractor and the Surety or sureties under the bond shall be jointly and severally liable for the cost of same.

#### 614.04 CONTRACT PLANS AND DRAWINGS

- A. STREETLIGHT PLANS** - The Contract Documents indicate the general arrangements of the electrical circuits and conduits and the locations of poles and manholes (in case of streetlights) and outlets, equipment, other devices, and appurtenances (in case of miscellaneous electrical works). The Contract Documents are intended to show and describe the Work entirely. However, every item necessary to complete the Work may not be specifically shown or described. Incidentals not shown or specified, but necessary for the proper operation of the streetlight system shall be included in the Work. Similarly for miscellaneous electrical works, equipment necessary for the proper operation of a complete electrical system, such as power connections, wiring, and minor items such as firings, transitions, hangers, etc, not shown or specified, shall be included in the Work. The Contractor shall be responsible for furnishing all materials for the installation, complete, so as to insure the successful operation of the streetlight system or miscellaneous electrical works.
- B. MANUFACTURER'S DRAWINGS** - Manufacturer's drawings shall consist of all shop and installation drawings, catalogs, photometric curves, performance data, pole installation details, etc. The Contractor shall secure and/or prepare these drawings and submit them as required by 105.02 before purchasing materials or proceeding with construction. Shop Drawings shall show complete details of construction for all portions of the Work included. The Contractor shall check each drawing to insure conformance with the Contract Plans and Specifications, and each drawing shall bear the Contractor's signature and certification. Drawings and data not clearly identified will be returned without approval to the Contractor.

Transmittals accompanying all Shop Drawings shall contain names and addresses of the Contractor, Subcontractors, and suppliers. Project title, reference to prior actions on submissions and specification reference shall also be indicated.

- C. AS-BUILT DRAWINGS** - The Contractor shall prepare the "ASBUILT" drawings after the Work is complete. The drawings shall be prepared and signed as per 108.12, and indicate the deviation from the original in redlines.

#### **614.05 ELECTRICAL MANHOLE**

- A. DESCRIPTION** - The Work consists of providing precast concrete or cast-in-place manhole and cast iron frame and cover to provide access to electrical conduit as shown in the Contract Documents. The Contractor shall furnish all labor, tools, material, and equipment necessary for excavation, shoring, dewatering, steel plating (necessary steel plating of the Roadway for moving traffic as directed by the Engineer), installation of pre-cast or cast in place manholes, backfilling per 804, compaction of fill, temporary patch and maintenance of the cuts until the permanent repairs are made as directed by the Engineer.

The Contractor shall verify the exact location of the proposed manhole in the field. The Contractor shall construct the manhole with concrete meeting 817.03 Specifications for Class B. Before installing the manhole, a 6 inch layer of crushed stone or washed gravel shall be placed, leveled, compacted, and then covered with tar paper. After installation, the paper shall be removed from the drain hole.

The Contractor shall construct cast-in-place manhole with forms, complete with centering cores and molds, to conform to shape, form, line, and grade required and maintain sufficiently rigid to prevent deformation under load. He will make all joints leak-proof and arrange horizontally or vertically. The Contractor shall place forms on successive units for continuous surfaces and fit to accurate alignment, assuring a smooth completed surface, free from irregularities.

All reinforcing bars installed within the manhole structure shall be bonded together. All concrete shall be 4,500 psi (twenty-eight (28) day strength) wet mix. The concrete shall be vibrated so there shall be no voids or honeycombing. A pulling-in iron shall be installed opposite of each conduit entrance; cable racks shall be installed as directed by the Engineer.

The Contractor shall provide with cable racks in all manholes as specified below and shown in the construction documents:

1. Cables in manholes shall be supported along the walls by the cable racks.
2. At least 2 cable racks shall be installed on each side wall of the manhole.
3. Each rack shall be mounted to the walls by way of 2 manhole rack supports, so that the racks are offset from the walls.
4. Each rack shall have at least 2 cable rack hooks or arms installed for cable routing and installation. Cable rack hooks or arm lengths shall be appropriate for the manhole size and amount of cable being installed.
5. The racks shall be long enough to cover the entire depth of the incoming conduits and shall be positioned to align with the incoming conduits.
6. All of the above hardware shall be galvanized steel.
7. The manhole rack supports shall be bolted through the manhole walls.
8. Splices in manholes shall be firmly supported on cable racks and located midway between the cable racks and supported with cable arms at approximately at the same elevation as the enclosing duct.

The Contractor shall provide a 2 inch diameter hole at 1 corner in the floor of the manhole centered 6 inches off each wall and drive a 3/4 inch by 10 foot long copper-clad steel ground rod into Earth as indicated in the Standard Drawings. In precast manholes, the hole shall be provided as a knock-out or pre-drilled. Field drilling of the precast manhole will not be allowed. The Contractor shall extend the ground rod approximately 6 inches above the finished manhole floor. After completion of manhole installation, a ground loop of bare copper ground wire shall be provided within the manhole braced to the manhole structures and bonded to the ground rod by an exothermic weld. Ground wires shall be soft drawn. Grounding shall be accomplished as soon as materials are in place to which the grounding wires are to be attached.

The Contractor shall connect all conduit grounding bushings, cable supports, other metallic parts, splices, neutral wire and ground wire run with each feeder to ground loop. Reinforcing bars shall be of the size and configuration as specified in the Standard Drawings for the size of the manhole to be installed. Frame and cover shall be heavy-duty cast iron and conform to the details of the Standard Drawings, and conform to AASHTO M 105 and M 306. The word "DCSL-TS" in 1 inch letters is to be cast in the depression shown in the center of the top of the cover and to be flush with the surface of cover.

Manufacturers' logo shall not appear on top of either frame or cover. The manhole frames shall be set to the required grade, in full bed of concrete mortar to make watertight connection. Unless otherwise indicated, the Contractor shall install the top of manhole covers approximately 1/2 inch above finished grade in unpaved areas and flush with finished surface in paved areas. All adjustment to the grade shall be made using a poured or precast concrete collar. Mortars can be used; however, it shall be high-strength and water-tight and be the same mix used for encasing conduits. Brick shall not be used to make the final grade adjustment.

Included in the Pay Item is the temporary patching around the manhole and maintenance of the patch until final repairs have been made.

Manholes come with the slump pits. Holes should be punched through for slump or as otherwise directed by the Department Electrical Representative, depending on the prevailing field condition including ground water table.

- B. MEASURE AND PAYMENT** - The unit of measure of Install Electrical Manhole with Frame and Cover will be per each. Payment will be made at the Contract unit price per each for install electrical manhole. Payment will include all labor, tools, materials, equipment, excavate, shoring, de-watering, manhole complete with all racks and pulling-in iron frame and cover, backfilling, compaction of backfill, temporary patching, maintenance of the cut until the permanent repairs are made, and all incidentals necessary to complete the Work specified herein.

#### 614.06 REMOVE ELECTRICAL MANHOLE

- A. DESCRIPTION** - The Contractor shall furnish all labor, materials, and equipment necessary to remove existing electrical manhole as shown in the Contract Documents or as directed by the Engineer. The Contractor shall remove the frame, cover, manhole roof, walls and floor. All electrical conduits shall be sealed with cement before backfilling. The excavation shall be backfilled in 6 inch layers and compacted. Backfill material shall consist of suitable soils or granular material. Before removing manholes, the Contractor shall remove all streetlight conductors from other manholes. Refer to following procedures for removal of conductors.

1. Locate all underground conductors from DC manhole or PEPCO manhole.
2. Coordinate with PEPCO to disconnect power from PEPCO power source before removal of conductors.
3. Remove all underground light conductors from other DC manholes or PEPCO manholes.

The Contractor shall be responsible for notifying PEPCO to disconnect the existing service when removing the existing equipment, and to re-establish the service when the new equipment has been installed. Coordination with PEPCO shall be the responsibility of the Contractor. All materials removed shall become the property of the Contractor and be disposed of off-site at no additional cost to the District. The manhole frame and cover shall be returned to the District when directed by the Engineer. Included within this Pay Item is the temporary patching of the pavement area where the manhole was removed and maintenance of the patch until final repairs have been made.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Electrical Manhole will be for each manhole removed. Payment will be made at the Contract unit price per each manhole removed, temporary patching, and maintenance of the cut until the permanent repairs are made and payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

#### 614.07 FRAME AND COVER FOR MANHOLE

- A. DESCRIPTION** - Work consists of furnishing and installing new manhole frames and covers for existing DC manholes. The frame and cover shall be heavy-duty cast iron, and conform to the details of the Standard Drawings, and to AASHTO M 105 and M 306. The word "DCSL-TS" in 1 inch letters is to be cast in the depression shown in the center of the top of the cover and to be flush with the surface of cover. Manufacturers' logo shall not appear on top of either frame or cover. The manhole frames shall be set to the required grade, in full bed of cement concrete or mortar to make watertight connection. All manholes shall have cement concrete or mortar collars or as otherwise directed by the Department Electrical Representative.

Unless otherwise indicated, the Contractor shall install the top of manhole covers approximately 1/2 inch above finished grade in unpaved areas and flush with finished surface in paved areas. All adjustment to the grade shall be made using a poured or pre-cast concrete collar. Mortars can be used; however, it shall be high-strength and water-tight and be the same mix used for encasing conduits. Brick shall not be used to make the final grade adjustment. The Work also includes temporary patching around the manhole and maintenance of the patch until final repairs have been made.

The Contractor shall install a 3/4 inch x 10 foot long copper-clad steel ground rod in the manhole. The manhole frame shall be grounded to the ground rod by approved methods.

Manholes come with the slump pits. Holes should be punched through for slump or as otherwise directed by the Department Electrical Representative, depending on the prevailing field condition including ground water table.

The Work also includes the removal of the frames and covers from the existing manholes as indicated in the Contract Documents.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Manhole Frame and Cover to existing electrical manhole will be each. Payment for install frame and cover will be made at the Contract unit price per each. The payment will include providing and installing the new frame and cover, adjusting frame and cover to new grade, and removal of the existing frame and cover, all labor, equipment, tools, materials and incidentals necessary to complete the Work as specified herein.

#### 614.08 CLEAN ELECTRICAL MANHOLE

- A. DESCRIPTION** - The Work consists of the removal of all water, dust, and debris from existing manholes. Prior to the removal, the Contractor shall determine the existence of hazardous waste within the manhole using appropriate test procedures. A positive test result for hazardous waste will require the Contractor to remove the hazardous wastes using the Department-approved appropriate procedures. The removal of the hazardous waste material will be as specified in 614.09.
- B. MEASURE AND PAYMENT** - The unit of measure for Clean Electrical Manhole will be each. Payment for cleaning electrical manholes will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

#### 614.09 REMOVE HAZARDOUS WASTE MATERIALS FROM MANHOLE

- A. DESCRIPTION** - Work consists of removal of all hazardous wastes from the existing manholes using appropriate procedures. The Contractor shall submit the hazardous waste removal procedures to the Engineer for approval, and shall have the approval prior to proceeding with the hazardous waste removal.
- B. MEASURE AND PAYMENT** - The unit of measure for Remove Hazardous Waste Materials from Manhole will be each. Payment will be made at the Contract unit price per each manhole actually cleaned of hazardous wastes. The payment will include all labor, equipment, tools, materials, and incidentals necessary to remove the hazardous waste from the manholes and from the job Site to an approved hazardous waste facility, and complete the Work as specified herein.

#### 614.10 REPAIR ELECTRICAL MANHOLE

- A. DESCRIPTION** - The Work consists of repairing existing District (DC) manholes after the manholes have been cleaned according to sections 614.08 and 614.09. The Contractor shall proceed with the repair work as follows.

Identify all damages in DC electrical manhole. Repair all damages in the manhole with non-shrink grout as specified in Section 703.

Remove existing conductors between manhole and other manholes and/or streetlights connected to the conductors designated by the Engineer. Patch conduit holes in DC or PEPCO manholes. The existing conduits that contained the removed conductors shall be abandoned between manholes, and between manholes and streetlights. The abandoned conduit ends shall be cut flush with the inside face of the manhole wall.

The abandoned conduit shall be filled with non-shrink grout meeting the requirements of 703 to a depth of 6 inches from the inside face of the manhole, and finished clean smooth with the inside wall of the manhole.

The Contractor shall be responsible for notifying PEPCO to disconnect the existing service prior to the removal of the existing equipment, and re-connection of the service after the new equipment has been installed. Coordination and scheduling with PEPCO shall be the responsibility of the Contractor.

- B. MEASURE AND PAYMENT** - The unit of measure for Repair Electrical Manholes will be each. Payment for repair electrical manhole will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

**614.11 ELECTRICAL HANDHOLE**

- A. DESCRIPTION** - Work consists of providing precast handholes to provide access to electrical conduit as shown in the Contract Documents. The Contractor shall furnish all labor, tools, material, and equipment necessary for excavation, shoring, de-watering, installation of handholes, backfilling, compaction of fill, temporary patch, and maintenance of the cuts until the permanent repairs are made. Steel plates may be required as directed by the Engineer and will be paid as specified in 612.19.

Handholes and covers shall be furnished as specified, and shall be located where designated on the Plans. When required, excavation shall be performed as nearly as practicable to the outside dimensions of the handhole. After boxes are set to proper grades, excavated spaces around the boxes shall be backfilled with suitable material placed and thoroughly tamped in 6 inch layers.

The Contractor shall verify the exact locations of handholes in the field and install per manufacturer's instructions.

In the 2 inch hole provided in the floor of the handhole, the Contractor shall drive a 3/4 inch x 10 foot long copper-clad steel ground rod into Earth as indicated in the Contract Documents. The Contractor shall extend the ground rod approximately 6 inches above handhole floor. After completion of handhole installation, the Contractor shall provide a ground loop of bare copper ground wire (No. 6 minimum or another size as specified in the Contract Documents) within the handhole and bond to the ground rod by an exothermic weld. The Contractor shall connect all conduit grounding bushings, cable supports, other metallic parts, splices, neutral wire and ground wire run with each feeder to ground loop.

The handholes shall conform to details indicated in the Standard Drawings. The word "DCSL-TS" in 1 inch letters is to be cast in the depression shown in the center of the top of the cover and to be flush with the surface of cover. Manufacturers' logo shall not appear on top of either frame or cover.

The handhole shall be set to the required grade. Provide a temporary patch around the handhole, and maintain the patch until permanent repairs are made.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Handhole will be each. Payment for Electrical Handhole will be made at the Contract unit price per each. The payment will include temporary patching and maintenance of the patch, and all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

**614.12 ELECTRICAL CONDUITS (CONCRETE ENCASED)**

- A. DESCRIPTION** - The Contractor shall furnish and install PVC conduits in the sizes and duct bank configurations shown in the Contract Documents. The conduit shall be encased in wet mix PCC meeting the requirements of Section 817.03 for Class F, 3500 psi concrete, unless otherwise directed by the Department or specified in the Contract Documents to use Class B, 4500 psi concrete. The Contractor shall furnish all labor, tools, material and equipment necessary to perform the following general work, with all costs included under this Pay Item:

- Saw cut
- 207.03: Excavation
- 207.03: Shoring
- 207.03(B): Dewatering
- 612: Steel plating (necessary steel plating of the Roadway, properly bolted down and temporary AC to protect edges of steel plates for moving traffic as directed by the Engineer).
- Installation of conduit(s)
- Penetration of DC and PEPCO manholes
- Concrete encasement
- Backfilling in layers of 6 inches
- Compaction of fill
- 407: Temporary asphalt patch (4 inch)

- Maintenance of the cuts until the permanent repairs are made, as directed by the Engineer

The Contractor shall excavate the trench at the locations indicated in the Contract Drawings. Conduit(s) shall be PVC schedule 40 and the size and ductbank configuration specified in the Contract Documents, and shall be installed to proper line and grade. The trench shall be opened progressively between manholes, or between manholes and the proposed streetlights, with simultaneous installation of conduit(s). Conduit(s) shall be installed with a minimum of 36 inches of cover in roadways and 24 inches in all other locations including sidewalk and grass surface, and shall be installed in dry trenches. The conduit shall be installed in full lengths using manufactures' supplied bends and couplings. When the Contractor must make field cuts, the conduit ends shall be reamed to remove any rough edges before joining together. The joints shall be cleaned, cemented, and the lengths of the conduits coupled tightly.

Where 2 or more conduits are being installed in the same trench, the Contractor shall use approved conduit spacers for the size and configuration of the conduit runs. Conduit(s) shall be installed to slope toward manhole. The slope of ductbank runs shall be at least 10 inches per 300 feet. All conduit concrete encasements shall use wet mix or otherwise specified by the Contract Documents or as directed by the Department. All conduit runs shall be complete and points of penetration of the wall of the manholes shall be sealed with wet mix concrete before any concrete encasement is installed. The wall penetration of PEPCO manholes will be done under the supervision and direction of PEPCO field personnel. The penetration of DC manholes will be done under the supervision and direction of the District personnel. At the end of each workday, the Contractor shall seal the ends of all conduits to prevent the entrance of dirt and water into the conduit system.

The Contractor shall provide 4 inch detectable aluminum warning tape 12 inch above the top of the concrete encasement of the ductbanks as shown in the Contract Drawings. The warning tape shall be detectable by means of sensors in use to detect buried cable and conduit. The color of warning tape shall be yellow. The warning on the tape will be "CAUTION, BURIED ELECTRICAL LINE BELOW".

The backfilling of the trench shall be in accordance of the provisions in 207.04. After the concrete encasement has been installed, all wood forms and trench shoring shall be removed completely during the backfilling operations; backfill will be done in layers of 6 inches. Each layer shall be compacted before the next layer is added. Backfilling can only begin 72 hours after the concrete is poured. Any exceptions must be approved by the Engineer.

New conduit may need to be joined to existing conduit as a part of this work by either intercepting or adding to the existing conduit line. The attachment shall be accomplished with couplings approved for the size of the conduits. The Contractor shall locate all underground utilities and underground structures prior to trenching.

Included within this Pay Item is the temporary patching of the trench and maintenance of the patch until final repairs have been made.

The Contractor shall locate any and all underground utilities before trenching. Besides, several locations in the District may have abandoned streetcar tracks, covered with pavement. The Contractor shall verify and locate that before trenching. If encountered with track, the Contractor shall run the conduit under the track if feasible, included in this Pay Item. If the Department determines that running the conduit under the track is not feasible, the Contractor shall remove the abandoned track first under a separate Pay Item.

1. **Trench** - The minimum depth and the maximum width of trenches shall be driven by the depth of concrete encasement (36 inches under roadway, and 24 inches at all other locations including sidewalk and grass surfaces) and the required concrete dimensions set forth in the Standard Drawings. Any deviation shall require prior approval of the Engineer. Trenches located adjacent to and parallel with curbs or pavements shall not deviate more than 6 inches from the designated lines.

Sawcut lines in paved areas shall follow existing joints or grooves where possible and shall be pre-marked and approved by the Engineer before sawing.

Trench backfill shall be placed in layers not to exceed 6 inches in thickness and compacted with mechanical tampers or other approved mechanical compactors per 207.04. Backfill materials shall conform to 804.05 and shall be recycled crushed concrete or its Department-approved equivalent. Backfill material for trenches in areas of pavement, paved shoulders, or stabilized aggregate shoulders shall consist of granular material. Backfill material for trenches in other areas shall consist of suitable soil or granular material, except that the material around and in the first 4 inches above the top of unit type duct-cable not encased in concrete shall not contain pieces larger than 1/2 inch.

2. **Conduits** - Conduits shall be of the size shown in the Contract Documents and/or as specified herein, and shall be concealed in the Structure and under the Roadways in compliance with the codes, and standards cited in 614.02. The spacing and location of conduits shall conform to the dimensions shown on the drawings. All conduits shall be rigidly supported in an approved manner during pouring of concrete. All PVC conduits shall have bell-ends. Ends of all conduits shall be plugged or capped to prevent seepage of grout, concrete, water, or dirt into the conduit during construction.

New conduit encasement shall have a minimum 12 inch separation from existing utilities lines for both along the line and at crossings. In case the minimum cover from the surface cannot be achieved while running the conduit above an existing utility, the new conduit shall be routed underneath the existing line.

Conduits shall be dripped at low points to prevent accumulation of condensation by sloping to boxes or installing "T" drains.

Where conduits pass through joints in concrete, approved expansion fittings shall be installed.

After installation, all conduits which will be left empty shall have a pull wire or cord installed. Pull wire or cord shall be made of corrosion resistant material with a minimum breaking strength of 200 pounds. Rigid conduit shall be cleared after installation by drawing an iron shod mandrel through each section of conduit line between pull boxes as it is constructed. The mandrel shall not be more than 1/4 inch smaller than the internal diameter of the conduit and shall have a rubber or leather gasket slightly larger than the bore of the conduit. Defective conduits shall be repaired, and the mandrel again drawn through.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Conduit (Concrete Encased) will be per linear foot of conduit or ductbank of conduits installed. Payment will be made at the Contract unit price per linear foot. The payment will include all labor, tools, materials, equipment, excavation, shoring, dewatering, steel-plating, concrete encasement, penetration of manholes (District-owned), back filling, compaction of fill, temporary patching, maintenance of the cut until the permanent repairs are made, and all incidentals necessary to complete the Work specified herein.

### 614.13 ELECTRICAL CONDUITS (BORED)

- A. DESCRIPTION** - The Work consists of the installation of conduit by the method of directional boring. The Contractor shall furnish all labor, tools, material, and equipment necessary for directional boring, also referred to as Horizontal Directional Drilling (HDD) to install conduit at the locations shown in the Contract Documents. All conduit placed under existing pavement shall be installed with no disturbance to the existing Roadway. Any damage to the existing pavement shall be repaired at the direction of the Engineer at no cost to the District.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall drill to install the conduits in the type and size specified in the Plans. Conduit(s) shall be PVC schedule 80 or High Density Polyethylene (HDPE), as specified in the Contract Documents. Conduits shall be installed to proper line and grade. Conduit(s) shall be installed with a minimum of 36 inches of cover in roadways and 24 inches in all other locations, including sidewalk and grass surface. The conduit shall be installed in full lengths using manufactures' supplied bends and couplings. The fittings shall not be cut or altered.

Conduit(s) shall be installed to slope toward manhole. The slope shall be at least 10 inches per 300 feet. All conduit runs shall be complete and points of penetration of the wall of the manholes shall be sealed with wet mix concrete. The conduit end shall be capped to prevent seepage of grout, concrete, water, or dirt into the conduit during construction. The wall penetration of PEPCO manholes will be done under the supervision and direction of PEPCO field personnel. The penetration of DC manholes will be done under the supervision and direction of the District personnel. At the end of each workday, the Contractor shall seal the ends of all conduits to prevent the entrance of dirt and water into the conduit system.

The Contractor shall locate any and all underground utilities and tunnels before trenching. Several locations in the District may have abandoned streetcar tracks, covered with pavement. The Contractor shall verify and locate before trenching by means of test pits.

- C. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Conduits (Bored) will be per linear foot of conduit or duct of conduits installed by boring. Payment will be made at the Contract unit price per linear foot. The payment will include all labor, tools, materials, equipment, excavation, boring, penetration of manholes (both DC's & PEPCO's), and all incidentals necessary to complete the Work specified herein.

**614.14 ELECTRICAL CONDUITS (STRUCTURE MOUNTED)**

- A. DESCRIPTION** - The Work consists of the installation of conduit on structures. The Contractor shall furnish all labor, tools, material, and equipment necessary to install conduits on structures including, but not limited to, the bridges identified in the Contract Documents. The conduits shall be either rigid steel with PVC coat or fiberglass-reinforced epoxy (FRE) resin conduit as mentioned in the Contract Documents. The conduits shall be installed in full lengths using manufactures' supplied bends and couplings.

Expansion Fittings: Conduit expansion and deflection fittings shall be installed as required where conduit crosses a structural expansion joint or open joint. Where expansion exceeds 3/4 inch, an expansion fitting shall be combined with the expansion and deflection fitting at the joint. Expansion fittings and expansion and deflection fittings shall be installed in place in accordance with the manufacturer's instructions.

Rigid Steel Conduit and Fittings: Conduit shall conform to the requirements of and be galvanized in accordance with the requirements of UL-6. Fittings for metal conduit shall conform to the requirements of and be galvanized in accordance with the requirements of UL-514. Conduit for use in corrosive environments shall also be coated on the outside with a PVC coating of 40 mils or another Department approved coating.

Fiberglass-Reinforced Epoxy Resin Conduit and Fittings: Conduit shall conform to the requirements of NEMA TC-14B. Conduit used in exposed areas shall be heavy wall and sunlight resistant. Epoxy adhesive used for joining shall conform to the requirements of NEMA TC-14. Protective shields shall conform to the same requirements as those with PVC conduit.

- B. CONSTRUCTION REQUIREMENTS** - Rigid metal conduit shall be installed with a minimum number of bends and in no case shall the total angle of bends between outlet boxes or junction boxes exceed 360 degrees. Except for factory ells, the center line radius of conduit bends shall not be less than 12 internal diameters of the conduit. All bends shall be regular and symmetrical and the conduit shall not be flattened or distorted. The conduit shall be coupled and connected at the conduit fitting, junction, outlet boxes and expansion fittings, to assure electrical continuity throughout the entire metallic conduit system. Conduit shall be terminated in the junction boxes with insulated bushings to protect the wires. The use of running threads is prohibited and in lieu thereof a Department approved coupling shall be used.

Conductive compound shall be applied to all threaded ends.

- C. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Conduits (FRE or Rigid Steel PVC-coated) will be per linear foot of conduit or duct of conduits installed. Payment will be made at the Contract unit price per linear foot. The payment will include all labor, tools, materials, equipment, excavation, boring, penetration of manholes (both DC's & PEPCO's), and all incidentals necessary to complete the Work specified herein.

**614.15 ROD AND CLEAN DISTRICT-OWNED CONDUIT**

- A. GENERAL** - Work consists of providing all labor, equipment and materials, necessary to rod and clean, and demonstrate the integrity of the existing electrical conduit line between manholes or between a manhole and a pole as directed by the Department. If the conduit is found to be blocked, collapsed or have a breakdown during the rod-clean phase, the location must be determined and marked so that repair can be made to the duct as described under 614.16. All material removed from the conduit as part of the cleaning operation shall be disposed of by the Contractor off site at no additional cost to the District.
- B. MEASURE AND PAYMENT** - The unit of measure for Rod and Clean District-Owned Conduit will be the linear foot. Payment will be made at the Contract unit price per linear foot. The payment will include all labor, tools, material, equipment needed to rod and clean the existing conduit, and all incidentals necessary to complete the Work specified herein.

**614.16 REPAIR EXISTING DISTRICT-OWNED CONDUIT**

- A. GENERAL** - The Work consists of repairing blocked, collapsed or a break-down in existing conduit discovered during the duct rod and clean phase, between the manholes, or between manholes and existing streetlight, or traffic signal poles.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall excavate, shore, and dewater the trench as necessary to expose the affected conduit. The Contractor shall make the repairs as needed to existing conduit and install concrete encasement around the repaired duct. Backfilling, compaction of the fill, temporary patching, and maintenance of the cuts until the permanent repairs are made shall be performed as directed by the Engineer.



- C. MEASURE AND PAYMENT** - The unit of measure for Repair Existing District Owned Conduit will be the linear foot. Payment will be made at the Contract unit price per linear foot of conduit. The payment will include all labor, tools, materials, equipment, excavation, concrete encasement, back fill, compaction of the fill, temporary patch of surface, maintenance of the cut until the permanent repairs are made, and all incidentals necessary to complete the Work specified herein.

#### **614.17 ADDITIONAL CONDUIT AND SWEEP BENDS IN POLE FOUNDATION**

- A. DESCRIPTION** - The Work consists of furnishing and installing additional conduits and sweep bends in pole foundations, that will be necessary only in case of existing lead feeder cables. This is beyond the conduits and sweep bends necessary for foundation installations.

The Contractor shall furnish and install, and provide caps for up to 2 additional conduit stubs (1 to street, 1 to the sidewalk), each with a sweep bend, in pole foundation whenever there is a lead cable or as directed by the Engineer.

Conduit(s) shall be PVC schedule 40 and the sweep bends shall be 24 inch radius.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Additional Conduit and Sweep Bends in Pole Foundation will be per linear foot. Payment will be made at the Contract unit price per linear foot of conduit and sweep bends. The payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

#### **614.18 PROBE-DISCOVER FAULTS IN THE STREETLIGHTING CABLE AND CONDUIT SYSTEM**

- A. GENERAL** - The Department will provide the Contractor the access to Plans, cable, and conduit plats, or GIS printout for each location that show the locations of the feeds between the PEPCO manholes, DC manholes, or lights that are out. The Plans, plats and printouts are not guaranteed to be 100 percent accurate, and the Contractor must verify field conditions for the layout of cables and conduits at its own expense. In case of a cable or conduit failure, the Contractor shall probe-discover faults in the streetlighting cable and conduit system upon specific directions from the Department. The Contractor shall proceed with this work at a specific location only after the Department approval. Work shall proceed at each designated location as follows:

The Contractor shall determine if the feeder cable is direct-buried cable(s) installed in conduit. If the conduit system is blocked, broken down, gas pipe, or a partial conduit system between the light pole and its feed source, the Contractor shall probe to locate and determine the problem using appropriate tools and testing equipment.

If the problem is determined to be a defective cable in the conduit or manhole, the Contractor shall proceed with the repair work under the appropriate Pay Items in this Contract as directed by the Engineer.

If the problem is with the conduit system or direct burial cable, the Contractor shall proceed with the Work under Pay Item, Developing Repair Procedures of Faults in the Streetlighting Cable and Conduit System.

- B. MEASURE AND PAYMENT** - The unit of measurement Probe-Discover Faults in the Street lighting Cable and Conduit System will be per each location as directed by the Engineer. Payment will be made for each location for all labor, and equipment necessary to complete the Work specified herein.

#### **614.19 DEVELOP REPAIR PROCEDURES FOR FAULTS IN THE STREETLIGHTING CABLE AND CONDUIT SYSTEM**

- A. GENERAL** - The Contractor shall, after the Probe-Discovery phase has been completed and if required, meet with the Department staff at each designated location to determine how the permanent repairs will be made to the fault. The Work shall be as follows:

Coordinate a meeting with the Department staff on location or in their office to determine the course of action to correct the fault.

Bring field notes or show findings from the Probe-Discovery Phase.

Set out the procedures on how to correct the fault.

Establish which Pay Items will be needed in the permanent repairs and estimated quantities to complete the repair.

Prepare permit application and drawings needed to perform the repair work.

- B. MEASURE AND PAYMENT** - The unit of measurement for Develop Repair Procedures for Faults in the Streetlighting Cable and Conduit System will be per each location as directed by the Engineer. Payment will be made for each location for all labor and equipment necessary to complete the Work specified herein.

#### **614.20 DRAWINGS-PERMIT APPLICATION FOR REPAIR IN THE STREETLIGHTING SYSTEM**

- A. GENERAL** - The Contract will act as the Public Space Permit to do all Work given to the Contractor under this Pay Item. The Contractor shall make the necessary permit drawings, showing locations of all cuts, conduit paths, submit drawings for approval to the Department and complete the Public Space Permit Application. The Contractor, for each designated location, will perform the following work:

Make necessary permit drawings of conduit runs, ensuring that all dimensions between the conduit and the face of the curbs are on the drawings.

Verbal cut numbers and all cuts are shown on the drawings with dimensions from the face of the curbs

Fill out the Public Space Permit Application for each cut made.

Deliver the drawings to the Department for approval and stamping for submission with the Public Space Permit Application.

The Public Space Permit Application will be delivered to the Department office for the necessary agent's signature; the Department staff will file the permit application.

The drawings will be added to the Contract as "ASBUILT" conditions after the Work is complete. The drawings shall be prepared and signed as per 108.12, and indicate the deviation from the original in redlines.

- B. MEASURE AND PAYMENT** - No separate payment will be made. The Work is measured and paid for under Pay Item Develop Repair Procedures for Faults in the Street Lighting Cable and Conduit System.

#### **614.21 UNDERGROUND STREETLIGHT CABLES**

- A. GENERAL** - The Work consists of furnishing all labor, materials, and equipment necessary to install current carrying conductors, as specified in the Contract Documents. The conductors will be installed in, but not be limited to, manholes, existing conduit, new conduit, transformer bases and poles.

- B. CONSTRUCTION REQUIREMENTS** - All cables shall be installed in continuous lengths, and without splices between termination points. The Contractor shall provide necessary equipment for the pulling in of the cables. The Contractor shall pull the cables through conduits without over-stressing, scoring or cutting the wire, and without damaging the insulation or outer covering.

Where strain on the cables is likely to be excessive, the Contractor shall use the Department approved environmentally friendly cable lubricant meeting the requirements of cable supplier. Where more than 1 cable is to occupy the same conduit, the cables shall be installed at the same time.

If the Contractor is not making the final splices or terminal connections immediately after installation, the cable ends shall be sealed to prevent moisture intrusion. The Contractor shall install 5 feet slack cable in each manhole to allow for racking. Each phase conductor and neutral shall be identified using standard color markings as indicated in 820.11.

All cables located in utility company (i.e., PEPCO) manholes shall be tagged to show ownership, circuit number, and voltage. Cables in District-owned manholes shall be tagged to indicate phase. After cables have been spliced, racked, and prior to final service connection by the utility company, the Contractor shall give each phase conductor, and neutral, an insulation resistance test between the conductors and ground. The test shall be performed in the presence of the Engineer.

The Contractor shall furnish all labor, materials and test equipment. The test equipment shall be calibrated and certified yearly by a testing laboratory or the equipment manufacturer. Copies of the certification shall be supplied to the Engineer.

If a fault exists, the Contractor shall locate the faulty cable section, furnish and install a new cable. If it is determined that the fault is due to a splice, the decision to repair the splice, or to replace the faulty cable section shall be determined by the Engineer.

The Contractor is responsible for notifying PEPCO to re-establish the service when the new equipment has been installed. Coordination with PEPCO will be the responsibility of the Contractor.

- 1. Cable Connections** - All wire and cable shall be continuous from origin to destination without running splices in intermediate trays, pull boxes, or manholes. In cases where splices are necessary because of long lengths, approval of splice locations shall be obtained from the Engineer. Splices shall not be permitted in conduits, ducts, trays, or transformer bases.

Splices in 600-volt rubber insulated wires, and cables (where permitted) shall be accomplished by means of compression connectors. The connector shall be suitable for the size wire used, and shall be of 1 piece tubular tinned copper construction. The indentation shall be such as to assure maximum electrical connection and sufficient physical strength. The connection shall be covered with approved electrical tape, half-lapped to a thickness not less than 50 percent greater than the conductor insulation.

If approved soldered connections are specified in the Special Provisions, each splice shall be covered with polyvinylchloride plastic insulating tape to provide insulation equivalent to that on the wire. Neoprene tape shall then be applied over the splice in half-lap wrappings to a thickness equivalent to the wire or cable outer jacket. 2 final laps of polyvinylchloride tape shall be applied, and the splice shall then be painted with an approved air drying environmentally friendly insulating protectants.

- 2. Circuit Identification** - The Contractor shall furnish and install identifying tags on all circuit cables, in all handholes for line and light identification. Tags shall be as per 820.14. Identification markings, designated by the Engineer, shall be stamped on the tags by means of small tool dies. Each tag shall be securely tied to the proper conductor by non-metallic core plastic. Self-adhesive plastic tags shall not be used unless approved by the Engineer.

Each conductor passing through a junction, or splice box, or terminating in a street light, or outlet shall be permanently identified as to circuit number and phase.

**C. MATERIALS** – Materials shall meet the following requirements:

- 820.11: Cable
- 820.14: Circuit identification

Wires shall be drawn into place free from electrical and mechanical injury. No lubricant other than an approved type will be permitted to be used on wire installed in conduit. All wires shall be permanently marked with approved fiber tags as described to expedite tracing of circuits where device terminals are not otherwise identified. Wire shall be placed in rigid conduit unless otherwise specified and the total cross sectional area of the wire shall not exceed 40 percent of the conduit cross section area.

- D. MEASURE AND PAYMENT** - The unit of measure for Install Underground Streetlight Cables will be per linear foot complete in place. Payment will be made at the Contract unit price per linear foot of cable. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

## 614.22 OVERHEAD CABLES

- A. GENERAL** - The Work consists of providing overhead cables of the size specified in the Contract Documents to provide service to streetlights mounted on wood poles. The streetlights are normally mounted on District-owned wood poles, but the installation may be on wood poles owned by other utilities.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall install the overhead cable using approved connection hardware and approved equipment. The Contractor shall ensure that the cable is not damaged during installation. The cable shall be installed according to the cable manufacturer's Specifications. The cable shall be installed with proper tension and sag according to the temperature on the day installed. The cable must maintain the NESC clearance requirements. All damaged cables will be removed from the Site and replaced at no additional cost to the District.

The overhead cable shall be a certified neutral supported cable of the size specified in the Contract Documents.

Tree branches or tree limbs that prevent the installation, or are within the cable clearance area, shall be pruned or removed at the direction of the Engineer under separate Pay Item for tree trimming. Qualified line clearance tree trimmers will perform all pruning work. Tree branches, tree limbs, and any other debris generated shall be removed from the Project Site and properly disposed of as a part of this work.

- C. MEASURE AND PAYMENT** - The unit of measure for Install Overhead Cables will be per linear foot. Payment will be made at the Contract unit price per linear foot of cable. The payment for installation will include all labor, equipment, tools, materials (including approved hardware for connections), and all incidentals (including splices) necessary to complete the Work specified herein

**614.23 COPPER GROUND WIRE**

- A. GENERAL** - The Work consists of providing copper ground wire in conjunction with current carrying conductors as indicated in the Contract Documents. The installation of copper ground wire may include the replacement of existing damaged copper ground wire as directed by the Engineer.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall install the ground wire in continuous lengths. All connections in manholes shall be made using exothermic welds with 2 coats of insulating protectants applied over welds and the ground wire within 1 foot of the weld. All connections to foundation ground rods shall be made with approved connectors. Grounding conductors shall be sized according to Section 250, National Electrical Code. The ground wire shall be installed simultaneously with current carrying conductors. The Contractor shall ensure that the ground wire is not damaged or kinked during installation. All damaged wire shall be removed and replaced at no additional cost to the District. The grounding system shall be installed, connected and tested before energizing the current carrying conductors.
- C. MEASURE AND PAYMENT** - The unit of measure for Install Copper Ground Wire will be per linear foot. Payment will be made at the Contract unit price per linear foot of cable complete in place. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

**614.24 REMOVE UNDERGROUND CABLE**

- A. GENERAL** - The Work consists of the removal and disposal of underground District owned cables, conductors and ground wire, as indicated in the Contract Documents, or as directed by the Engineer. The Work includes cable in ducts and direct buried cables.
- B. REMOVAL PROCEDURES** - The Contractor shall ensure that when the cable is removed, no remnants of the cables remain in the duct.

The Contractor shall remove the designated underground alley light or streetlight cables between DC manholes and PEPCO manholes; between PEPCO manhole and DC manhole; between DC manhole and DC manhole; or between DC or PEPCO manhole to light pole, according to following procedures:

Locate power source of each alley light or streetlight circuit.

Disconnect the power before removal of cables between manholes.

Remove all underground cables between manholes or light and manhole.

The Contractor shall be responsible for notifying PEPCO (if PEPCO manholes are a part of this Work) to disconnect the existing service when removing the existing cable and to re-establish the service when the new cable has been installed. All coordination with PEPCO for this Work shall be the responsibility of the Contractor.

Lead jacketed or lead insulated cables shall be disposed of in the manner prescribed for hazardous waste. The disposal shall meet the District and Federal environmental regulations. The area around each manhole entrance shall also be cleaned of all hazardous waste and debris before the Contractor leaves the Site. The Contractor will dispose of all debris and hazardous waste generated as part of the Work at no additional cost to the District.

In ducts or trenches where more than 1 cable is to be removed, the Contractor shall be paid for the linear foot of 1 cable, not all removed cables.

- C. MEASURE AND PAYMENT** - The unit of measure for Remove Underground Cable will be per linear foot. Payment will be made at the Contract unit price per linear foot of cable. When multiple cables are to be removed from a single duct, all removed cables will be considered as 1 cable for payment. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

**614.25 REMOVE EXPOSED RACEWAY ON WOOD POLE**

- A. DESCRIPTION** - The Contractor shall identify wood poles or investigate wood poles as identified in the Contract Documents with raceways that protect alley light conductors through manholes. The Contractor shall remove raceways after removal of existing feeders as per 614.24.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Exposed Raceway on Wood Pole will be made at the Contract unit price per each raceway removed. Payment will be made at the Contract unit price per each raceway. The payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

#### 614.26 FOUNDATION FOR STREETLIGHT POLES

- A. DESCRIPTION** - The Work consists of furnishing and installing streetlight pole foundations at the locations specified in the Contract Documents. The Contractor shall install the number and size of the conduits, and sweep bends in the foundations specified in the Contract Documents as part of this Work.

Pole foundations at an intersection: If not specified in the Contract Documents, the Contractor shall provide in the foundation one 2-inch conduit and sweep bend (for streetlight cable or spare for future use), one 1-1/2-inch conduit (for ground rod), and one 4-inch conduit and sweep bend (for signal cable use or spare for future use). This shall apply to all poles at an intersection (signalized or unsignalized) or type of usage (e.g., combination streetlight and traffic signal, standalone streetlight or standalone traffic signal). If any conduit is spare for future use, it must continue and terminate in the respective manhole.

Pole foundations not at an intersection: If not specified in the Contract Documents, the Contractor shall provide in the foundation one 2-inch conduit and sweep bend (for streetlight cable), and one 1-1/2-inch conduit (for ground rod). This shall apply to poles not at an intersection.

- B. CONSTRUCTION REQUIREMENTS** - The foundation shall be cast in place at the locations specified in the Contract Documents and centerline of the foundation will be located 36 inches from the face of the curb unless otherwise indicated in the Contract Documents. The foundation shall not be installed at locations where the minimum clear area on a sidewalk will be less than 36 inches. A 1-1/2-inch conduit shall be installed through the foundation for the installation of a 3/4 inch x 15 foot ground rod. The ground rod and connection shall be included as a part of this Work.

The Contractor shall be responsible for ensuring that all reinforcing steel, anchor bolts, ground rods, conduit and other appurtenances are properly located before concrete is poured. The anchor bolts shall be set to the bolt circle specified in the Contract Documents and shall project 3 inches above the top of foundation. Where existing conduit is reused it shall be connected with new PVC conduit going into the new foundation using approved electrical couplings. The conduit for the electrical conductors shall be set as close to the center of the foundation as possible. All conduits shall terminate with bell-ends. All foundation caps shall be set 1 inch above grade. The foundation shall be allowed to set for a minimum of 72 hours before installation of the pole.

The Contractor shall be responsible for the disposal off site of all excavated Earth and debris resulting from this Work at no additional cost to the District.

**C. MATERIAL**

- 801.01 (A) and (B), AASHTO M 85, Type I: PCC – Class B
- 820.12, FS 1094A: Conduit – Schedule 40
- 812.02, AASHTO M 31, Grade 60: Reinforcing steel
- Anchor Bolts – 1-1/4 inch diameter and 36 inches long with 4-inch hook with hex nuts and washers; steel per ASTM A 36 or F 1554 Grade 55, hot-dipped galvanized per ASTM A 123 or A 153
- Ground rod – 3/4 inch diameter and 15 feet long

- D. MEASURE AND PAYMENT** - The unit of measure for Install Foundation for Streetlight Poles will be per each foundation installed. Payment will be made at the Contract unit price per each foundation. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

#### 614.27 REMOVE STREETLIGHT FOUNDATIONS

- A. GENERAL** - The Work consists of complete removal of streetlight pole foundations as shown in the Contract Documents. The Contractor shall cut and seal all conduits with concrete that is to remain in place, remove the anchor bolts, reinforcing steel, and the ground wire or rod. Where the foundation is located within a Tree Space, the Contractor shall backfill the excavation with approved

material to grade. Where the foundation is located in a paved area the Contractor shall backfill with approved material to within 6 inches of grade, and then install a temporary asphalt patch meeting the requirements of 407.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Streetlight Foundation will be per each foundation removed. Payment will be made at the Contract unit price per each foundation removed. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

#### 614.28 STREETLIGHT BASE – BREAKAWAY AND STEEL

- A. GENERAL** - The Work consists of providing Breakaway and Steel Streetlight Bases at locations shown in the Contract Documents. The bases shall be provided with all necessary factory supplied hardware for the access door, installation, and grounding.

- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall install the base on the existing streetlight foundation. The base shall be trued and leveled by means of factory supplied shims. The base shall be grounded to the foundation by means of factory supplied lugs. The Contractor shall set the base with care so as not to damage the finish or cause deformation. All damage to the finish will be repaired and/or replaced at no additional cost to the District. If the material is damaged during the time between installation and acceptance by the District, the Contractor shall repair and/or replace in kind at no additional cost to the District.

Replace Streetlight Base at Existing Streetlight Pole work includes, but is not limited to, replacing damaged and deteriorated streetlight pole transformer base with a new streetlight base. The Contractor shall disconnect service to the streetlight; temporarily remove the existing streetlight pole; remove the damaged or deteriorated base, install a new streetlight base on the new or existing foundation, and reinstall existing streetlight pole and equipment. The Contractor shall make all necessary splices, and ensure that the streetlight is operational.

- C. MATERIAL** – Material shall meet the following requirements:

- Breakaway Base –Aluminum, ASTM A 356
- Steel Base –AASHTO M 111M/M

- D. MEASURE AND PAYMENT** - The unit of measure for furnish and install Streetlight Base will be per each. Payment will be made at the Contract unit price per each Streetlight Base installed. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

The unit of measure for Replace Streetlight Base will be per each. Payment will be made at the Contract unit price per each Streetlight Base replaced. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

#### 614.29 STREETLIGHT POLE

- A. GENERAL** - The Contractor shall provide new streetlight poles and arms as specified in the Contract Documents. Transformer base installation for pendant posts shall be covered by a separate item. All accessories including bolts, bolt caps, nuts, washers and clips necessary for installation are included in the Work. All equipment that the Contractor receives shall be stored according to manufacturer recommendations. The bases and shafts shall be installed true and level, and any required shimming shall be done with factory-supplied shims. However, no more than 2 shims shall be used.

The Contractor shall set the post with care so as not to damage the finish. All damage to the finish will be repaired and/or replaced at no additional cost to the District. The Contractor shall maintain the pole properly until acceptance by the Department, and replace any material damaged in kind at no additional cost to the District. All debris generated as part of the Work will be disposed of by the Contractor at no additional cost to the District.

Feeder cable (#10 AWG stranded wire RHW-2 or as specified in the Contract Documents), and ground (#8 AWG or as specified in the Contract Documents) cables associated with the pole installation shall be included in this Bid Item. There shall be 2 feet slack at transformer base (or base of light pole) and 5 feet slack at manhole (or handhole). This Bid Item will cover the length of cables from the fixture to the pole foundation including the slack at the base. Cable length beyond the base will be paid by the respective cable Pay Items. However, the cables and ground runs shall be continuous un-spliced from the fixture to the manhole (or handhole) via foundation and transformer base (or base of light pole).

Splicing of any cables (live or ground) in the pole bases is not acceptable. If there are instances where splices in pole bases are required, the Department electrical representative shall be contacted to approve or disapprove.

When directed by the Engineer, the Contractor shall deliver new poles to DC Warehouse. The Contractor should call 24 hours in advance of delivery of the required material. The Contractor shall get a receipt for acceptance or rejection and the quantities involved.

The Department has adopted a procedure to develop a unique ID for each pole. The ID will be attached to the pole on a tag (Department approved) in a Department approved fastening method. The Department will provide the new pole ID numbers to the Contractor. The Contractor shall furnish the tag, prepare the ID, and install the tag to the pole as an incidental to pole installation, and submit the required ID information to the Department for inclusion into the Department GIS inventory. The orientation of the tag shall be in a manner so that it is visible from the Roadway side and can be inventoried from moving vehicles.

The following paragraphs describe various poles, while the details are provided in 820.02.

1. **Pendant Pole with 8 Foot Straight Arm** - Work includes provision of steel pendant pole with an 8 foot arm, or as specified in the Contract Documents. Included shall be all electrical wiring, power cable, and ground wires. Materials shall meet the requirements as specified in the Contract Documents.

The height of the poles can be less than 30 feet (generally 28'-6" or other as specified in the Contract Documents) or more than 30 feet (generally 38'-6" or other as specified in the Contract Documents).

2. **Pendant Pole with Decorative Arm** - It will include provision for steel pendant post with decorative arm and all electrical wiring both power cables and ground wires. The material shall meet the requirements as called for in the Contract Documents. Whenever a "decorative arm" is called for in the context of metal streetlight poles, it would imply decorative arm with the Department approved wrap (refer to the Standard Drawings). For metal streetlight poles, the arm shall include decorative wrap as an incidental in the Pay Item.

The height of the poles can be less than 30 feet (generally 28'-6" or other as specified in the Contract Documents) or more than 30 feet (generally 38'-6" or other as specified in the Contract Document).

3. **No. 16, 18, 716, and Twin-20 Streetlight Pole** - Work shall include drilling or slotting newly installed base in order to install the pole on a new 15 inch bolt circle foundation. The Contractor shall install the pole plumb. If required, shimming shall be done only with manufacturer's supplied shims. The Contractor shall furnish new #16 casing and base doors, as a part of this Pay Item.

4. **5A Alley Post with 3-foot Arm** - Work shall include installation of post by direct embedment in the ground. The Contractor shall install the post grounding system before installing any power cables. A 3/4-inch x 10 foot ground rod shall be installed beside the post. The Contractor shall ground the post with a #8 AWG stranded bare copper wire (or as specified in the Contract Documents) connected to the post grounding lug and to the ground rod with exothermic welds and covered with 2 coats of insulating protectants. When setting the post, the Contractor shall use care so as not the damage the factory applied finish. Damage to the post shall be repaired by the Contractor at no additional cost to the District.

The poles shall not be installed on any property entrances. In case of conflicting dimensions in the Contract Documents, the Contractor shall notify the Engineer for resolution.

- B. **MEASURE AND PAYMENT** - The unit of measure for Install Streetlight Pole will be per each furnished and/or installed. Payment will be made at the Contract unit price per each pole. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

### 614.30 WOOD POLE

- A. **GENERAL** - The Contractor shall furnish and install new Class 3 Wood Pole as per Materials Specification in 820 and as specified in the Contract Documents. All accessories including guy wires, insulators necessary for installation are included in the Work. All hardware that the Contractor receives shall be stored according to manufacturer recommendations.

The Contractor shall drive and set the post with care so as not to damage it. All damages will be repaired and/or replaced at no additional cost to the District. The Contractor shall maintain the pole properly until acceptance by the Department. All debris

generated as part of the Work will be disposed of by the Contractor at no additional cost to the District.

Included in the Pay Items shall be furnishing and installing 3/4-inch x 10 foot ground rod at the base and continuous ground run to the manhole (or handhole).

The Department has adopted a procedure to develop a unique ID for each pole. The ID will be attached to the pole on a tag (Department approved) in a Department approved method. The Department will provide the new pole ID numbers to the Contractor. The Contractor shall furnish the tag, prepare the ID, and attach the tag to the pole as an incidental to pole installation, and submit the required ID information to the Department for inclusion into the Department GIS inventory. The orientation of the tag shall be in a manner so that it is visible from the Roadway side and can be inventoried from moving vehicles.

More details are provided in 820.02.

1. **Guy Wires** - Guy wires shall meet the strength requirements. They shall be considered to take the entire load in the direction in which they act and the Structure is to be considered to act as a strut only, except for those structures considered to possess sufficient rigidity so that the guy wires can be considered an integral part of the Structure. The strength requirements for guy wires shall follow NESC (Rule 264).
2. **Guy Insulators** - Guy insulators shall be in accordance with NESC. Where guy insulators are used in accordance with NESC Rule 215C2, the guy insulators shall meet the following requirements:
  - a. *Material* - Insulators shall be made of wet-process porcelain, wood, fiber-reinforced polymer, or other material of suitable mechanical and electrical properties.
  - b. *Electrical strength* - The guy insulator shall have a rated dry flashover voltage at least double of and a rated wet flashover voltage at least as high as, the nominal line voltage between conductors of the guyed circuit. The dry and wet flashover values shall be determined according to the Low Frequency Dry and Low-Frequency Wet Withstand Voltage Tests specified in ANSI C29.1. Guy insulators made of fiber-reinforced polymer plastic or other suitable materials that can reasonably be expected to be degraded by ultraviolet light shall be protected against UV degradation. A guy insulator may consist of 1 or more units.
  - c. *Mechanical strength* - The rated ultimate strength of the guy insulator shall be at least equal to the required strength of the guy in which it is installed.

- B. **MEASURE AND PAYMENT** - The unit of measure for Install Wood Pole will be per each furnished and installed. Payment will be made at the Contract unit price per each pole. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work specified herein.

### 614.31 REMOVE STREETLIGHT POLES

- A. **GENERAL** - The Contractor shall furnish all labor, material, and equipment to remove streetlight poles and associated equipment, (including conversion kits, lamps, photo cells, wiring within the poles, street signs, and poles) as shown in the Contract Documents. All poles that are to be reinstalled shall be carefully removed. All parts damaged by the Contractor will be replaced by the Contractor at no additional cost to the District. All posts shall be disassembled and inspected by the Contractor for parts that can be reused at a later time. The Contractor shall supply the District with an inventory of all parts that are removed and reusable. The Contractor shall clean all reusable poles, parts thereof and luminaires, and pack them for delivery and storage. The luminaires shall be properly labeled and packed securely in boxes. The Contractor will deliver the reusable poles or parts to the District's warehouse. All debris, including broken parts, generated as part of this Work, will be disposed of by the Contractor at no additional cost to the District.

The Contractor must secure exposed anchor bolts, wires, and conduits from public reach for the transition period in a manner acceptable to the Department.

If the pole is in good condition and is to be reused in the Project, the Contractor shall transport the pole to its own storage site.

Backfill and compact all holes created by removing existing metal light poles, except holes that will be used again for new light poles. Backfill materials shall consist of suitable soils or granular material.

All streetlight poles and alley light poles are included in this specification.



For combination poles (traffic signal and streetlights), pre-emption and signal cables shall be disconnected and reconnected by District personnel. The Contractor shall remove, tape, rack, and test the pre-emption cable as directed by the Engineer. The pre-emption cable shall be reinstalled with traffic signal cable.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove Streetlight Pole will be each. Payment will be made at the Contract unit price per each. The payment will include all labor, tools, materials, equipment, disassembly of pole parts, inventory of parts removed and reusable, delivery of parts, stacking in the warehouse and/or pole yard, disposal of broken parts, debris, and all incidentals necessary to complete the Work specified herein.

### 614.32 REMOVE STREETLIGHT CONTROL PEDESTAL

- A. GENERAL** - The Contractor shall provide for the removal of existing streetlight control pedestals. The pedestals shall be removed after all series lights (if any) are converted off the circuit, and PEPCO has disconnected the pedestals from their system. The pedestal shall be completely removed, the conduits shall be filled with cement, and the excavation shall be backfilled in 6 inch layers and compacted to match the surroundings. All material removed as part of this Work shall become the property of the Contractor and shall be disposed of at no additional cost to the District.
- B. MEASURE AND PAYMENT** - The unit of measure for Remove Streetlight Control Pedestal will be each. Payment will be made at the Contract unit price per each. The payment will include all labor, tools, materials, equipment, excavation, back fill, compaction of the fill, and all incidentals necessary to complete the Work specified herein.

### 614.33 CLEAN AND PAINT STREETLIGHT POLES

- A. GENERAL** - The Work consists of the cleaning and preparation for painting the streetlight poles, painting of the poles, and proper disposal of any hazardous waste.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall apply a 2-coat paint system as specified herein. The painting of steel and other metal work shall include complete removal of existing paint, rust mill scale, and hazardous waste by metal brush, and proper disposal, complete preparation of the metal surfaces, application and protection of the drying paint coatings, protection of workers, and the environment and furnishing all labor, materials, tools, equipment, and incidentals necessary for proper execution of the Work.
- C. CERTIFICATION** - A certified Painting Contractor or Subcontractor, in accordance with Section 707.03(B), shall perform all field painting. All Contractor or Subcontractor personnel working on this item of Work shall be qualified and have current certification.
- D. PROTECTION OF WORKERS AND THE ENVIRONMENT** - Protection of workers and the environment shall be provided by the Contractor as an integral requirement of the performance of the Work. The Contractor shall employ the best current methodology for protection of the workers and employees, and submit a plan to the Engineer for approval.
- E. MAINTENANCE AND PROTECTION OF HIGHWAY AND PEDESTRIAN TRAFFIC AND ADJACENT PROPERTY** - The Contractor shall be responsible for any disfigurement by splatters, smirches, and splashes of paint on vehicular traffic, pedestrians, or adjacent property. The Contractor shall also be responsible for damage to the streetlight pole and adjacent property through the use of equipment. The Contractor shall correct any damages at no additional cost to the Department.

Proper cloths will be required to minimize splatters of paint on concrete surfaces. Any damage or disfigurement shall be replaced or cleaned at the sole expense of the Contractor.

**F. CONDITIONS FOR SURFACE PREPARATION AND PAINT APPLICATION**

1. Surface preparation shall not be performed when the surface is below 32° F, within 5° F of the dew point or when anticipated weather conditions would preclude application of the primer on the same day.
2. Painting shall not be performed when it is likely that moisture in the form of precipitation, fog, or dew will contact surfaces that have not cured to water resistance.
3. All surfaces shall be painted with 2 coats of iron oxide primer.

4. All surfaces shall then be painted with 2 finish coats of Duron Duraclad 12 Series, or approved equal, the color to match appropriate Federal Color Chip as directed by the Engineer. Each coat is to be applied separately according to manufacturer's recommendations.

#### **G. SURFACE PREPARATION**

1. Surfaces shall be prepared for repainting by cleaning with a biodegradable graffiti remover and a de-scaling acid compound.  
Biodegradable graffiti remover equal to TAGAWAY, manufactured by Equipment Trade Service Co., Inc.  
De-scaling acid compound equal to COIL SNAKE, manufactured by Equipment Trade Service Co., Inc.
2. The Engineer will be the sole approving authority of the adequacy of the surface preparation.
3. After the prepared surfaces of existing steel have been inspected and accepted, the surfaces shall be primed the same day. Should rust-back occur before primer application, the affected area shall be cleaned at no extra cost to the District.

#### **H. GENERAL REQUIREMENTS FOR FIELD PAINTING**

1. All paint shall be stored, mixed, thinned, and applied in accordance with the manufacturer's recommendations. In cases where the manufacturer's recommendations are more lenient than the requirements in this specification, the manufacturer's recommendations shall govern only if specifically authorized by the Engineer.
2. Prior to application of each coat, the surfaces to be painted shall be cleaned as necessary so as to be dry and free of dirt, grease, glue, and paper residue, and rust. All residue of abrasives, paint, and dust remaining after cleaning or other operations shall be removed using a commercial grade vacuum cleaner equipped with a brush type cleaning tool or by double blowing with clean air.
3. All paint shall be mixed using power mixers of a type recommended by the manufacturer. Only complete kits of the iron oxide primer shall be mixed. Iron oxide primer that has exceeded its pot life shall be discarded. Paints shall be frequently mixed during application. Iron oxide primer shall be continuously agitated and shall be applied from containers equipped with a mechanical agitator, which shall be in constant use during application. Paints shall be frequently remixed during application. Paints shall be thinned only with prior approval of the Engineer.
4. Application of paint shall result in a tight film of specified thickness, well bonded to the metal or underlying coatings, including all crevices, and corners, and shall be free from laps, streaks, sags, bubbles, runs, over sprays, dry spray, shadow-through, skips, excessive film build-up, misses, and other defects.

#### **I. REPAIRS**

1. All defects or damaged areas shall be repaired at the Contractor's expense. Said areas shall be coated with full system as required in these Specifications. Repair may be limited to touch-up of damaged areas, but in no way shall the number of coats, the required coating system, or the dry film thickness of each coat be modified because of the repair procedure.
2. Defects in the paint film, including damage such as scratches, and areas of non-adherent paint, and rusting shall be repaired.

#### **J. PERFORMANCE TESTS AND PRODUCT CERTIFICATION** - The following information shall be submitted as a complete package for approval for each coat in the system selected at least 30 days prior to the anticipated beginning of painting operations:

1. A 1 quart sample of each coat in the system
2. Certification from the manufacturer that the materials supplied for use as field and repair primer, and finish coats contains no more than 0.005 percent lead.
3. Product and material safety data sheets and application guides the proposed system to the Engineer for material approval.

#### **K. PAINTING SCHEDULE AND CONTRACTOR'S SUBMITTALS** - Before any painting operations begin, the Contractor shall submit in writing to the Engineer, as part of the permit application to DCRA, his proposed work schedule, which shall include:

1. A system procedure or plan for all cleaning and painting operations.
2. The type and method of protection against paint splatters, spray drippings, and other disfiguring elements while cleaning, and painting over roadways, pedestrian and bicycle paths, and areas in the vicinity of private property.

**L. INSPECTION**

1. Authorized personnel representing the District shall inspect all Work. As each operation (cleaning, spot painting, and each coat of painting) is completed and prior to any succeeding operation, the Contractor shall notify the Engineer for approval before the next operation may begin. Any Work not meeting the approval of the District Inspectors shall be rejected and redone until it meets their approval. The method of correction shall be approved by the Engineer prior to proceeding. Should any Work be done which proceeds past the point where Inspector approval is required, the Contractor shall, at the option of the Engineer, remove said Work back to that point at no additional cost.
2. Cleaning and surface preparation of each streetlight shall be entirely completed and accepted before painting commences. All paint shall be suitably dry before any succeeding coat of paint is applied. Any paint applied without prior approval of the Engineer to begin painting shall be removed. This corrective Work shall be at the sole expense of the Contractor.

**M. MEASURE AND PAYMENT** - The unit of measure for Clean and Paint Streetlight Pole will be per each. Payment will be made at the Contract unit price per each pole. Payment will include all cleaning and surface preparation, application and protection of paint coatings, repair of damaged or unsatisfactory paint surfaces, preparation and submittal of all required procedures and information, performance of all additional Work required by this specification, and all labor, materials, tool, equipment, disposal of unsuitable materials, and incidentals necessary to complete the Work specified.

**614.34 ARM ON STREETLIGHT POLE**

**A. GENERAL** - The Contractor shall provide all labor, materials, and equipment necessary to furnish and install a metal arm on an existing streetlight pole (wood or metal) owned by the District, or any other utility company, as specified in the Contract Documents. All arms shall be installed as shown on the Standard Drawings or as specified in the Contract Documents. Work includes installing the necessary current carrying conductors and any protective moldings, grounding of the arm and fixture, and installing the tap where the District owns the secondary conductors feeding the pole. Where the utility company owns the secondary conductors, the Contractor shall leave a 3 foot pigtail for the utility company's use in making the final connections. The following grounding requirements shall apply based on the type of pole:

1. In case of existing metal poles, this Pay Item shall include furnishing, and installing continuous un-spliced ground wire run from the manhole (or handhole) to fixture via foundation, and transformer base or base of light pole. There shall be 2 foot slack at transformer base (or base of light pole), and 5 feet slack at manhole (or handhole).
2. In case of existing wood poles, this Pay Item shall include furnishing and installing continuous un-spliced ground wire run from the ground rod at the pole base to the fixture.

All debris generated as part of this Work shall become the property of the Contractor and shall be disposed of at no additional cost to the District.

**B. MEASURE AND PAYMENT** - The unit of measure for Install Arm on Streetlight Pole (Metal or Wood) will be per each arm complete in place. Payment will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

**614.35 BANNER ARM ON STREETLIGHT POLE**

**A. GENERAL** - The Contractor shall provide banner arms on streetlight poles as specified in the Contract Documents and as directed by the Engineer. The arms, including mounting hardware, shall be constructed of corrosion-resistant material. The Contractor shall submit catalog cuts and samples to the Engineer for approval before any orders are placed. The Contractor shall follow the below guidelines for mounting arms on streetlight poles,

1. **For Pendant Poles** - The banner arms shall be mounted such that there is an absolute minimum clearance of 16 feet from the finished grade to the bottom of the lower arm and such that a 2 feet x 4 feet long banner can be installed by others.
2. **For Twin 20 & #18 Streetlight Poles** -The maximum banner size for the pedestrian walkway side shall not exceed 2 feet x 4 feet and shall have an absolute minimum of 12 feet clearance from the bottom of the banner to the finished grade.

The maximum banner size for #18 poles on the Roadway side shall not exceed 1.5 feet x 2 feet and shall have an absolute

minimum clearance of 14 feet from the bottom of the banner to the finished grade. The maximum banner size for Twin 20 poles on the Roadway side shall not exceed 1.5 feet x 3 feet and shall have an absolute minimum clearance of 14 feet from the bottom of the banner to the finished grade.

3. **For #16 Streetlight Poles** - The maximum banner size for #16 poles on pedestrian walkway side shall not exceed 2 feet x 2.5 feet and shall have an absolute minimum clearance of 11 feet from the bottom of the banner to the finished grade. Banners shall not be attached on the Roadway side for this type of pole.
4. **General Provisions** - Banner designs shall meet all roadway code requirements. Banners shall not be attached to fiberglass poles.

The Contractor shall use care when mounting the banner arms so as not to damage the pole finish. The Contractor shall repair all damage to the pole and pole finish at no additional cost to the District. All debris generated as part of this Work shall become the property of the Contractor and shall be disposed of at no additional cost to the District.

- B. **MEASURE AND PAYMENT** - The unit of measure for Install Banner Arm on Streetlight Pole will be per each. Payment will be made at the Contract unit price per each. The payment for installation will include all labor, tools, materials, equipment, and all incidentals necessary to complete the Work specified herein.

#### 614.36 STREETLIGHT GLOBE

- A. **GENERAL** - The Work consists of providing streetlight globes of the size specified in the Contract Documents. The globes will be installed on "Washington" type poles. If refractors are specified, the Work includes providing refractors and using manufacturer's hardware to complete the item of Work.
- B. **MEASURE AND PAYMENT** - The unit of measure for Install Streetlight Globe will be per each. Payment will be made at the Contract unit price per each. The payment for installation will include all labor, tools, materials, equipment, disposal of debris, and all incidentals necessary to complete the Work specified herein.

#### 614.37 LUMINAIRES

- A. **GENERAL** - This section covers high pressure sodium (HPS), metal halide and light emitting diode (LED) luminaires. The Contractor shall furnish all labor, materials, and equipment necessary to remove the existing fixture and install the specified luminaire of wattage(s), as specified in the Contract Documents. All luminaires installed will be of cut-off type (Type III).

Materials shall be as per the Contract Documents and Division 800.

It is the responsibility of the Contractor to insure that the proper size luminaire is installed. Care must be taken during the installation of the luminaire so that the conductors are not damaged. All conductors damaged by the Contractor will be replaced at no cost to the District. The new luminaire shall be attached securely to the supporting arm or bracket in accordance with the manufacturer's instructions. All luminaires installed must be leveled during the installation, in accordance with the manufacturer's instructions to level the luminaire.

In the case of luminaires installed on wood poles, the Contractor may be required to adjust the arm or bracket. If the arm or bracket has an adjustment turn buckle, the Contractor shall use the buckle to bring the luminaire into a level position. If the Contractor cannot adjust the arm so as to level the luminaire, the Contractor shall notify the Engineer.

All conductors that terminate on the luminaire terminal block will be installed to ensure a good connection without damaging the conductors. The conductors should be pushed upward as far as possible away from the heat generated by the ballast (if any). The Contractor will make sure that on luminaires with multi tap ballast (if applicable) the taps are installed properly according to the manufacturer's instructions.

All fixtures shall be grounded by connecting the luminaires using a ground wire. The ground wire shall be a minimum #8 AWG stranded copper wire. The ground wire and conductors to the fixture shall be un-spliced between the feeder manhole or handhole, and the fixture. At the pole foundation, the ground wire shall be clamped to the ground rod with heavy duty compression-type clamp. For fixtures that do not typically have ground terminals, the Contractor shall require the product vendor to attach lugs at the fixture for effective grounding. No additional payment will be made for the lug attachment.

The photoelectric control shall be oriented so that the word NORTH is directed towards true north. The Contractor shall check to

assure that the eye of the control is not facing a foreign light source.

The Contractor shall install a new lamp or assembly of the proper type and size. Before leaving the location, the Contractor shall cover the photoelectric control and check that the light is operating properly.

Removal and disposal of the existing fixture are incidental to this Work. All debris generated and material removed by the Contractor shall become the property of the Contractor and removed from the Site.

If necessary the Contractor shall install luminaires with streetlight monitoring wireless electronic locking photo control devices at locations as shown on the Contract Documents or as specified by the Engineer.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Luminaires will be per each complete luminaire furnished and installed. Payment will be made at the Contract unit price per each. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

### 614.38 CONVERSION KITS

- A. GENERAL** - The Contractor shall furnish all labor, materials and equipment necessary to install high pressure sodium (HPS) vapor conversion kit, lamp and night watchman photo cell.

Luminaires installed shall be of wattage as specified in the Contract Documents. The conversion kit shall be installed inside a #14 or #16 casing and/or other fixture housing, with the proper size and type lamps. Installation shall include the photocell.

During the installation the Contractor shall meet the following conditions:

1. Kit is held in place by a minimum of 3 bolts.
2. Conductors are not placed in direct contact with the ballast assembly.
3. Feeder conductors and night watchman photocell lead wires are placed on terminal block or butt end crimped in the appropriate splices and taped.
4. The kit installation does not interfere with the installation and proper tightening of the globe holding devices.
5. The appropriate decal indicating the type and size will be placed on the street side of the casing.
6. The kit shall be mounted so that the lamp center is as close as possible to the center of the globe.

If necessary the Contractor shall install the fixture with streetlight monitoring wireless electronic photo control devices at locations as shown on the Contract Documents or as specified by the Engineer.

All debris generated, and material removed shall become the property of the Contractor, and be removed from the Site.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Conversion Kit will be per each conversion kit, lamp and photocell furnished and installed. Payment will be made at the Contract unit price per each. The payment for installation will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

### 614.39 GLARE SHIELD FOR ANY TYPE OF FIXTURE

- A. GENERAL** - The Contractor shall furnish and/or install internal or external glare shields for specified luminaires on pendant, upright, or other type of poles as directed by the Department.

The shield shall block lights in unintended directions, but distribute light to the intended coverage areas without diminishing the intensity or changing the photometric properties on the coverage areas. The glare shields must be Department approved. Representative drawings of glare shields are shown in the Standard Drawings.

If called for furnishing only, the appropriate glare shields shall be delivered to DC Warehouse or as directed by the Department.

If called for installation, the Contractor shall install the Department provided glare shield, in an orientation directed by the COTR. The Contractor shall transport the Department provided materials from the DC Warehouse to the Site. The shield shall be installed according to manufacturer's instructions, and shall fit the fixture properly. The Contractor shall supply any supplemental accessories to complete job.

- B. MEASURE AND PAYMENT** - There will be 2 measures and payments, one for furnishing only of the glare shield, and other for installation only.

The unit of measure for Furnish Glare Shield, Any Type will be per each glare shield delivered to the Department. Payment will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

The unit of measure for Install the Department Furnished Glare Shield, Any Type will be per each glare shield installed. Payment will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

#### 614.40 REMOVAL OF LUMINAIRES AND ARMS

- A. DESCRIPTION** - The Contractor shall remove all luminaires and arms on wood poles and luminaires on metal poles using bucket truck, after removing conductors from DC or PEPCO manhole. Removal of conductors shall be as follows:

1. Locate power source for underground conductors from a DC manhole or a PEPCO manhole for each luminaire.
2. Disconnect power from PEPCO power source before removal of conductors.
3. Remove all underground streetlight conductors from manholes.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove of Luminaire and Arm will be each. Payment for luminaire removal from wood pole will be made at the Contract unit price per each, which payment will include all labor, equipment, tools, materials and incidentals necessary to complete the Work specified herein.

No separate measure or payment will be made for the removal of light arm from steel pole, when pole itself is removed. The cost would be incidental to Pay Item for removal of the steel pole.

#### 614.41 SCHEDULE 40 PVC U-GUARD

- A. GENERAL** - The Contractor shall furnish all labor, materials, and equipment necessary to furnish and install PVC U-Guard on a wood pole owned by the District, or any other utility company as shown in the Contract Documents, or when the Contractor receives a work order from the District. The size to be installed will be stated in the Contract or on the work order.

The Contractor shall install a guard any time that he installs a service to underground street and/or alley lights fed from overhead secondary conductors, or an underground fed light installed on a wood pole. When required by the Contract Documents or the work order, the Contractor shall install a u-guard (starting from grade level) on each pole, in order to protect the feeder or service cables running along the side of the pole. The cost of all mounting hardware and concrete collars shall be included as part of this Work.

The Contractor shall furnish and install a precast concrete collar to cover the exposed PVC conduits and provide the connection between the underground conduits and the u-guard. The concrete collar should protect two 4-inch PVC conduits (or any other size as shown on the Contract Document) that carry streetlight cables. The collar should be installed such that it starts below the grade level and extends 2 inches above the grade level and maintains 1/2-inch clearance with the pole.

All debris generated as part of this Work shall become the property of the Contractor and shall be disposed of at no additional cost to the District.

The Work can involve both replacing a missing or damaged u-guard or a new installation.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Schedule 40 PVC U-Guard will be for each linear foot furnished and installed. Payment will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and all incidentals necessary to complete the Work as specified herein.

**614.42 GROUND ROD****A. DESCRIPTION**

- 1. Existing Wood Poles** - The Contractor shall inspect existing streetlight wood poles identified in the Contract Documents, in work orders or as directed by the Engineer, for the existence of an electrically sound ground system for the streetlight arm. The Contractor shall perform that within thirty (30) Calendar Days of the Project initiation. If no ground path is found, the Contractor shall notify the Engineer who may issue an approval or work order for the installation of a grounding system.

If the approval or work order is issued, the Contractor shall install a 3/4 inch x 10 foot ground rod at the base of the pole in such a way as to have a minimum soil contact of 8 feet. A #8 AWG bare copper ground wire shall be provided and connected to the rod by thermite welding. The ground wire shall be attached to the streetlight fixture with approved clamp. A 1 inch U-Guard shall be installed to protect the ground wire from grade level to a minimum of 10 feet along the pole.

- 2. Existing Manholes** - DC Manholes or manholes identified in the Contract Documents will be checked to verify the existence of a ground rod. If no ground rod is found, a 3/4 inch x 10 foot copper-clad ground rod shall be installed through the floor of the manhole in such a way as to have a minimum soil contact of 8 feet. The Contractor shall make the electrical connections in the existing DC manholes between the ground rod, neutral conductor and any ground wires using exothermic welds, and cover the welds, and exposed cables with 2 coats of insulating protectants.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Ground Rod at Existing Wood Pole or in Existing Manhole will be each. Payment for a new ground rod will be made at the Contract unit price per each. The payment will include all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

**614.43 PAYMENT TO TRAFFIC SIGNAL CONTRACTOR FOR CONNECTION AND DISCONNECTION OF TRAFFIC SIGNAL CABLES**

- A. GENERAL** - The Contractor shall make payments to the District designated Contractor for Traffic Signal cable connections and disconnections for combination streetlight and traffic signal poles. DC forces or District-designated traffic signal Contractor will perform all traffic signal cable disconnection and connection. Up to 4 visits by the traffic signal contractor may be needed per combination pole. The Contractor shall include in his bid the amount shown in the Pay Item Schedule to pay the traffic signal contractor for Work performed as required in the Contract. The traffic signal contractor will submit all invoices to the Contractor for payment. After payment has been made, the Contractor shall submit the paid invoices to the Engineer for reimbursement by the District. The District will pay the Contractor only the invoice amount.

- B. MEASURE AND PAYMENT** - The unit of measure will be lump sum. Payment will be made to the Contractor based on paid Traffic Signal Contractor's invoices. Contractor mark-up shall not be allowed.

**614.44 PAYMENT TO PEPCO FOR CONNECTION, DISCONNECTION AND INSPECTION OF SERVICE TO STREETLIGHTS**

- A. GENERAL** - The Contractor shall make payments to the Potomac Electric Power Company (PEPCO) for service connections, disconnections and PEPCO manholes entry fees. Up to 2 visits by PEPCO forces may be needed. The PEPCO manhole entry fee package will be enclosed with the Contract Documents. The Contractor must schedule his Work around 2 PEPCO manhole entries per manhole; any additional service visits will be the responsibility of the Contractor at no additional cost to the District. The Contractor shall include in his bid the amount shown in the Pay Item Schedule to pay PEPCO for Work performed as required in the Contract. PEPCO will submit all invoices to the Contractor for payment. After payment has been made, the Contractor shall submit the paid invoices to the Engineer for reimbursement by the District. The District will pay the Contractor only the invoice amount.

- B. MEASURE AND PAYMENT** - The unit of measure will be lump sum. Payment will be made to the Contractor based on the paid PEPCO invoices. Contractor markup shall not be allowed.

**614.45 ELECTRICAL JUNCTION BOX**

- A. DESCRIPTION** - Junction boxes of the sizes and types specified shall be furnished and installed as shown on the Plans. All junction boxes embedded in concrete structures shall be provided with drains. Any necessary deviation from the Plans resulting from existing grade conditions shall be done only under the direct approval of the Engineer, in which case the method of installation for the junction box shall be determined by job conditions.

At each location in the electrical cable runs where the Contractor elects to make cable splices other than those shown on the Plans or as specified, a junction box of the type indicated on the drawings for similar installations shall be furnished and installed at no additional cost to the District.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Junction Box will be each. Payment for Electrical Junction Box will be made at the Contract unit price per each. The payment will include temporary patching and maintenance of the patch, and all labor, equipment, tools, materials, and incidentals necessary to complete the Work as specified herein.

**614.46 INCIDENTAL ITEMS**

- A. DESCRIPTION** - The items described here are requirements to all works called for in this section and are incidental to the respective Pay Items.
- B. PROJECT SECURITY** - Portions of the general Project Site will be open to the public during construction. The Contractor shall take necessary measures to prevent vandalism and theft of materials, equipment, and tools, as well as the completed Work on the Project Site. The Department shall not be held liable for any loss or damage resulting there from.
- C. ELECTRICAL TEST** - The Contractor shall be responsible for furnishing all personnel and equipment required to perform the following tests and demonstrations successfully to the satisfaction of the Engineer.

Not less than 30 days prior to commencement of each required electrical test, the Contractor shall submit to the Engineer the types, styles, or catalog numbers of all testing equipment to be used for such tests. At the same time, the Contractor shall include a written certification that the testing equipment was last calibrated not more than 60 days prior to the date when such tests are performed by a testing agency, whose qualifications as such are acceptable to the Engineer.

1. **Ground Test** - Each ground rod, structure ground, and ground grid shall be measured for Earth resistance immediately after being installed, and before the ground wire is attached. If the Earth resistance measurement exceeds 25 ohms, the Contractor shall proceed as specified in 820.10. Units of measurement for reporting shall be expressed in ohms.
2. **Cable Insulation Test** - The insulation resistance shall be measured for each insulated cable, except pole and bracket cable, located in each primary feeder, secondary feeder, and distribution circuit, including duct cable used in distribution circuits. The test shall be performed on each cable of each circuit with all ballasts disconnected, and all connections to Earth grounds, including ground rods and grounding connections to light poles, disconnected. Units of measurements for reporting shall be expressed in mega ohms. The cable insulation resistance shall exceed 10 mega ohms at 60° F.
3. **Demonstration** - The Contractor shall demonstrate to the satisfaction of the Engineer that all:
  - a. Lighting and control circuits are continuous and free of short circuits.
  - b. Circuits are free from unspecified grounds.
  - c. Circuits are properly connected in accordance with applicable wiring diagrams.
  - d. Circuits are operable, which demonstration shall include the functioning of each control not less than 10 times, and continuous operation of each lighting circuit for not less than one-half (1/2) hour and/or as specified in the Special Provisions.
  - e. The Contractor shall record all faults, the method and date of correction of each, and submit a written report to the Engineer in an orderly and approved format.



- D. PAINTING ELECTRICAL WORKS** - Cleaning and painting shall be done in accordance with 707 except that primer shall be zinc-chromate alkyd type conforming to the requirements of Federal Specification TT- P-645. Painted parts shall not be loaded for shipment until paint is thoroughly dry, and in any case not less than 24 hours after final shop paint has been applied. No degree of tackiness shall be present at time of loading for shipment.

After electrical equipment installations are complete, all exposed shop painted surfaces shall be field painted with 1 coat of gray channel paint meeting requirement of Federal Specification TT-E-489C. Also, all exposed conduits, supports, and other galvanized fittings, or exposed parts thereof shall be field painted with 1 coat of zinc oxide galvanized primer paint meeting FS TT-P-641B, Type II. Before painting, all oil, grease, or white oxide shall be removed by cleaning with oil-free naphtha solvent.

- E. STRUCTURE GROUNDS** – Each bridge, wall, overhead section of guide sign structure, all non-current carrying metal parts for roadway lighting systems, and other structures having electrical elements contained therein, or attached thereto shall be permanently grounded and checked for a grounding condition.

Furnishing of all materials necessary to provide the entire structure grounding system, including ground rods complete in place, shall be included in this item. Grounding shall be accomplished as soon as materials are in place to which the grounding wires are to be attached.

Each lighting standard shall be grounded with a stranded copper wire (size as recommended by NEC and a minimum of No. 8 AWG) connecting the pole shaft to the adjacent manhole or handhole. Each conduit pipe cap inside a lighting standard shall be replaced with an insulated grounding bushing fitting. This bushing shall be bronze, threaded, and shall be provided with an insulator ring mechanical bonding wire connection.

Connections of all grounding cables shall be made with approved solderless mechanical connectors made of copper alloy with silicon bronze components.

In order to provide continuity in the grounding of conduit at light poles on bridge structures, No. 8 AWG, stranded, bare, soft drawn continuous un-spliced copper wire shall be installed between grounding lugs of each grounding bushing, and the fixture via the ground lug or bolt in the pole base. There shall be 2 feet slack at transformer base (or base of light pole). Where the Plans require the use of a raceway employing a handhole with locknuts and bushing connections, the Work shall be connected between the grounding bushings and the pole ground connection.

In order to minimize potential differences between units of a bridge structure, each unit shall be electrically tied to each adjacent unit both longitudinally and transversely with grounding cable connecting the outside girders or beams together, or as shown on the Plans. The superstructure shall be grounded with wire brazed to the Structure and connecting to the rods as shown on the Plans. The ground and bonding jumper copper wire, suitably looped, shall be installed to allow for movement of the girders. Transverse electrical ties need not be made when the lateral separation between sections of parallel bridges is 6 feet or greater. 2 coats of insulating protectants shall be applied over all exothermic welds and exposed cable.

- F. TEMPORARY LIGHTING** – All roadway construction projects within the District where the existing lighting system cannot be maintained during construction shall use temporary lighting. This lighting can be a mixture of existing poles, temporary poles for construction or parts for the new system being installed. In no case will the illumination levels be less than the existing illumination levels entering and exiting the Project limits.

During the construction, the lighting Contractor will install temporary lights according to the Department requirements and maintain all streetlights and circuits within the Project area. The light should be such that it may not produce any dark spots on the Roadways and pedestrian facilities, nor may it produce glares to motorists or house windows. If there is no electric power, or if the power is cutoff, the lighting Contractor will arrange or restore power so that there is no blackout time between dusk to dawn. Pendant poles with temporary base or wood poles may be used for temporary lighting.

#### **614.47 NAVIGATION LIGHTS**

- A. GENERAL** - The navigation lights shall be furnished and installed on bridges in compliance with Code of Federal Regulations (CFR) Title 33, Part 118 and U.S. Coast Guard (USCG) Publication “A Guide to Bridge Lighting”, and shall be subject to USCG approval. Material and workmanship shall conform to the standards of National Electrical Code (NEC) and the requirements of PEPCO. The Contractor shall furnish all labor, materials, and equipment necessary to furnish, install, and wire navigation lights complete and ready for service on structures in accordance with the Plans as shown in the Contract Documents or as directed by the Department.

The navigation lighting work and materials shall conform to the requirements of following sections of the Department Standard Specifications for Highways and Structures:

- 615: Street Lighting
- 703: Concrete for Structures
- 811: Paints, Coatings and Preservatives
- 815: Metal for Structures

No. 8 single-conductor wire (or as specified in the Contract Documents) shall be used from the service pole to the first junction box on the Structure, and No. 10 single-conductor wire (or as specified in the Contract Documents) shall be used for other wiring. All materials shall be subject to inspection and approval before installation. No changes or substitutions will be allowed without the Department's written consent.

The conduit, boxes, fittings, wiring, supports, and accessories shall be furnished and installed as shown on the plan, and required by the NEC. The approved conduit expansion joints shall be provided at each bridge expansion joint, and flexible conduits shall be used from the bridge superstructure to the substructure and in the transition areas between rigid members. All conduit connections, flexible conduits, and pull and junction boxes mounted on bridges shall be waterproof.

Navigation lights shall be installed in the manner indicated on the Contract Plans. Location and lantern color shall be in accordance with the current rules and regulations for lighting bridges, furnished the U.S. Coast Guard (USCG 33 CFR 118) requirements. Navigation lights shall also be furnished and installed in accordance with the USCG 33 CFR 118, and shall be subject to USCG approval. Navigation lights shall be watertight and weatherproof. Navigation lights shall be installed by means of steel corrosion-resistant, vibration-resistant bolts and fasteners.

The 180 degree lens shields shall be installed on all red navigation lights, and 360 degree lens shields on all green lights. The installation of lens shield and associated mounting hardware shall maintain the U.S. Coast Guard standards for visibility of navigation lighting.

If the navigation lights are required to be upgraded or redesigned on an existing bridge, the existing lights shall remain in use during the construction period. Upon Notice to Proceed, the Contractor shall become responsible for maintaining and operating the existing lights until the new lights are in operation. The Contractor shall be responsible for maintaining all circuits, switching, and power service for the existing and permanent navigation lighting until the final acceptance of the completed Work, and approved by U.S. Coast Guard.

Navigational obstructions fixtures shall be operated automatically from sunset to sunrise and at other times when visibility is less than 2000 yards. Lights shall be equipped with an automatic lamp changer with the capacity of 4 lamps and a step-down transformer to operate standard low voltage refocused lamps. Lights shall be arranged to be turned on and off automatically from sunset to sunrise. Lights shall be controlled by a photoelectric control.

- B. ELECTRICAL SERVICE** - Power will be furnished within 100 feet of the end of the bridge by 120/240 volt, single phase, 60 hertz, 3-wire service. The Contractor shall furnish and install a wood pole on which the power company will terminate its service lines. The Contractor shall install service entrance equipment on the wood pole in accordance with the requirements of SE-8. The safety switch shall be rated at 30 amps, 240 volts, 2-pole, solid neutral 120 AC, and fused for 15 amps.

Navigation lights shall be equipped with an automatic lamp changer with the capacity of 4 lamps and a step-down transformer to operate standard low voltage refocused lamps. Lights shall be arranged to be turned on and off automatically from sunset to sunrise. Lights shall be controlled by a photoelectric control mounted near the top of the service pole. Wiring shall be enclosed to and from the photoelectric control in rigid galvanized conduit.

The control shall operate a 2-pole, 30 ampere, normally opened, magnetic relay mounted in a NEMA 3R lockable weatherproof control center cabinet. A weatherproof enclosure containing a fusible disconnect switch of the appropriate voltage and ampere rating (or as shown on the Plans) shall be mounted on the service pole.

A ground rod shall be installed adjacent to the service pole. A continuous copper grounding conductor shall be installed to connect the ground rod. All metallic, noncurrent carrying materials in the lighting system shall connect to the grounding conductor. A length of approved bare copper wire shall be attached to the ground rod with suitable ground rod clamps. This wire shall be connected to the neutral and grounding conductors at the service pole.

The electrical testing will consist of continuous, nightly, automatic operation after the Contractor completes the lighting work, or until all other items in the Contract have been accepted, whichever occurs later. The wires and cables shall be inspected for physical damage, and proper connection. The Contractor shall correct any defects in materials or workmanship that occur during the testing period at his own expense.

- C. **MEASURE AND PAYMENT** - The unit of measure for Install Navigation Lighting as specified in the Contract Documents will be the lump sum. Navigation Lighting Work will be paid for at the Contract lump sum price, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work.

#### 614.48 REMOTE MONITORING SYSTEM (RMS)

- A. **GENERAL** - The Work consists of furnishing and installing the Department approved streetlight monitoring, wireless-enabled communication gateway device which gathers information from streetlight fixtures equipped with streetlight monitoring wireless electronic devices paid under separate Pay Item and sends the information to a central facility.

The Work will include installing the RMS system, establishing fully functional communications with all streetlight fixture units specified in the Contract document and further communicating the information to specified remote computers at a Department central location for monitoring and management purposes. The Contractor will procure and install all system hardware and software and configure them as necessary to achieve a fully functional system in the field and at the central location. The system will be subject to a comprehensive acceptance test demonstrating a fully functional system.

- B. **MATERIALS** – Materials shall meet the following requirements per 820.
- C. **MEASURE AND PAYMENT** - The unit of measure for Install Remote Monitoring System (RMS) will be each. The RMS Work will be paid for at the Contract unit price per each RMS device fully installed and configured. The payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work specified herein.

#### 614.49 OVERHEAD SIGN LIGHTING SYSTEM

- A. **GENERAL** - The Work consists of furnishing and installing the Department approved overhead sign lighting system as per the Department standards at locations specified in the Contract Documents, or as directed by the Engineer. Sign lighting should be placed on a track system that must be mounted at the bottom of the sign that allows all of the lights to be serviced from the side of the road. The Contractor shall provide complete sign lighting system including luminaries, track system, conduits, cables, grounding, and all other incidentals necessary to complete the Work as specified herein. If necessary, a manhole should be installed close to the sign lighting at location specified on the Contract Drawings or as specified by the Engineer, which will be paid under different Pay Items.
- B. **MEASURE AND PAYMENT** - The unit of measure for Install Overhead Sign Lighting System will be lump sum. Install Overhead Sign Lighting System will be paid for at the Contract lump sum price, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work specified herein.

#### 614.50 ELECTRICAL RECEPTACLE ON STREETLIGHT POLE FOR SEASONAL LIGHTING

- A. **GENERAL** - The Contractor shall provide electrical receptacles on streetlight poles as specified in the Contract Documents, and as directed by the Engineer. The electrical receptacle, including mounting hardware, shall be weather-proof and constructed of corrosion-resistant material. The Contractor shall submit catalog cuts and samples to the Engineer for approval before any orders are placed. The Contractor shall meet the requirements under 614.02 and the guidelines below for mounting electrical receptacles on streetlight poles.
1. **Electrical Receptacle** - The electrical receptacle shall be equipped with Ground Fault Circuit Interrupter (GFCI) protection, and shall be weather proof and rain tight rated. The Contractor shall install a locking device to prevent unauthorized use of power by another entity after the seasonal lighting is removed. All electrical receptacles installed shall be new.
  2. **Power Requirements** - The Contractor shall secure Memorandum of Agreement (MOA) with PEPCO about electric bills and payment. The MOA shall indicate the maximum allowable load (Watts), and duration of power usage. The Contractor shall submit the MOA together with approved Public Space Permit to the Department prior to the completion of the design. The design documents shall not be approved, and Contractor shall not be allowed to install electrical receptacle without the MOA. The Contractor shall be responsible to check and verify that the load connected to the electrical receptacle does not draw current higher than the rating of the wire size and electrical receptacle. The electrical receptacle shall be rated 120 Volts.

The electrical loads connected to the receptacle shall be designed such that the total voltage drop, including streetlights, does

not exceed 3 percent of the supply voltage.

- 3. Installation** - The electrical receptacle shall be installed permanently meeting the requirements of the applicable codes listed under 614.02. The Contractor shall drill 3 holes; 2 holes for mounting the electrical receptacle and one 1/2-inch diameter hole for wire entry. All holes drilled shall be treated to prevent corrosion of poles. The electrical receptacle shall be mounted 12 feet from center line of the receptacle to finish grade. The clearance requirement shall apply to #16, #18, Twin-20, and Pendant poles.

The Contractor shall install 1-#10 AWG Black and 1-#12 AWG Green, RHH-2, copper conductor rated at 600 Volts feeder cable for the receptacle. The cables shall be connected at the base of the pole, and to the terminals of the electrical receptacle. The Contractor shall provide 2 feet slack of cable. The method of splicing the cables shall meet the requirements under 615. Splicing shall not be allowed in between the termination points.

The Contractor shall be responsible for maintenance of all electrical receptacles installed, and shall remove all electrical loads after the duration of the event.

- B. MEASURE AND PAYMENT** - The unit of measure for Install Electrical Receptacle on Streetlight Pole for Seasonal Lighting will be per each. Payment will be made at the Contract unit price per each. The payment for installation will include all labor, tools, materials, equipment, and all incidentals necessary to complete the Work specified herein.

#### 614.51 GATEWAY SIGN SYSTEM

- A. GENERAL** - The Work consists of constructing horizontal District of Columbia Gateway Sign as per the Department standards at locations shown on the Contract Drawings or as specified by the Engineer. The Gateway Sign should be placed on the concrete base. The Contractor shall provide complete gateway sign system including new 120/240V electrical service pedestal on a concrete base, new horizontal gateway sign on a concrete base, electrical conduits from PEPCO power feed (manhole) to electrical pedestal, and from electrical pedestal to the signage, feeder cables, and complete grounding system including ground rod and ground cables. In case of overhead power source, the Contractor shall provide riser along with other conduits as necessary to protect the cables. Contractor shall coordinate with PEPCO for all service connections.
- B. MEASURE AND PAYMENT** - The unit of measure for Install Gateway Sign system will be per each gateway sign installed. Gateway Sign work will be paid for at the Contract unit price per each sign installed, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work specified herein.

#### 614.52 REMOVE PVC COATED RIGID STEEL CONDUIT

- A. GENERAL** - The Contractor shall furnish all labor, materials, and equipment to remove PVC coated rigid steel conduit. The Work shall include removal of designated length of the conduit and all conduit attachments and accessories. It shall also include securing and capping the adjacent portion of the conduit (if any) that remains using necessary attachments. This Pay Item shall also include removal of exposed raceway conduit.

All parts damaged by the Contractor shall be replaced by the Contractor at no additional cost to the District. Any resulting holes on the Structure shall be sealed and patched.

- B. MEASURE AND PAYMENT** - The unit of measure for Remove PVC Coated Rigid Steel Conduit will be per linear foot removed. The Contractor shall furnish all labor, materials, and equipment as described to remove PVC coated rigid steel conduit or raceway conduit of any size and as shown in the Contract Documents.

## 615 MECHANICAL WORK

### 615.01 DESCRIPTION

Mechanical work shall consist, where applicable, of furnishing, installing, testing, and placing in satisfactory operation all ventilation equipment, pumping equipment, and other equipment as specified herein and in the Contract Documents to make a complete mechanical system.

### 615.02 CODES AND STANDARDS

The materials, equipment, tests, and installations shall conform to the latest published applicable codes and standards of the organizations mentioned below:

- District of Columbia Sanitary Codes
- American Society of Mechanical Engineers
- American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., ASHRAE Guides and Data Books
- Air Moving and Conditioning Association
- Society of Automotive Engineers
- National Electrical Manufacturers Association
- American Society for Testing Materials
- Institute for Electrical and Electronics Engineers
- National Fire Protection Association
- American National Standards Institute
- Underwriter's Laboratories, Inc.
- Hydraulic Institute Test Code

### 615.03 MATERIALS

Materials for mechanical work shall be as specified in the Contract Documents.

### 615.04 SHOP AND WORKING DRAWINGS

All shop and Working Drawings relating to mechanical work shall be submitted as specified in 105.02.

### 615.05 VENTILATION SYSTEM

The ventilation system shall consist of air supply fans, forced exhaust fans, exhaust fans, motors, transmissions, duct work, and other equipment as specified herein and in the Contract Documents in strict compliance with all codes and standards cited in 615.02.

All fans and parts thereof shall be capable of satisfactorily withstanding the effect of all stresses and loads under the starting and operating conditions specified for fan motors.

In cases where fans are intended for vehicular tunnel service, the Contractor shall furnish certification that the proposed fans, motors, dampers, sound attenuators, and other ventilation system accessories that can be exposed to elevated airflow temperatures are in compliance with the high temperature requirements contained in the current edition of NFPA 502. In addition, the Contractor shall submit certification that the proposed fans and accessories comply with all relevant requirements contained in the current edition of NFPA 502.

In cases where the proposed fan provides emergency tunnel ventilation or serves critical areas such as electrical, control, and communications spaces, the Contractor shall furnish the Engineer with certified copies of the performance curves for the fans he proposes to furnish and install prior to approval of fans by the Engineer. Performance curves shall be plotted for the operation of the fan with abscissa as cubic feet per minute and ordinates as:

- Total pressure in inches of water
- Static pressure in inches
- Total efficiency in percentage
- Static efficiency in percentage
- Horsepower input to the fan
- Horsepower output of driving motor

Typical curves for fans are not acceptable for any fan that provides emergency ventilation or serves a critical area as described above. In cases where reversible fans are specified, the Contractor shall provide performance curves for both directions of fan operation.

Typical fan curves are acceptable for fans that do not serve critical areas.

In addition to fan curve, each fan shall have a brass or stainless steel nameplate showing the name of the manufacturer, type of fan, fan number, shop order number, serial number, cubic feet of air per minute, and static pressure at rated maximum operating speed. Nameplate shall be fastened on the fan with self-tapping screws.

### **615.06 PUMPING SYSTEM**

The Contractor shall furnish, install, test, and place in satisfactory operation all pumping equipment and accessories as specified in the Contract Documents or as required for a complete installation in strict compliance with all codes and standards referred to in 615.02.

The Contractor shall furnish certified characteristic curves of the pump along with other data to the Engineer for his approval of the pumps. The performance curves shall show the total head, horsepower, efficiency, and volume of water delivered for the full range from the point of no delivery to that of free delivery.

### **615.07 MOTORS**

The Contractor shall furnish and install the type and size of motors and associated equipment as specified in the Contract Documents.

The Contractor shall furnish certified performance curves before the motors are approved. Performance curves shall include the speed, starter current, power factor, efficiency, horsepower output, and kilowatt input, all plotted against torque from 50 percent to 125 percent of full load at rated voltage.

Each motor shall have a brass or stainless steel nameplate showing the name of the manufacturer, type of motor according to NEMA design, full load current, voltage, speed, temperature rise (by resistance), and service factor. Nameplate shall be fastened on the motor with self-tapping screws.

The motor conduit box and bearings shall be 1 size larger than the standard size.

Each motor shall be given the standard NEMA commercial test, and the Engineer shall be furnished, for approval, a notarized copy of such tests, before the motors leave the place of manufacture.

The Contractor shall submit certification that motors serving emergency ventilation fans can withstand elevated temperatures as defined in the current edition of NFPA 502.

### **615.08 MEASURE AND PAYMENT**

The unit of measure for Mechanical Work will be lump sum. Payment will be made at the Contract lump sum price, which payment will include the cost of all equipment, manufacturer's guarantees, tests, and all labor, materials, tools, and incidentals necessary to complete the Work.

## 616 TRAFFIC SIGNING

### 616.01 WOOD SIGN POSTS

**A. DESCRIPTION** - Work consists of furnishing, fabricating, and erecting all break-away type wood signposts, of the dimensions specified in the Contract Documents. Work also includes furnishing foundation sleeves for ground-mounted signs specified in the Contract Documents.

**B. MATERIALS**

- 822.12(C): Wood Posts
- 811.07C): Preservative
- Post Sleeves shall be 12 gauge steel, galvanized in accordance with AASHTO M 111
- 811.02(D): Primer Sealer
- Paint shall meet requirements of FS TT-P-71 and shall be tinted to match color green, No. 14109 of Federal Standard 595

**C. CONSTRUCTION REQUIREMENTS** - Sleeves shall be set as part of PCC footing work. Posts shall be cut to length and drilled or cut for the breakaway requirements as necessary, and specified in the Contract Documents and as specified in AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals prior to the preservative treatment.

Samples of posts with their preservative coating shall be submitted before erection for the written approval of the Engineer.

1. **Painting** – Post shall be given 1 complete coat of primer sealer and 1 uniform coat of green paint. Erection shall not begin until paint is dry to heavy thumb pressure. Painting of posts will not be required on posts used in work zones as temporary sign supports.
2. **Erection** – Permanent Wood Sign Posts shall be set plumb in the sleeves at the depth, and lateral position as specified in the Contract Documents. The space between rim of sleeves and projection of posts shall be carefully cleaned and filled with joint sealant meeting requirements of FS TT-S-227, Class B. Sealant shall be tool finished smooth. Backing material for sealant shall be installed as directed.

**D. MEASURE AND PAYMENT** - The unit of measure for Wood Sign Posts will be per linear foot. Payment will be made at the Contract unit price per linear foot, complete in place, which payment will include furnishing galvanized steel sleeves, sealant, cutting post tops, and incidentals necessary to complete the work. Wood Post foundations will be paid under 602.

### 616.02 METAL SIGN POSTS

**A. DESCRIPTION** - Work consists of furnishing and erecting new flanged steel channel sign posts at locations as specified in the Contract Documents or as directed by the Engineer.

**B. MATERIAL**

824.03, ASTM A 499 Grade 60: Flanged Steel Channel Posts

**C. CONSTRUCTION REQUIREMENTS** - The posts to support the specified sign shall be driven to the depth shown in the Standard Drawings. The posts shall be driven using drive caps designed for the size of posts used. The posts shall be plumbed and if more than 1 post is required per sign, the Contractor shall ensure that the distance between posts is correct to accept the pre-drilled sign.

The weight of the post shall be as specified, and shall be 2.00, 3.00 or 4.00 pounds per foot. The posts shall be painted with baked green enamel. All punching, boring, cutting or shearing shall be performed prior to painting. The posts shall be punched with continuous 3/8 inch diameter holes on 1 inch centers for the entire length of the post with the first hole 1 inch from the top.

- D. MEASURE AND PAYMENT** - The unit of measure for Metal Sign Posts will be per linear foot. Payment will be made at the Contract unit price per linear foot, complete in place, which payment will include furnishing all labor, equipment, cutting post, and incidentals necessary to complete the work.

### 616.03 GUIDE SIGN PANELS AND TRAFFIC SIGN PANELS

- A. DESCRIPTION** - Work consists of furnishing, fabricating and erecting Guide Sign Panels and Traffic Sign Panels, of sheet aluminum or of extruded aluminum, including all letters, numerals, symbols, and characters, borders, reflective sheeting, and mounting hardware. All features of the sign shall meet the requirements of the MUTCD. The locations and sign messages, and/or symbols will be as indicated in the Contract Documents. Sign supports shall be as specified in the Contract Documents.

- B. MATERIALS** – Materials shall meet the following requirements:

- 824.02, AASHTO M 268: Reflective Sheeting
- 824.04: Sheets, Plates, Angles, Z-bars, Lock Tabs, Support Angles and Panel Hardware
- 824.04, ASTM B 209: Sheet Aluminum
- 824.04, ASTM B 221: Extruded Aluminum
- 824.04: Demountable Characters and Borders, Non-demountable Characters

The Contractor shall submit manufacturer's certification in accordance with AASHTO M 290.

- C. CONSTRUCTION REQUIREMENTS** - The size of letters and messages shall be as specified in the Contract Documents. Guide sign borders shall be of the width and color specified.

Guide Sign Panels exceeding 4 square feet in area shall be fabricated of extruded aluminum sheets. Guide Sign Panels less than 4 square feet in area shall be fabricated of flat aluminum sheets. Guide Sign Panels shall meet the requirements of the MUTCD. The reflective sheeting for Guide Sign Panels shall be Type III high intensity sheeting.

Traffic Sign Panels, including regulatory and warning signs meeting the requirements of the MUTCD for color and size, shall be fabricated of flat aluminum sheets. The reflective sheeting for Traffic Sign Panels shall be Type III or Type IX as specified in the Contract Documents.

The reflective sheeting shall be free of ragged edges, cracks, and extraneous material and applied to prepared aluminum backing. The aluminum backing shall be properly prepared by degreasing, and etching, or treated according to the recommendations of the sheeting manufacturer. Sign faces comprising 2 or more pieces, or panels of reflective sheeting shall be carefully matched for color to provide a uniform appearance during daylight and darkness. Alternate successive width sections of sheeting shall be reversed and consecutive to insure that corresponding edges of sheeting lie adjacent on finished sign. Non-uniform shading and undesirable contact between adjacent widths of applied sheeting will not be permitted.

Patched sheeting shall not be permitted.

The reflective sheeting for extruded aluminum sign panels shall be the pressure sensitive type. Splicing of the sheeting will not be allowed, except splices permitted by the sheeting manufacturer. The sheeting shall be rolled over the edge of the extrusion 1/4 inch. Letters, numerals, symbols, borders, and route numbers for extruded aluminum sign panels shall be demountable copy of the specified reflective sheeting applied to properly prepared flat sheet of: 0.032 inch minimum thickness aluminum sheet of 6061-T6 alloy. Mounting shall be accomplished with aluminum blind rivets with the head painted the color of the copy, and the surface shall present a smooth surface.

The reflective sheeting for sheet aluminum sign panels shall be pressure sensitive or heat activated type. Splicing of the sheeting will not be allowed except splices permitted by the sheeting manufacturer. Splices will not be permitted on signs which are screen processed with transparent color.

Guide Sign Panels shall be fabricated from an aluminum extrusion to 0.125 inch thickness at the surface and to 0.078 inch at the walls, as per Standard Drawing 617.03.

Traffic Sign Panels shall be cut from a single aluminum sheet of 0.063 inch thickness, or as shown on the Contract Plans, and



fabricated to the size and shape shown on the Contract Plans. Sheets may be sheared, blanked, sawed, or milled; no flame cutting will be permitted. Cut edges shall be true, smooth, and free from burrs or ragged breaks, and panels shall show no deviation from flatness when examined from a distance of 20 feet. Mounting holes shall be punched or drilled.

Sign Panels shall be provided with the necessary mounting hardware, including angles on the back face at the joints to hold the abutting panels firmly and in proper alignment. All sign panel fastenings, lock tabs, and aligning angles shall be applied in such a manner as to cause a minimum of projection of the sign face. Where lock tabs are not used, end panel sections shall be provided with hook-bolted connections to horizontal stringers to keep all panel sections tightly joined, and centered horizontally on the stringers. These hook-bolt connections shall not be visible from the sign face.

Backs of sign panel sections shall be provided with suitable fasteners to permit easy attachment to the supporting zee stringers. Stringers shall be fastened to the panels with aluminum or stainless steel bolts, nuts, and washers, or with extruded aluminum lock tabs. Lock tabs shall be fastened to the sign panels by spot welding or by counter-sunk head aluminum bolts. Aluminum bolts shall be used in strict accordance with the manufacturer's recommendations, subject to the approval of the Engineer. 2 copies of the manufacturer's Specifications and instructions for the bolts, and type of aluminum used shall be delivered to the Engineer prior to use. Tubular stiffeners shall be provided with end flanges with the bolt holes where indicated on Plans. Stiffeners shall be fastened to the zee stringers with bolts through the neutral axis of the zee section web.

Where aluminum comes in contact with steel other than stainless steel, a 1/16 inch thickness approved insulating material as specified herein shall be placed between the 2 members. This material shall be used in all cases whether indicated on the Plans or not.

Field drilling of holes will not be permitted in any part of the structural assembly unless approved by the Engineer.

All welding of aluminum alloys, except spot welding, shall be performed by the inner-gas-shielded, tungsten or consumable-electrode method. Both the welding procedure and the welders shall be qualified in accordance with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, SECTION IX. 3 certified copies of the qualification test (Form Q-1, Form Q-1G and/or Form Q-1F whichever is applicable) as required by the above code, shall be properly completed and furnished to the Engineer. All welds shall be neatly formed, and shall be free from cracks, blow-holes, and other irregularities.

No field welding will be permitted on any part of the sign panel.

Legends for sheet aluminum signs shall be applied by the direct or reverse screening process. Legends shall be uniform in color, free from ragged edges, runs, drops, and other faults affecting sign appearance. Copy registration shall be accurate. The finished screened area shall exhibit uniform film thickness, hiding power, and proper color, and shall be satisfactory to the Engineer.

Alternate details may be submitted to the Engineer for approval, for structural framing and brackets needed to mount sign panels to supports.

The Contractor shall furnish, for approval of the Engineer, complete Shop Drawings for guide signs showing panel assembly, stringer size and spacing, letter size, letter and word spacing, bracket and support spacing, type and color of message components, and sign face arrangement.

All panel fabrication, including cutting and punching, or drilling of holes, shall be complete prior to metal degreasing and application of reflective sheeting. Metal panels shall be cut to size and shape, and shall be free of buckles, warp, dents, cockles, burrs, and defects resulting from fabrication. The front surfaces of all sign panels shall be flat.

All guide, regulatory, warning, or other traffic sign panels damaged as a result of the Contractor's operations, shall be restored to their original condition or be replaced by the Contractor at his own expense, to the satisfaction of the Engineer.

Prior to final acceptance of the Work, the signs will be inspected. If specular reflection is apparent on any sign, the sign panel shall be adjusted by the Contractor at his sole expense to eliminate this condition.

- D. MEASURE AND PAYMENT** - The unit of measure will be the square foot of sign panel or traffic sign mounted in place. Payment for Guide Sign Panels and Traffic Sign Panels will be made at the Contract unit price per square foot, which payment will include furnishing, fabrication, erection, mounting brackets and hardware, final sign adjustments, and all labor, tools, materials, equipment, and incidentals necessary to complete the Work.

#### 616.04 FEDERAL AID PROJECT SIGN

- A. GENERAL** - The Contractor shall furnish, erect, maintain, and remove as directed by the Engineer 1 Federal Aid Project Sign at each end of the Project under construction as shown on the detailed drawing included in the Contract Documents. Cost figures for insertion on signs, rounded to the nearest \$1,000.00, will be provided by the Engineer. The Engineer will provide the Project description and the U.S. Route number if any.

The sign shall be 3 foot x 5 foot x 3/4 inch exterior plywood, substrate smooth sanded on 1 side. The sign will be mounted on three 4 inches x 4 inches x 12 foot posts (or approved alternate) at location(s) designated by the Engineer. The sign face shall be painted with 3 coats of outdoor white enamel; sign rear with 1 coat of same enamel. Lettering shall be of silk screen enamels; black for all lettering; crimson red for the D.C. Logo. The sign shall include the Rebuilding DC logo as shown in the Contract Documents. The abbreviation of street names is not acceptable.

**B. COLORS**

- Red – Pantone 485
- Blue – Pantone 280
- Light Blue – Pantone 305
- Gray – CiCy 2, and Black over White

- C. FONTS** - Ariel Narrow Italic or Ariel Narrow Bold Italic may be used. Sizes: 180 pt., 140 pt., 120 pt. and 100 pt.

- D. ARTWORK** - Rebuilding DC Logo will be provided with the fonts outlined, EPS-JPEG Adobe Illustrator file on Mac formatted 3.5 disk or as required by the Engineer.

- E. OUTPUT** - Digitally reproduced sign. Printed or silk screened.

- F. MEASURE AND PAYMENT** - The unit of measure for Federal Aid Project Sign will be per each sign furnished for the Contract. Payment for Federal Project Sign will be made at the Contract unit price per each, which payment will include labor, materials, equipment, and incidentals necessary to furnish, erect, maintain, and remove the sign.

#### 616.05 DELINEATORS, REFERENCE POSTS AND OBJECT MARKERS

- A. DESCRIPTION** - Work consists of furnishing and installing Delineators, Reference Posts and Type I, II, III, and End of Road Object Markers as shown in the Contract Documents or as directed by the Engineer. The Delineators, Reference Posts, and Object Markers shall be installed in accordance with the requirements of the MUTCD.

- B. CONSTRUCTION REQUIREMENTS** - The Delineators, Reference Posts, and Object markers will be installed on flanged channel posts. The posts shall be driven to the correct height, and plumbed prior to installing the Delineators, Reference Posts, and Object Markers.

**C. MATERIALS**

- 824.02: Reflective Sheeting Type III
- 824.03, ASTM A 499 Grade 60: Flanged Steel Channel Posts 1.33 LB/LF

- D. MEASURE AND PAYMENT** - The unit of measurement for Delineators, Reference Posts, and Object Markers will be each. Payment will be made for each Delineator, Reference Posts, and Object Marker complete in place, and which payment includes the flanged steel channel post support and all labor, equipment, and incidentals to complete the Work specified herein.

**616.06 BREAKAWAY BASE SIGN SUPPORT SYSTEMS**

- A. DESCRIPTION** - The Work consists of furnishing and installing Breakaway Base Sign Support Systems as specified in the Contract Documents. Breakaway Base Sign Support system is shown in the Standard Drawings 620.04 and 620.06. The Contractor may submit an alternative system which meets or exceeds NCHRP Report 350, Test Level 3.
- B. CONSTRUCTION REQUIREMENTS** - The Contractor shall furnish and install Breakaway Base Sign Support Systems, including post hinge assembly units as specified in the Contract Documents, and in conformance with the manufacturer's recommendations. The Contractor shall grade the ground around the foundation as part of this Work. The Contractor shall provide the type of foundation for the Breakaway Base Sign Support System specified, and shall ensure that the foundation is trued, and at the proper dimensions to accept the support system and specified sign.
- C. MATERIALS** - Breakaway Base Sign Support Systems shall conform to the breakaway requirements specified in AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and approved by the Engineer.
- 824.03, AASHTO M 1164: STEEL AND HARDWARE
  - 817.03(A) Type F: Concrete
- D. MEASURE AND PAYMENT** - The unit of measure for Breakaway Base Sign Support System will be for each. Payment will be at the Contract unit cost for each Breakaway Base Sign Support System. A Breakaway Base Sign Support System will consist of a post, hinge assembly, base plates, and necessary hardware, and a foundation for the complete system in place. Payment also includes all labor, equipment, excavation, backfill, grading adjacent to the foundation, and incidentals to complete the Work specified herein.

**616.07 MODIFY AND REPAIR EXISTING SIGN**

- A. DESCRIPTION** - The Work consists of modifying existing sign messages, and repairing existing signs. Ground mounted and over head signs are included. Sign patching, and the replacement of demountable copy will be necessary as a part of this Work.
- B. CONSTRUCTION REQUIREMENTS** - Damage to reflective sheeting may be repaired, and the edges sealed according to the requirements of the manufacturer's recommendations. The sign patch material shall be the same type and color as the surrounding sheeting. Patching will not be permitted on any letter, numeral, arrow symbol, or border. Overlayment and demountable copy including borders that are existing, shall be removed to facilitate the installation of the new overlayment. Deformations in the sign panel shall be smoothed, and corners straightened.
- Overlayments of 3 feet or less in length shall be accomplished with 1 panel. Overlayments greater than 3 feet in length shall be accomplished with panels no less than 3 feet wide. All joints shall be tightly butted and not overlapped.
- Overlays shall be attached to the signs with aluminum rivets of a length to securely fasten the overlay to the sign panel. The rivets shall be installed in a pattern that will prevent the buckling of the panels.
- C. MATERIALS**
- 824.02, Type III or IX: Reflective Sheeting
  - 824.04: Aluminum
- D. MEASURE AND PAYMENT** - The unit of measure for Modify and Repair Existing Sign will be the square foot. Payment will be at the Contract unit cost for the square foot of sign overlayed, which payment will include furnishing, installing overlays for existing signs and all labor, equipment, and incidentals to complete the Work specified herein.

**616.08 REMOVE AND RELOCATE EXISTING SIGNS AND SUPPORTS**

- A. DESCRIPTION** - The Work consists of removing and relocating existing signs, and sign supports, as specified in the Contract Documents. Ground mounted and overhead signs, and ground mounted sign supports are included.

- B. CONSTRUCTION REQUIREMENTS** - Existing signs and sign supports will be removed, that are relocated for traffic pattern changes or during construction work. If the existing signs and sign supports are to be replaced with new signs of similar messages or a part of a sequence of signs, new signs shall be installed prior to the relocation or removal of the existing signs and supports. When the existing sign is to be replaced using the existing supports, the existing sign shall not be removed until a new sign is ready and on Site for immediate installation. The existing sign support shall be totally removed, holes and foundation cavities backfilled. The holes for flanged steel channel posts and wood posts shall be backfilled with suitable material as specified in 804. The posts shall be extracted with a minimum disturbance to the area surrounding the existing sign. The wood sign posts foundation and sleeve shall be extracted with the wood post. Foundations for breakaway base sign support systems shall be demolished to a depth of 1 foot below grade.

Existing overhead signs shall be removed and relocated, and the existing sign luminaires shall also be removed. All cable feeding the luminaires shall be removed and terminated in a manner so as to maintain service to the remaining overhead sign luminaires.

- C. MEASURE AND PAYMENT** - The unit of measure for Remove and Relocate Existing Signs, and Supports will be the square foot. Payment will be made at the Contract unit price per square foot of sign removed or relocated. Payment for relocated ground mounted breakaway sign supports for relocated signs will be paid according to 616.06. Payment will include all labor, equipment, necessary backfill, tools, and incidentals necessary to complete the Work specified herein.

## 617 IMPACT ATTENUATORS

### 617.01 DESCRIPTION

This Work consists of furnishing, assembling, and installing permanent impact attenuators at designated locations. Also included is replacement or refurbishment of damaged existing attenuator systems. The attenuator systems shall be furnished in the type and size specified, and in the locations as shown in the Contract Documents. They shall be installed according to the manufacturer's recommendations and comply with the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350, TL-3. All materials supplied with the attenuator systems shall be the same as tested, and certified in the NCHRP report, and by the Federal Highway Administration.

Shop Drawings shall be submitted according to 105.02 (B) prior to installation of the attenuator system.

### 617.02 SAND-FILLED MODULE IMPACT ATTENUATOR

**A. GENERAL** – Work consists of furnishing and installing permanent attenuators of the frangible sand-filled inertial crash cushion module type to construct arrays at proposed locations shown on the Contract Plans, or restore damaged arrays at designated existing locations.

**B. MATERIALS** – Each module shall consist of an outer container, inner core, lid and sand. The modules shall be federal yellow or as shown on the Plans. They shall be durable, waterproof, and resistant to deterioration from ultra-violet rays, deformation from dynamic loadings due to vibration in the placement area, and long-term stresses induced by thermal expansion, and contraction and fill settlement.

1. Outer containers, inner cores and lids shall be an approved type.

2. Sand shall conform to 803.01 dried to contain not more than 1 percent moisture by weight. Sand shall also contain 3 to 5 percent sodium chloride as dry rock salt by weight.

**C. INSTALLATION PROCEDURES** – Sand modules shall be installed in accordance with the following procedures and the manufacturer's recommendations:

1. **New locations** – The modules shall be placed on a concrete, or asphalt pad, or Roadway pavement in the configuration as shown on the Contract Plans. Care shall be taken to ensure that the modules are placed in the specified sizes containing the proper weight of sand. Prior to placement, circles shall be painted on the pad in the proper location with the specified weight of sand indicated in pounds.

2. **Existing locations** – In attenuator repair contracts, sand modules shall be replaced in existing installations as they are damaged by vehicle impact. Within 48 hours of notification by the Engineer, the Contractor shall commence operations for restoration of the Site. The Contractor will be provided with a sketch of the Site showing the number and orientation of the modules, and weight of sand in each module. Prior to beginning Work, the Contractor shall photograph the damaged array to verify the condition.

The Contractor shall remove all damaged modules, dirt, debris, and sand in the immediate area and dispose of these properly. Sand may be salvaged and reused if it meets the requirements of (B) (2) above. Undamaged elements may be reused for temporary locations. Reusable lids shall be used to replace missing lids on existing modules. New modules shall be installed per manufacturer's recommended procedures. To insure that installations are restored as soon as possible, the Contractor shall maintain an adequate supply of materials on hand. Unused modules and lids remaining at the end of the Contract will be purchased from the Contractor under the terms describe in Payment.

**D. MEASURE AND PAYMENT** – The unit of measure will be per each. The total will be the number of new modules installed in new permanent locations and/or used to replace damaged modules in existing installations.

Payment for this item will be made at the Contract unit price per each, which payment will include furnishing and installing new modules, removal and disposal of damaged modules, dirt, debris, sand, and all labor, tools, equipment, and incidentals required to

complete the specified Work.

In replacement contracts, unused modules remaining after the conclusion of the Project will be purchased from the Contractor under the terms in Payment. Unused and undamaged modules paid for under this item will become the property of the District and be delivered to a designated storage yard. Installation of reusable lids is considered to be incidental work and allowances should be made when preparing bid price for sand modules.

### 617.03 QUAD BEAM IMPACT ATTENUATOR

- A. GENERAL** - Work under this item consists of furnishing, assembling, and installing Quad Beam Impact Attenuator systems of the size, and of the type specified in the Contract Documents, complete in place at the locations shown on the Contract Drawings. The Quad Beam Attenuator systems shall be installed according to the manufacturer's recommendations and in compliance with the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350, TL-3.

The Quad Beam Impact Attenuator shall be installed on a PCC pad of the size indicated on the manufacturer's drawings and shown on Standard Drawing 627.06.

- B. MATERIALS** - Each Quad Beam Impact Attenuator shall contain all external and internal parts necessary to give satisfactory service at the indicated Site.

Components shall meet the following requirements:

- 1. Cartridges** – The energy absorbing cartridge boxes shall be of the number and arrangement indicated by the manufacturer for the intended application. Cartridge boxes shall be manufactured from a weather resistant plastic material. Cartridges boxes are of 2 types. 1 type shall contain paper honeycomb material, and the other type of cartridge box shall contain steel honeycomb material which shall be coated to minimize the effects of corrosion.

Each bay of the attenuator shall contain cartridge support brackets.

- 2. Diaphragms** – Diaphragms shall be made from 10 gage ASTM A 36 M steel quadruple corrugated beam. The length of each diaphragm shall be as required for each application. 2 support legs shall be welded to channel which, in turn, shall be welded to the quadruple corrugated beam. Ski shaped plates shall be welded to the bottom of the support legs. The diaphragms shall be designed to lock onto, and be guided by, an anchored and mounted support structure.

After fabrication, the diaphragms shall be hot dip galvanized in accordance with AASHTO M 111.

- 3. Fender panels** – Fender panels shall be fabricated from 10 gage steel quadruple corrugated beam guide rail sections. Each fender panel shall be drilled and slotted so that when assembled in the field, the front end shall be bolted to a diaphragm by means of the 3 horizontally placed 16 mm bolts, one of which shall be a "mushroom bolt." The back end of each quadruple corrugated beam fender panel shall overlap and be connected to the fender panel of the next bay by means of mushroom bolts, which shall fit through the long horizontal slot in the forward fender panel, and the short vertical slot in the overlapped fender panel. (The bolt shall have a nut and square washer on the inside.) This permits movement, front to back, of 1 set of fender panels relative to the panels in the following bay.
- 4. Nose wrap** – The nose wrap shall be made of cross-linked, high density polyethylene molded to match the quad beam. It shall offer substantial yielding yet possess strong ability to recover to its original molded shape.
- 5. Backup** – If a concrete back-up structure is not to be provided, a tension strut back-up assembly shall be provided. The details of this assembly shall be as indicated in the manufacturer's or Working Drawings.
- 6. Hazard marker** – A hazard marker shall be wrapped around and securely attached to the nose of the attenuator facing oncoming traffic. The material shall be 0.025 gauge aluminum sheet, and the legend shall be made from Type III High Intensity Reflective Sheeting.
- 7. Metal** – All metal shall be AASHTO M 183 unless otherwise specified and galvanized per AASHTO M 111.

Fasteners – American Standard Regular Bolts, unless indicated otherwise in the Contract Documents.

Anchor bolts shall be ASTM A 193 grade B7 grouted into the concrete pad with non-shrink grout.

- C. **CONSTRUCTION REQUIREMENTS** - Installation of the attenuator shall be accomplished by the Contractor with experienced workers in accordance with the recommendations of the manufacturer.
- D. **SHOP DRAWINGS** - Before fabricating the unit, Shop Drawings shall be submitted for approval by the Engineer.
- E. **MEASURE AND PAYMENT** - The unit of measure for Quad Beam Impact Attenuator will be per each unit installed, complete in place. Payment for Quad Beam Impact Attenuator will be made at the Contract unit price per each, which payment will include fabricating, furnishing, assembling, PCC pad, concrete back-up structure, and installing the units, and all labor, tools, materials, equipment, and incidentals needed to complete the specified Work.

## 618 EROSION AND SEDIMENT CONTROL

### 618.01 DESCRIPTION

This Work shall consist of installing temporary measures to control soil erosion and sediment through the use of swales, dikes, sediment basins or traps, berms, silt fences, dams, paved chutes or flumes, riprap, slope drains, fiber mats, netting, gravel, mulches, grasses or other devices, or methods throughout the duration of the construction. Permanent control provisions, contained in the Contract shall be coordinated with the temporary control provisions to the extent practical to assure economical, effective, and continuous control throughout the construction and post-construction periods.

The District of Columbia Department of Transportation has adopted the D.C. Department of Health, Environmental Health Administration, Bureau of Environmental Quality Watershed Protection Division "Storm Water Management Guide book" and "Standards and Specifications for Soil Erosion and Sediment Control". All Work described herein shall be performed in strict conformance with the requirements specified in the above referenced manuals, of Best Management Practices, and of Sections I (Temporary Structural Practices), and II (Permanent Structural Practices) as applicable of the DCRA Standards and Specifications, and in accordance with the erosion control regulations in the current Title 21 of the D.C. Municipal Regulations (DCMR 21, Chapter 5). Latest copies of these referenced publications are available, from the Department of Consumer and Regulatory Affairs, One-Stop Permit Office.

### 618.02 CONSTRUCTION REQUIREMENTS

Erosion and Sediment Control drawings and details, if included in the Contract Plans, may be used by the Contractor without submitting them for approval. If they are not part of the Contract Plans, or if the Contractor wishes to use an alternate approach, Plans, details along with a written proposal and schedule for accomplishment of soil erosion and sediment control work shall be submitted to District of Columbia, Department of Health, Environmental Health Administration, Bureau of Environmental Quality Watershed Protection Division through the Department of Consumer Regulatory Affairs Office for approval. No Work on land disturbing activities shall be started without the approved Plans, and until the control Plans, schedules, and methods of operation have been reviewed and approved by the Engineer.

The Engineer has the authority to limit the surface area of erodible Earth material exposed by clearing and grubbing, and by excavation, borrow and fill operations. The Engineer may direct the Contractor to provide immediate permanent or temporary control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment, and to prevent damaging erosion or sediment deposits on neighboring lands. Such work may involve the construction of interim berms, dikes, dams, sediment basins, and slope drains, and use of interim mulches, mats, seeding, or other control devices or methods, as necessary to control erosion and sedimentation. Fill and cut slopes shall have approved silt fence, and be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable. In some instances, incremental heights of slopes for sequential seeding and mulching will be specified.

The Contractor shall be required to incorporate all permanent erosion and sediment control features into the Project at the earliest practicable time as outlined in his approved schedule. Temporary erosion and sediment control measures will be used as needed to correct conditions that develop during construction that were not foreseen during the design stage; as needed prior to installation of permanent control features; and as needed temporarily to control erosion or sedimentation that develops during normal construction practices, but are not associated with permanent control features on the Project.

Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations, and permanent erosion and sediment control features can follow immediately thereafter if the Project conditions permit; otherwise, temporary control measures may be required between successive stages. Under no conditions shall the surface area of erodible Earth material exposed at one time by clearing and grubbing exceed 50,000 square feet without approval of the Engineer. The limitation will apply to clearing operations only unless exempted by the Engineer.

The Engineer will limit the area of excavation, borrow, and Embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent erosion and sediment control measures current in accordance with the approved schedule. Should seasonal limitations make such coordination unrealistic, temporary control measures shall be taken immediately to extent feasible and justifiable.

Under no conditions shall the amount of surface area of erodible Earth material exposed at one time by excavation, borrow, or fill within the Right-of-Way exceed 50,000 square feet without prior approval by the Engineer. This is in addition to the limitation on clearing and grubbing previously set forth.



The Engineer may increase or decrease the surface area of erodible Earth material to be exposed at one time by clearing and grubbing, excavation, borrow, and fill operations as determined by an analysis of Project conditions. The Roadbed area will be included in the surface area limitations if Site conditions are judged to be unfavorable by the Engineer. Erosion and sediment control measures shall be required on construction work outside the Right-of-Way where such work is necessary as a result of roadway construction. Included are borrow pit operations, haul roads and equipment storage sites within the District of Columbia.

The erosion and sediment control features installed by the Contractor shall be acceptably maintained by the Contractor until accepted by the District.

In the event of conflict between these requirements and laws, rules, or regulations of other Federal, State, or local agencies, the more strict laws, rules, or regulations shall apply.

The Contractor shall be fined \$500.00 per day/per occurrence for failure to provide and/or properly maintain approved erosion and sediment control, as determined by the Engineer.

### **618.03 MEASURE AND PAYMENT**

When Erosion and Sediment Control is listed as an item in the Pay Item Schedule, the unit of measure will be lump sum. No direct measure will be made whether or not the Work is listed as a Pay Item. Payment for Erosion and Sediment Control, when it is listed as a Pay Item, will be made at the Contract lump sum price, which payment will include all labor, materials, tools, equipment, and incidentals necessary to complete the Work as specified herein. Also included is the removal and disposal of all materials, and restoration of the affected areas to the satisfaction of the Engineer.

When Erosion and Sediment Control is not listed as an item in the Pay Item Schedule, no direct payment will be made and the cost of meeting the requirements of this Work shall be reflected in and distributed among the various Contract Pay Items.

Temporary erosion control measures required due to Contractor negligence, carelessness, or failure to install permanent controls as scheduled shall be at the Contractor's expense.

The Engineer reserves the right to employ outside assistance, or to use District forces to provide needed erosion control measures if the Contractor fails to do so. Such incurred direct costs plus Project engineering costs will be charged to the Contractor.

## 619 ANTI-GRAFFITI COATING

### 619.01 DESCRIPTION

This section includes surface preparation and field application, of the anti-graffiti coating to the surfaces scheduled and the removal procedure of graffiti from the anti-graffiti coating.

### 619.02 MATERIALS

#### A. ANTI-GRAFFITI COATING MATERIALS

1. Coatings shall meet requirements of the following:
  - ASTM B 117 and ASTM D 714 (salt spray minimum acceptable of 8000 hours).
  - ASTM D 530 (hardness)
  - ASTM D 412 (tensile strength and elongation)
  - ASTM D 522 (pass 3/8 inch mandrel)
  - ASTM 968 (abrasion test)
  - ASTM E 96 (vapor transmission)
  - Water clear, non-yellowing, free of waxes and urethanes.
  - Shall allow moisture vapor transmission.
2. Primer/clear base coat shall be a water-based high performance under coating used as sealer and shall be water repellent capable of blocking penetration of water. Intermediate coats shall be capable of adding coating adhesion to substrate.
3. Top coatings shall be two part A and B permanent anti-graffiti top coating.
  - a. Clear finish shall be clear flat [flat is defined as the finish of the top coating reading less than five degrees on a Gardner Gloss Meter] or clear semi-gloss or clear gloss.
  - b. Pigmented finish shall be pigmented flat or pigmented semi-gloss or pigmented gloss.
4. Graffiti Remover shall be non-flammable, biodegradable, with a pH 7 - 8.5 and recyclable, allowing graffiti removal without the use of blasting equipment, hot water, or high pressure wash equipment.

#### B. PRODUCT CERTIFICATION - The following information shall be submitted as a complete package for approval for each coat in the system selected at least two months prior to the anticipated beginning of painting operations, as applicable to the coating system specified for the Project:

1. Technical data sheets, application instructions, and material safety data sheets for each coat shall be submitted by the Contractor per the requirements of this section for review and approval from the Engineer
2. A color chip of the finish coat, of minimum size 4 inches by 6 inches
3. Volatile organic compounds, measured in pounds per gallon
4. All products, including water repellents, adhesive promoters, base coats, top coats and removal agents for the complete system shall be supplied by the same manufacturer and shall be certified as compatible.
5. All products shall be packaged in substantial containers with each bearing a label on which shall be precautions for use. Each container shall contain the date of manufacturer, the batch number and the product designation.
6. The Contractor shall supply detailed written instructions from the coating manufacturer on repair procedures, including surface preparation, repair primer, repair intermediate coat, application methods, and any time restrictions. No Work will be allowed until these written procedures are submitted to the Engineer.

The written procedures shall be followed.

7. The manufacturer shall have a technical service representative on hand to assist the Contractor the first time that these products are used by the Contractor.

**C. LABELING AND PACKAGING**

1. All containers shall be listed in accordance with ANSI Standard Z129.1.
2. Label Requirements – The following information shall be listed in clear, legible type on the label of each container, for each product.
  - a. Product name including component type if applicable.
  - b. Color name or number of the particular product and component.
  - c. The lot number or batch number of the product and component.
  - d. The date of manufacturer of the product and component.
  - e. The manufacturer's name and complete address.
  - f. Shelf life expiration date.
3. Summary mixing instructions shall be listed on the label of each component or reference the appropriate component which lists the mixing ratio.
4. Any materials hazardous according to OSHA/EPA regulations shall be listed on the label if they exist in the product in amounts greater than one-tenth of a percent (0.1%) if carcinogenic.

**619.03 JOB PERFORMANCE**

- A. GENERAL** - The coating of new or existing substrates with the anti-graffiti system work shall include complete preparation of the substrates, application and protection of the drying anti-graffiti coatings, protection of workers and the environment and furnishing all labor, materials, tools, scaffolding and other equipment, and incidentals necessary for proper execution of the Work.

Elements (concrete, metal and other surfaces as determined by the Engineer) to be coated shall be indicated on drawings and or as directed by the Engineer.

- B. CAPABILITY OF WORKERS** - All field coatings shall be performed by a Contractor or a subcontractor certified by the Anti-Graffiti Coating manufacturer.

The manufacturer's certification shall be submitted to the Department as part of the required submittals for this work. Failure to provide the required manufacturer's certification(s) shall be grounds for disqualification of the coating Contractor.

**C. WEATHER CONDITIONS FOR SURFACE PREPARATION AND ANTI-GRAFFITI COATING APPLICATION**

1. Without exception, no outdoor or field coating shall be performed if the ambient, surface and material temperature is below 45°F, or above 95°F without prior written approval of the Engineer, and the manufacturer.
2. Surface preparation shall not be performed when the steel surface is below 45°F, within 5°F of the dew point or when anticipated weather conditions would preclude application.
3. Should the manufacturer's requirements for a particular material be more stringent than this specification, the manufacturer's requirements shall prevail. Application of coatings outside of normal temperature and humidity recommended ranges as established by the manufacturer shall be rejected as not meeting this specification.

- D. PAINTING SCHEDULE AND CONTRACTOR'S SUBMITTALS** - Before any coating operations begin the Contractor shall submit in writing to the Engineer his proposed work schedule which shall include:

1. A systematic procedure or plan for coating operations
2. A written program for worker protection
3. The type and method of protection against spatters drippings, and other disfiguring elements while coating over roadways, waterways and areas in vicinity of abutments and piers
4. The Contractor shall provide adequate, portable lighting equipment in fully functional condition, of a design approved by the Engineer, and at no cost to the Department, to supply adequate illumination to the underside of structures while coating and for any inspection.

**E. INSPECTION**

1. All Work shall be inspected by authorized personnel representing the manufacturer. As each operation (each coat of Anti-Graffiti) is completed and prior to any succeeding operation on a section, the Contractor shall notify the manufacturer's representative for approval before the beginning of the next operation. The Engineer shall have final inspection approval.
  2. Any Work not meeting approval of the manufacturer's representative shall be rejected and redone until it meets their approval. The method of correction shall be approved by the manufacturer's representative prior to proceeding. Should any Work be done which proceeds past the point where manufacturer's representative approval is required, the Contractor shall, at the option of manufacturer, remove said Work back to that point at no additional cost to the Department. The Contractor shall correct Work or replace material which is found defective. The method of correction shall be approved by the manufacturer's representative.
  3. Cleaning and surface preparation of each section shall be entirely completed and accepted before coating commences in that section. All coats shall be suitably dry throughout a full section and accepted before any succeeding coat of coating is applied in that section. Any coating applied without the prior approval of the manufacturer's representative to begin coating shall be removed as directed by the manufacturer's representative. This corrective Work shall be at the sole expense of the Contractor.
  4. When surface preparations are complete, surfaces shall be checked for cleanliness. Cleanliness shall meet the job sample previously established.
  5. Dry coating film shall be randomly measured for thickness, and shall be inspected for non-uniform areas, holidays, runs or sags. Areas not meeting specification requirements shall be corrected to the satisfaction of the manufacturer's representative.
  6. On masonry substrates a destructive test shall be performed.
  7. Two (2) thermometers for measuring the surface temperature of substrates will be supplied by coating contractor. Upon completion of the Contract, the equipment shall remain the property of the Contractor.
  8. Additional methods and equipment may be used for inspection procedures by and at the discretion of the manufacturer's representative.
  9. The Contractor shall furnish all necessary apparatus such as ladders, scaffolds, platforms and lighting as required for the inspector to have reasonable and safe access to all Work for inspection. Rigging shall meet OSHA requirements.
- F. REPAIRS** - All defective or damaged areas shall be repaired, at the Contractor's expense. Said areas shall be coated with the full system as required in these specifications. Repair may be limited to touch up of damaged areas but in no way shall the number of coats, the required coating system, or the dry film thickness of each coat be modified because of the repair procedure. Should an area be damaged through to the substrate, said area shall receive the specified degree of surface preparation as well as the full coating system as a repair remedy.
- G. MAINTENANCE AND PROTECTION OF HIGHWAY AND PEDESTRIAN TRAFFIC AND ADJACENT PROPERTY** - The Contractor shall be responsible for any disfigurement by splatters, smirches and splashes of coatings on vehicular traffic and pedestrians, adjacent property and on any portion of the structure or area under the structure. The Contractor shall also be responsible for damage to the structure and adjacent property through the use of scaffolding and other equipment. Proper drop cloths shall be required to minimize splatters of coatings on concrete surfaces. Any damage or disfigurement shall be replaced or cleaned at the sole expense of the Contractor.

**619.04 ENVIRONMENTAL PROTECTION****A. PROTECTION OF WORKERS AND THE ENVIRONMENT**

1. Protection of workers and of the environment shall be provided by the Contractor as an integral requirement of the performance of the Work. The Contractor shall employ the best current methodology for protection of the worker/employee and the environment by containment of all hazardous material in consideration of the following:
  - a. The release of volatile organic compounds (VOC's) and isocyanates during painting.
  - b. Protection of workers to prevent exposure to hazardous waste, VOC's, isocyanates, and any other compound deemed hazardous by the jurisdictional agencies.
  - c. U.S. Environmental Protection Agency (EPA), U.S. Occupational and Health Administration (OSHA), and District of Columbia Department of Health (DOH) requirements and guidelines pertaining to all of the above.

The VOC regulations on bridge projects in the District of Columbia are subject to the Federal Rules for National Volatile Organic Compound Emissions Standards for Architectural Coating, published September 11, 1998 by the Environmental Protection Agency, and its subsequent amendments. The D.C. Department of Transportation will not restrict the application of coatings for architectural, industrial and maintenance purposes on bridge structures to the limits of Section 700 of 20 DCMR. Coatings and paints with VOC contents that comply with the Federal Standards would not be subject to the limits of Section 700, 20 DCMR.

The Contractor shall obtain all recent Federal Regulations and shall follow the restrictions therein for painting operations. The Contractor, with the assistance of the D.C. Department of Transportation, shall obtain a permit from DOH to engage in blast cleaning and painting operations.

Applicable portions of DCMR Title 20 Section 605 are as follows:

*700 ORGANIC SOLVENTS*

The Contractor is encouraged to minimize organic solvents discharged by using low VOC rated coatings for the specified paint system. It is recommended that the Contractor obtain a complete copy of 20 DCMR prior to preparation of bids. Publications may be purchased by mail or in person from:

D.C. Office of Documents and Administrative Issuances

- B. CONTRACTOR'S METHODS** - The methods proposed by the Contractor shall be approved by the Engineer before Work may proceed. Approval by the Engineer does not relieve the Contractor of any responsibility for meeting all Federal, State and local regulations on air quality, water quality, hazardous materials, hazardous waste, public health or the laws of any regulatory agency.
- C. MEETINGS** - The Contractor, with the Engineer in attendance, shall hold meetings to inform all workers of the potential safety and health hazards of this Work and what steps are being taken to reduce the risk of contamination, and to give instructions in the use of protective equipment. The protection of the workers and the environment and the recovery, transportation and disposal of hazardous waste shall be of the utmost importance.

#### **619.05 COATING SYSTEMS**

- A. DESCRIPTION** - The Anti-Graffiti Coating system shall be a non-sacrificial permanent coating, consisting of primer/base coat (if required by manufacturer), intermediate coat(s) (if required by manufacturer) and top coat. The base coat shall be a transparent/clear coating, the top coat shall be available in a transparent/clear coating and available in a fully pigmented coating and available in dead flat, semi-gloss, and gloss finishes; the colors and sheen to be selected by the Engineer. The top coat shall be a two part A and B system.
- B. QUALITY ASSURANCE**
  - 1. **Applicator Qualifications:** Engage manufacturer to provide a manufacturer's certified applicator who has completed anti-graffiti coating system applications similar in material and extent to those indicated for Project, and whose work has a record of successful in-service performance.
  - 2. **Source Limitations:** Obtain base coatings, top coatings, and removal agent from the same manufacturer.
- C. ANTI-GRAFFITI PERFORMANCE REQUIREMENTS** - Anti-graffiti coatings shall comply with the following:
  - 1. Permanent coating system. Coatings shall not require re-application regardless of number of graffiti taggings. Coatings shall have capability of being applied to multiple surfaces (metals, masonry, concrete).
  - 2. Show no signs of deterioration or change of appearance after graffiti removal; no ghosting staining or shadowing.
  - 3. Capability of removing 100% of all types of paint and graffiti materials from treated surfaces without damaging the coating or the substrate.
  - 4. Upon graffiti removal, no evidence of graffiti shall remain.
  - 5. Capable of withstanding a minimum of 120 cleaning cycles over the same area without measurable coating deterioration.
  - 6. Shall not increase dirt pick-up of substrate.
  - 7. Meet the following test results for the following chemicals:

- |                        |                        |
|------------------------|------------------------|
| a. MEK                 | No effect after 5 days |
| b. Carboxylic Acid     | No effect after 5 days |
| c. 75% Phosphoric Acid | No effect after 5 days |
| d. 37% HCL             | 3 hours blister        |
| e. 50% Sulfuric Acid   | No effect after 5 days |
| f. 20% NIT             | 68 hours blister       |

**D. GRAFFITI REMOVER** - The Contractor shall provide graffiti remover from manufacturer of the anti-graffiti coating system to the Department at a rate of 5 gallons of graffiti remover per every 5,000 square feet of anti-graffiti coating installed. Package graffiti remover material in unopened, factory sealed containers identified with labels describing the contents. Acceptable container sizes shall be 55 gallon drums, 5 gallon pails, 1 gallon pails, or cases (12 or 16 ounce bottles).

#### 619.06 SURFACE PREPARATION

Prior to application of each coat, the surfaces to be painted shall be cleaned as necessary so as to be dry and free of dirt, grease and oil or any other contamination.

#### 619.07 GENERAL REQUIREMENTS FOR PAINT APPLICATION

- a. **STORAGE AND PREPARATION OF PAINT** - All paint shall be stored, mixed, and applied in accordance with the manufacturer's recommendations. In cases when the manufacturer's recommendations differ from the requirements specified herein, those which are more stringent shall govern. In cases where manufacturer's recommendations are more lenient than the requirements in this specification, they shall govern only if specifically authorized by the Engineer. All paint shall be mixed as recommended by the manufacturer.

All paint shall be used directly from original shipping containers without any additions or thinning except manufacturer's water repellents/silane/siloxane series.

Sealers as directed by Manufacturer shall be clear: All ingredients in any container of paint shall be thoroughly field mixed before use and agitated often enough during application to keep the pigment in suspension paint first shall be mixed in the original container and not transferred until all settled pigment is incorporated into the vehicle. However, a portion of the vehicle may be poured off temporarily to simplify mixing.

#### B. APPLICATION METHODS

1. **Airless Spray Application** - The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The equipment shall be maintained in proper working condition. Paint ingredients shall be kept uniformly mixed in the spray pots or containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary. Fluid tips shall be of proper orifice size and fan angle, and the fluid control gun of proper construction, as recommended by the manufacturer of the material being sprayed and the equipment being used. Fluid tips shall be of the safety type with shields to prevent penetration of the skins by the high pressure stream of paint.

The air pressure to the paint pump shall be adjusted so that the paint pressure to the gun is proper for optimum spraying effectiveness. This pressure shall be sufficiently high to properly atomize the paint. Pressures considerably higher than those necessary to properly atomize the paint should not be used.

Spraying equipment shall be kept clean and shall utilize proper filters in the high pressure line so that dirt, dry paint, and other foreign material are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint.

Paint shall be applied in a uniform layer with overlapping at the edges of the spray pattern. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke. All runs and sags shall be brushed out immediately or the coating shall be removed and the surface repainted.

Paint shall be suitable for the particular spray application method used. Particular care shall be observed with respect to paint temperature and operating techniques in order to avoid deposition of paint which is too viscous, too dry, or too thin. Airless

paint spray equipment shall always be provided with an electric ground wire in the high pressure line between the gun and the pumping equipment. Further, the pumping equipment shall be suitably grounded to avoid the build-up of any electrostatic charge on the gun. The manufacturer's instructions shall be followed regarding the proper use of the equipment.

2. **Brush Application** - Brushes shall be of a style and quality that will enable proper application of coatings. The brushing shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. Coatings shall be worked into all crevices and corners where possible. All runs or sags shall be brushed out. There shall be a minimum of brush marks left in the applied paint. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskins.
3. **Roller Application** - Roller application may be used on flat or slightly curved surfaces and shall be in accordance with the recommendations of the paint manufacturer and roller manufacturer. Paint rollers shall be of a style and quality that will enable proper application of paint having the continuity and thickness required. Roller application shall not be used on irregular surfaces.

- C. **CLEAR ANTI-GRAFFITI COATING APPLICATIONS** - Prior to the application of the top finish coat (s) a determination must be made by the manufacturer's representative concerning the base coatings required on the substrate (metals, masonry, concrete, etc).

**Step 1** - Apply water repellent and or adhesion alternatives to all masonry substrates (If required by manufacturer).

**Step 2** - Apply primer/ base coat (barrier coat) to create a pin-hole free substrate. Primer/base coat shall be strained through a bucket strainer. Any solid material captured in the straining process should be reintroduced to the material by squeezing through the strainer. Strain 5 to 7 times. Apply primer/base coat with an air-less sprayer equipped with a 5-17 tip. When applying the base coat, ensure that enough material is applied so that there is a bluish hue to the substrate. This ensures (per coat) that enough of the primer/base product has been applied to the substrate. Back roll only to remove bluish hue, do not over work base coat. If second coat is required repeat the process only after first coat has dried leaving the substrate in its original aesthetic form (wet-look to be gone).

**Step 3** - Apply top coat over primer/ base coat no sooner than 24 hours and no longer than 48 hours after primer/base coat application.

- A. Prior to the application of the top coat(s), a determination must be made concerning the primer/ base coatings required on the substrate.
- B. Once step A is complete, mix top coat part A to ensure proper solution uniformity. Some solids in part A may settle which need to be thoroughly mixed into a homogenous mixture before the introduction of the part B component.
- C. Pour contents of the part B component in the container of part A. Mix components for 3 to 5 minutes by drill blade at a slow steady pace until a homogeneous solution is achieved.
- D. Apply one coat of top coat solution in a crosshatch pattern. One vertical pass and one horizontal pass are considered crosshatching and are considered one coat. When spraying, keep the spray gun 10 to 12 inches from the substrate and the application pressures just high enough to create an efficient fan. High pressure will result in over atomization of the product, possibly having negative effects, a reduced trans efficiency rate, and create unnecessary amount of over spray. Make sure to overlap the previous pass by 40% -50%. This will eliminate flash line and improve appearance. Back rolling of all coats of the top coat may be necessary.
- E. After step D, allow coating to dry to the touch, yet still tacky, then apply second coat of finish coat if necessary.
- F. Top coat should be applied at a 3.5 mils - 4.0 mils dry (7.0 - 9.0 mils, wet) per coat to achieve optimal performance.

Do a test sample prior to application. The test sample will confirm appearance, compatibility coverage, and color. A sign off and approval sheet shall be completed prior to final application.

Allow Top Coat to cure for minimum of 7 days prior to removal of graffiti.

- D. **PIGMENTED ANTI-GRAFFITI COATING APPLICATIONS** - Prior to the application of the top finish coat(s) a determination must be made by the manufacturer's representative concerning the base coatings required on the substrate (metals, masonry, concrete, etc).

**Step 1** - Apply water repellent and or adhesion alternatives to all masonry substrates. (A block filler compatible with solvent based top coat may be required).

**Step 2** - Apply block filler compatible with solvent top coat as needed to create a pin-hole free substrate.

**Step 3** - Apply pigmented top coat a minimum of 24 hours after primer/base coat application.

- A. Prior to the application of the top coat(s) a determination must be made concerning the primer/ base coatings required on the substrate.
- B. Once step A is complete mix top coat part A to insure proper solution uniformity. Some solids in part A may settle which need to be thoroughly mixed into a homogenous mixture before the introduction of the part B component.
- C. Pour contents of the part B component in the container of part A. Mix components for 3 to 5 minutes by drill blade at a slow steady pace until a homogeneous solution is achieved.
- D. Apply one coat of mixed solution in a crosshatch pattern. One vertical pass and one horizontal pass are considered crosshatching and are considered one coat. When spraying, keep the spray gun 10 to 12 inches from the substrate and the application pressures just high enough to create an efficient fan. High pressure will result in over atomization of the product, possibly having negative effects, a reduced trans-efficiency rate, and create unnecessary amount of over spray. Make sure to overlap the previous pass by 40% -50%. This will eliminate flash lines and improve appearance.
- E. After step D, allow coating to dry to the touch, yet still tacky, then apply second coat of finish coat if necessary.
- F. The pigmented top coat should be applied at a 3.5 mils - 4.0 mils DMT (7.0 - 9.0 mils, WMT) per coat to achieve optimal performance.

Do a test sample prior to application. The test sample will confirm appearance, compatibility coverage, and color. A sign off and approval sheet shall be completed prior to final application

Allow pigmented top coat to cure for minimum of 7 days prior to removal of graffiti.

Mixing in open containers shall be done in a well-ventilated area away from sparks or flames. All varsol, turpentine and any other solvents shall be stored at least 300 feet away from any paint being stored in previously opened containers, paint being mixed, and paint operations. Any paint which becomes mixed or contaminated with any such varsol, turpentine, solvents, or any other foreign substance shall be rejected on this basis alone and immediately removed from the Work area to the satisfaction of the Engineer.

## **619.08 MEASURE AND PAYMENT**

The unit of measure for Anti-Graffiti Coatings will be per Square Foot.

Anti-Graffiti Coatings will be paid for at the Contract unit price per Square Foot for the accepted items in the Schedule of Prices, which payment will include all cleaning and preparation of the surfaces, application and protection of drying coats, repair of damaged or unsatisfactory coats, application of substrates, protection of all portions of structure or structures against any disfigurement and against any physical damage, protection of and access to adjacent property, environmental protection, and furnishing all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.



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## 701 PILING

### 701.01 DESCRIPTION

Work shall consist of furnishing, driving, cutting off and load-testing of piles of the type and dimensions specified on the Plans.

Piles shall be of timber, precast reinforced concrete, precast prestressed concrete, cast-in-place concrete with steel casing or steel H-beam, as specified, constructed and driven in accordance with these Specifications, and as indicated on the Contract Documents or as directed by the Engineer.

### 701.02 MATERIALS

Materials shall conform to the following requirements:

- 816: Piles and splices shall also be as indicated on the Contract Documents
- 817: Concrete
- 812.02: Reinforcement

Prior to driving any pile, the Contractor shall submit written certification from the manufacturer that the materials meet the requirements of the Specifications. Certified mill test reports shall be submitted for steel piles.

### 701.03 PREPARATION FOR DRIVING

- A. In areas where piles are to be driven and excavation or embankment construction is to be performed, the excavation or embankment shall be completed before the driving of piles begins.
- B. When piles are located in embankment fill 5.0 feet or greater in depth, an augured hole through the Embankment will be required for each pile location. The augured hole shall not be carried into the original material beneath the Embankment construction. Holes shall be drilled with a power auger. Holes shall be clean and equal to or slightly larger than the maximum cross-sectional dimension of the pile. If left overnight, holes must be protected or be re-augured the following day. Augured holes shall be filled with sand or other suitable material after driving piles.
- C. The Contractor shall supply a stable reference elevation close to the pile, which is satisfactory in the opinion of the Engineer, for determination of the pile penetration. At the time of driving piles, furnish the Engineer with elevations of the original ground and template at each pile or pile group location. The Contractor shall mark piles, to the satisfaction of the Engineer, for obtaining blow counts during pile driving operations.

### 701.04 DRIVING

- A. **GENERAL** - Piles, including Length Test Piles and Load Test Piles if required, shall be driven only in the presence of the Engineer. Permanent piles shall not be driven until test piles for the particular section have been driven, tested and approved by the Engineer. No pile shall be driven within 20 feet of new PCC placements which have cured for less than fourteen (14) days. If a load test is required, permanent piles shall not be driven until the load test data have been analyzed and permission to drive permanent piles is obtained from the Engineer. No pile driving is permitted within a radius of 100 feet of any pile load test during load testing operations. The hammer used to drive permanent piles shall be of the same size, type and manufacture as the hammer used to drive length test piles. Each pile shall be driven continuously from the start of driving until the bearing capacity is secured. Unless specifically authorized by the Engineer, intermittent driving to secure increased bearing values will not be permitted. Piles shall be stored and handled so as to avoid damage. Damaged piles shall not be driven and shall be replaced at the Contractor's expense.
- B. **PRACTICAL REFUSAL** - Piles shall be driven at least to minimum pile tip elevations and pile design loads indicated in the Contract Documents. If the indicated pile design load is not attained when the minimum pile tip elevation is reached, driving shall continue until the Engineer is satisfied that the pile design load is attained. If extremely hard pile driving conditions exist and/or "practical refusal" is reached at an elevation higher than the specified minimum pile tip elevation, the pile tip elevation may be modified, but only with prior approval of the Engineer. Unless otherwise determined by the Engineer, "practical refusal" shall be defined as the conditions reached when the actual driving bearing capacity of piles is as follows:
  1. 3.0 times pile design load for design loads of 40 tons or less per pile.

2. 2.5 times pile design load for design loads greater than 40 tons per pile.

C. **HAMMERS** - Piles may be driven with approved diesel hammers, gravity hammers, air hammers or with single or double-acting steam hammers of such capacity and in such manner that the piles will be driven to the depths and load capacities required without injury or damage to the piles. The use of gravity hammers on concrete piles will not be allowed. Unless specifically outlined on the Plans, the following minimum requirements will apply:

1. **Hammers for Timber or Steel Piles** - Timber or steel piles shall be driven with an approved steam, air, diesel or gravity hammer.

a. Steam, air or diesel hammers shall develop an energy of not less than 7,000 foot-pounds per blow when driving timber piles and 15,000 foot-pounds per blow when driving steel piles.

b. Gravity hammers shall weigh not less than 3,000 pounds and not less than the weight of the driving head and pile. The height of fall shall be so regulated as to avoid injury to the pile and in no case shall exceed 15 feet.

2. **Hammers for Precast Concrete, Steel Shells or Steel Pipe Piles** - Precast concrete, steel shells or steel pipe piles shall be driven with an approved steam, air or diesel hammer, which shall develop an energy of not less than 15,000 foot-pounds per blow and not less than 1 times the weight in pounds of the pile being driven.

If required pile penetration is not obtained with hammers meeting above requirements, hammers shall be provided which give the greater output needed. Sonic or other type hammers may be used only with prior written approval of the Engineer. The hammer to be used for driving permanent piles shall be the same that was used to drive the test piles. If the Contractor changes hammers, the Contractor shall drive additional test piles at the Contractor's expense, before driving the permanent piles, even if the energy ratings of the hammers are identical.

D. **LEADS** - Piles shall be held in fixed leads during driving. In lieu of fixed leads, the Contractor may use, with the prior approval of the Engineer, any method in which the pile is properly guided and supported and the hammer guided and rigidly supported independently of the pile. Leads shall be adjustable as to batter and shall either be telescopic or of such length as to extend from the highest point to the lowest point which the hammer must travel. If swing leads are used, all piles shall be driven with templates of type, size and in locations approved by the Engineer.

E. **FOLLOWERS** - Followers meeting the approval of the Engineer may be used if necessary in driving of piles, but shall be operated in conjunction with the telescopic or extension leads. When a follower is used, 1 pile in any group of 10 shall be a long pile driven without a follower, and shall be used as a test pile to determine the average bearing power of the group. The intent of this specification is that the leads and hammer, or the leads and a suitably braced follower, follow the pile head and support it throughout the entire driving period.

F. **ACCURACY OF DRIVING** - All piles shall be located accurately as to position and batter; and any pile driven out of place or injured in driving shall be pulled and redriven or replaced as may be directed by the Engineer, at the sole expense of the Contractor. No variation greater than 1/4 inch per foot from the vertical or specified batter will be acceptable, and the top of each driven pile shall not be out of position by more than 6 inches. Contractor shall submit center of gravity calculations for pile groups. Center of gravity calculations shall be performed about the long axis of footings for bent caps, abutments, retaining walls, and piers other than column piers. For footings for box culverts and column piers, center of gravity calculations shall be performed about both major axes. Allowable tolerance for center of gravity for steel or concrete pile groups shall be the greater of 1 1/2 inches or 3 percent of the distance between the extremes about the axis. Allowable tolerance for center of gravity for timber piles shall be the greater of 2 1/4 inches or 4 1/2 percent of the distance between the extremes about the axis.

G. **BEARING CAPACITY OF PILES** - All piles shall be driven to the minimum bearing capacity specified on the Plans or in the Special Provisions. Determination of pile capacity, except for the load tested pile, will be based on the following formulae:

$$P = \frac{2WH}{S + 1.0} \text{ for gravity hammers}$$



$$P = \frac{2WH}{S + 0.1} \text{ for single - acting power hammers}$$

$$P = \frac{2(E)}{S + 0.1} \text{ for double - acting powerhammers}$$

Where:

W = Weight, in pounds, of striking parts of hammer

P = Safe bearing capacity in pounds

H = height of fall in feet

E = energy per blow, actual foot pounds

S = Average penetration in inches per blow for the last 5 to 10 blows for gravity hammers, and for the last 10 to 20 blows for power hammers.

1. The above formulae are applicable only when:
  - a. The hammer has a free fall.
  - b. The head of the pile is not broomed or crushed.
  - c. The penetration is reasonably quick and uniform.
  - d. There is no appreciable bounce of the hammer after the blow.
  - e. A follower is not used.
2. In the event of hammer bounce, twice the height of the bounce shall be deducted from H to determine its value in the formulae.
 

The manufacturer's rated energy per blow will not be used in bearing capacity formulas; this energy will be determined by the Engineer. No allowance will be made for hammer bounce or spring action in computation of energy per blow. For diesel hammers, the energy rating to be used in bearing capacity formulae shall be as follows:

  - a. 85 percent of the manufacturer's rated energy per blow for a double acting (enclosed ram) hammer.
  - b. 75 percent of the manufacturer's rated energy per blow for a single-acting hammer.

The foregoing formulae shall be used as guides only. In all cases the Engineer will be the sole judge as to the final tip Elevation of all piles.

- H. CUTOFFS AND CLEANUP** - Cutoffs shall be made in 1 plane at the correct Elevation or Elevations shown on the Plans. In general, the length of pile shall be sufficient to permit the complete removal of all material injured by driving. All cutoffs shall become the property of the Contractor and shall be removed from the Site. Any material forced up between the piles and all loose and displaced material around the piles shall be removed to the correct Elevations, leaving clean solid surfaces to receive the concrete. Such material is to be removed at the Contractor's expense.
- I. LENGTH OF PILES** - Unless otherwise outlined on the Plans, piles shall be driven to a minimum depth of penetration of 10 feet, measured from the cutoff elevation to the tip of the pile, except when driven in fill areas, where the minimum depth of penetration shall be 10 feet below undisturbed ground.

#### 701.05 LENGTH TEST PILES AND LOAD TESTS

- A. LENGTH TEST PILES** - When required, the Contractor shall test piles at the locations shown on the Plans or designated by the Engineer. These piles shall be of sufficient length to provide for any variation in soil conditions. They shall be driven to the requirements as specified herein. Piles thus driven, if in a planned pile location and if a satisfactory bearing is obtained, shall become permanent structure piles. The length test piles shall be driven to practical refusal as set forth in 701.04(B) and evaluated by

the Engineer. The hammer used for length test piles shall be of the same type and manufacture that the Contractor proposes to use for all pile driving under this Contract.

- B. LOAD TEST PILES** - No load test piles shall be driven until length test piles are driven to practical refusal and evaluated by the Engineer. Load tests shall be performed at locations and upon piles shown on the Plans or as designated by the Engineer. The number of pile load tests may be increased or decreased by the Engineer. Piles selected for load testing shall be tested as individual vertical foundation piles driven to the minimum bearing capacity called for in the Contract Documents, to determine the relationship between load applied and pile reaction.
1. The hammer used for load test piles shall be of the same type and manufacture that the Contractor proposes to use for all pile driving under this Contract. The method of loading, bracing, etc., and the facilities for observing the load test and measuring settlements will be at the option of the Contractor; however, prior to testing, the Contractor shall submit Plans for approval showing in sufficient detail the methods and equipment proposed for use. The bracing for the pile shall be completely in place before any test load is applied and shall remain in place until after the completion of the load test. Loading shall not be started until forty-eight (48) hours after completion of driving, and is subject to the Engineer's approval. Prior to any loading application, the Contractor shall submit to the Engineer certification from an acceptable testing laboratory that all appropriate equipment (e.g. jacks, pressure gauges, etc.) have recently been properly calibrated. The certificates will not be acceptable if more than six (6) months old. The Contractor shall furnish the Engineer with adequate facilities for making settlement readings twenty-four (24) hours per day, including lighting and shelter from rain, wind and direct sunlight in the instrumented area. The Contractor shall assign an employee, who fully understands loading and test equipment procedures, to be present during each entire load test.
  2. The Contractor shall be responsible for each load test, and any pile failing to meet the Engineer's approval, whether because of damage while driving or any other reason, shall be withdrawn, and a new pile driven at the Contractor's expense. All movement readings will be recorded by the Engineer and the Contractor shall neither add nor remove loading increments until permitted by the Engineer.
  3. If a hydraulic jack is used, the capacity shall be not less than 225 percent of the pile design load indicated on the Plans. The detailed method of applying, measuring and recording load tests shall be submitted in writing to the Engineer for approval prior to pile testing and shall include sufficient sketches to fully illustrate the proposed method. Any loading platform used shall have a safe capacity of 4 times the pile design load indicated on the Plans. If steel H piles are used for reaction or anchor piles, the jacking or reaction beam shall be held down by positive rigid connections to steel H sections. Cable tie-downs will not be permitted. The distance from the test pile to any reaction pile shall be not less than 5 feet measured from center to center. If reaction or anchor piles are driven at permanent pile locations and meet all specification requirements, payment for such piles will be made at the Contract Price for Piles. Reaction or anchor piles which are not permanent piles as determined by the Engineer shall, at the direction of the Engineer, be left in place or be pulled out and the hole backfilled with sand.
  4. The test load shall be concentrically applied as near the ground surface as practicable and by such method that the test load acting on the pile at any time may be definitely determined and controlled.
  5. If in the opinion of the Engineer the test pile is found to be in satisfactory condition at the conclusion of the load test, it shall be completed and incorporated into the Structure as a permanent pile. If the Engineer determines the test pile has not met requirements, the pile shall be withdrawn and a new one driven or spliced as needed and driven to required depth after pile tip Elevations are determined from new test piles. Upon completion of the test, all temporary work in connection therewith shall be removed. The heads of the piles tested shall be cut to the proper Elevations required to conform to Plans and the resulting cutoffs shall become the property of the Contractor and be removed from the Site.
  6. Prior to driving a pile to be load tested, the Contractor shall submit to the Engineer written details outlining his chosen method for the pile load tests. The following are 3 methods for performing the pile load tests:
    - a. **Standard Load Test** - The load shall be applied in sequential increments of 25, 50, 75, 100, 125, 150, 175 and 200 percent of the pile design load indicated on the Plans.

- i. *Measurements* - Methods satisfactory to the Engineer for obtaining measurements of vertical movements shall be furnished. Readings of these vertical movements made to an accuracy of 0.001 inch shall be taken before and after the application of each new load increments and two (2), four (4), eight (8), fifteen (15), thirty (30), sixty (60) minutes, and every two (2) hours until application of the next load increment. Additional load increments shall not be applied until rate of settlement caused by previous load increments less than 0.01 inch in one (1) hour, or until at least two (2) hours have elapsed, whichever occurs first. Full test load of 200 percent of the pile design load indicated on the Plans shall be maintained on the pile for a minimum period of forty-eight (48) hours, or such additional time as stipulated by the Engineer. Settlement readings will be taken at the beginning and at the end of the period, and at four (4) hour intervals during the period.
  - ii. *Length of Test* - If all settlement has ceased or if no progressive settlement occurs during the last four (4) hours of the forty-eight (48) hour test, the unloading of the pile may begin. However, if any progressive settlement is observed during the last four (4) hours of the forty-eight (48) hour test, the full load test shall be maintained on the pile for an additional twelve (12) hours; during the last four (4) hours of this additional period the pile shall not show continued settlement.
  - iii. *Unloading* - During the unloading of the pile, the rebound shall be measured when the load remaining on the pile amounts to 75, 50, 25, 10, and zero percent of the full test load, which decrements of load released at no less than one (1) hour intervals. Rebound readings shall be taken immediately before and after removal of each decrement. Final rebound readings shall be taken twenty-four (24) hours after the entire test load has been removed; or at more than twenty-four (24) hours if the Engineer determines that the pile continues to rebound slowly.
  - iv. *Safe Allowable Load* - Unless otherwise evaluated by the Engineer, the safe allowable load will be considered as 50 percent of the load which, after a continuous application, for a minimum period of forty-eight (48) hours and for extended periods if required by the Engineer, produces a net permanent settlement nor greater than 0.25 inch measured at the top of the pile.
- b. **Quick Load Test** - Quick Load test shall be in accordance with ASTM D 1143.81.

The load shall be applied in increments of 10 to 15 percent of the proposed design load with a constant time interval between increments of two-and-a-half (2-1/2) minutes. Load increments shall be added until continuous jacking is required to maintain the test load or until 200 percent of the pile design load is reached, whichever occurs first, at which time the jacking shall be stopped. After a five (5) minute interval, the full load shall be removed from the pile in 4 approximately equal decrements with five (5) minutes between decrements. Readings of time, load and settlement shall be taken and recorded immediately before and after the application of each load increment and at intermediate time intervals as directed. After the maximum load has been applied, readings shall be taken and recorded when the jacking is stopped, after two-and-a-half (2-1/2) minutes, and again at five (5) minutes thereafter. Readings of time and rebound shall be taken and recorded after all load has been removed, after two-and-a-half (2-1/2) minutes, and again at five (5) minutes thereafter.

c. **High Strain Dynamic Load Test**

- i. *General*
  - A) Dynamic testing involves attaching at least 2 strain transducers and 2 accelerometers to the pile near the pile head during initial driving or at a convenient location during restrrike testing. A cable connects the gages near the pile head with the Pile Driving Analyzer located a safe distance from the pile, but not more than 300 feet from the pile.
  - B) The Contractor shall secure the services of a Dynamic Testing Consultant. Dynamic testing shall be performed on the load test piles during the final 10 to 40 feet for Timber or steel piles and the full length for concrete piles of initial driving and/or during re-strike driving a minimum of one (1) to two (2) days after initial driving.

- C) Dynamic pile testing may also be performed on an additional 5 percent of the production piles as directed by the Engineer. The production pile testing shall be performed during re-strike to monitor hammer and drive system performance, assess pile installation stresses and integrity, and to evaluate pile capacity.

**ii. Equipment and Personnel**

- A) All equipment necessary for the dynamic monitoring such as gages, cables, etc., shall be furnished by the Dynamic Testing Consultant. The equipment shall conform to the requirements of ASTM D 4945-00, Standard Test Method for High Strain Dynamic Testing of Piles and AASHTO T 298-99, High Strain Dynamic Testing of Piles.
- B) An engineer with a minimum five (5) years of experience and/or who has achieved Basic Level or better on the Foundation QA Examination for Providers of PDA Testing Services shall be in charge of Pile Driving Analyzer (PDA) operation and of result interpretation, either on Site or by remote connection.
- C) To prepare the pile for transducer attachment, either a generator or a DC drill of sufficient power shall be available. A hammer drill is required for preparation of concrete piles.

**iii. Execution**

- A) Construction Access - Prior to lifting the pile to be dynamically tested, the Contractor shall provide a minimum of 3 feet of clear access to 180 degree opposite faces of the pile for pile preparation. The Dynamic Testing Consultant or the Contractor's personnel shall then drill and prepare holes for gage attachment.

The Contractor's personnel shall attach the gages to the pile after the pile has been driven to the required penetration depths. Driving shall then continue using routine pile installation procedures. When the level of the gages is within 1 foot of any obstruction endangering the survival of sensors or cables, driving shall be halted to remove the gages from the pile. If additional driving is required, the obstruction shall be removed or the pile shall be spliced and the gages shall be reattached to the head of the next pile segment prior to the resumption of driving.

- B) Testing Procedures - Preconstruction Wave Equation Analyses. Ten (10) days prior to driving the load test piles, the Contractor shall submit the pile and complete driving equipment data form to the Engineer. The Dynamic Testing Consultant shall use the submitted information to perform wave equation analyses and shall prepare a summary report of the wave equation results. The wave equation analyses shall be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses.

Approval of the proposed driving system by the Engineer shall be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of the pile design load times 2.5 at a driving resistance not greater than 20 blows per inch, within allowable driving stress limits. The hammer should also be sized such that the penetration per blow at the required ultimate capacity does not exceed 0.5 inches.

A new pile driving system, modifications to existing system, or new pile installation procedures shall be proposed by the Contractor if the pile installation stresses predicted by wave equation analysis or calculated by the Pile Driving Analyzer measurements exceed the following maximum values:

**TABLE 701.05 PILE DRIVING ANALYSIS MAXIMUM VALUES**

Pile Type	Compression Stress	Tension Stress
Steel	0.9 F <sub>y</sub>	0.9 F <sub>y</sub>
Prestressed Concrete	0.85 f' <sub>c</sub> -f <sub>pe</sub>	3 f' <sub>c</sub> + f <sub>pe</sub>
Precast Concrete	0.85 f' <sub>c</sub>	3 f' <sub>c</sub>
Timber	3 σ <sub>a</sub>	3 σ <sub>a</sub>

Notes:

$F_y$  = Steel Yield Strength in psi

$f'_c$  = Concrete Compressive Strength in psi

$f_{pe}$  = Effective Prestress After Losses in psi

$\sigma_a$  = Allowable Timber Design Stress in psi

Sample Timber Allowable Stresses,  $\sigma_a$ , in psi

1200 Douglas Fir

1100 Red Oak

1200 Southern Pine

800 Eastern Hemlock

- C)** Load Test Pile Program - Load test piles shall be driven to the minimum pile penetration depth or an ultimate capacity of 2.25 times the design load based upon the preliminary driving resistance indicated by wave equation results. Adjustments to the preliminary driving criteria may be made by the Engineer based upon the dynamic testing results.

All load test piles shall be re-driven with dynamic testing after a minimum waiting period of one (1) day. The pile or piles that are statically load tested shall be re-struck with dynamic testing within forty-eight (48) hours after completion of the static load test to obtain a correlation between static and dynamic test results for reference across the Site. The re-strike driving sequence shall be performed with a warmed up hammer and shall consist of striking the piles for 20 blows or until the pile penetrates an additional 3 inches, whichever occurs first. In the event the pile movement is less than 1/4 inch during the re-strike at satisfactory hammer energy output, the re-strike may be terminated after 20 blows.

- D)** Production Pile Testing - Dynamic pile testing may be performed on 5 percent of the production piles during restrike driving over the duration of the production pile installation at the direction of the Engineer.

The Engineer may request additional piles to be dynamically tested if the hammer and/or driving system is replaced or modified, the pile type or installation procedures are modified, the pile capacity requirements are changed, unusual blow counts or penetrations are observed on any other piling behavior differ from normal installation.

- E)** Dynamic Load Test Pile Program - The Dynamic Testing Consultant shall prepare a written report of the load test pile program. This report shall contain a discussion of the pile capacity obtained from the dynamic and static testing. The report shall also discuss hammer and driving system performance, driving stress levels, and pile integrity.

The dynamic pile test data obtained from the end of initial driving and the beginning of re-strike of all the load test piles, shall be analyzed using an approved wave equation analyses program.

These analyses shall be performed by an engineer who has achieved Advanced Level or better on the Foundation QA Examination for Providers of PDA Testing Services. The Engineer may request additional analyses at selected pile penetration depths.

For a blow count based driving criterion, the Dynamic Testing Consultant shall perform a refined wave equation analysis or analyses based upon the variations in the subsurface conditions and/or drive system performance observed in the load test pile program results. Refined wave equation analyses are not required for re-strike situations or when piles are driven to depth.

- F)** Dynamic Testing Reports - Within one (1) day of production pile testing, the Dynamic Testing Consultant shall prepare a hand written daily field report summarizing the dynamic testing results. As a minimum, the daily reports shall include the calculated driving stresses, transferred energy, and estimated pile capacity at the time of testing. Non-uniform piles require a wave equation analyses for capacity determination. Variations from

previous trends in the dynamic test data shall also be noted. Daily field reports shall be transmitted to the Engineer.

Once per month, or upon completion of various project or testing phases, the Dynamic Testing Consultant shall prepare a formal report summarizing the dynamic testing results. This report shall be submitted no later than ten (10) working days after the completion of the reported part of the testing.

#### **701.06 STEEL H PILES**

- A. SPLICES** - The Contractor may, at his option, splice pieces of steel H-piles to secure the lengths required; however, only 1 splice per pile will be permitted. Splices shall be as shown on the Plans or as approved by the Engineer. Pile lengths shorter than 5 feet will not be permitted. Insofar as practicable, the splice will be located so that its final position will be in firm material underlying the foundation. All splice material shall conform to 815.01(A) or (B). Splicing in the leads will not be permitted unless approved by the Engineer. All welding shall be done by the electric-arc process and shall conform to the Specifications of AASHTO/AWS D1.5 as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.
- B. SPLICE WELDS** - All temporary and permanent pile splice welds shall be made only by welders qualified in accordance with 706.18(C). No jet welding will be permitted without prior written approval from the Engineer.

#### **701.07 CAST-IN-PLACE CONCRETE PILES (STEEL CASING)**

- A. INSPECTION OF METAL SHELLS** - At all times prior to the placing of concrete in the driven shells, the Contractor shall have available a suitable light for the inspection of each shell throughout its entire length. Any improperly driven, broken or otherwise defective shell shall be corrected to the satisfaction of the Engineer, by removal and replacement, or the driving of an additional pile, at the sole expense of the Contractor.
- B. SPLICING** - Splicing of steel shells shall be in accordance with the manufacturer's recommendations.
- C. REINFORCEMENT** - Unless otherwise shown on the Plans, Cast-In-Place Piles shall have reinforcement extending 20 feet into the pile measured from the cutoff elevation.
- D. DRIVING** - For special types of piling, pile-driving heads or caps, mandrels, or other device, in accordance with the manufacturer's recommendation for the particular type of pile specified, shall be provided to protect the pile head against damage during pile driving and hold the axis of the pile in line with the axis of the hammer.
- E. PLACING CONCRETE** - All pile shells in a footing shall preferably be fully driven before any are filled with concrete, but in no event shall concrete be placed in a shell, until all driving within a radius of 15 feet has been completed. Shells shall be cut off at the required Elevation and shall be free of water when concrete is placed.

#### **701.08 PRECAST REINFORCED CONCRETE PILES**

- A. FORM WORK** - Forms for precast concrete piles shall conform to the general requirements for concrete formwork as specified under 703 as well as the American Concrete Institute's Standard Specifications for Tolerances for Concrete Construction and Materials (ACI 117-90).
- B. REINFORCEMENT** - Reinforcement shall be placed in accordance with details shown on the Plans, and as outlined in 704.
- C. CASTINGS** - The piles shall be cast in a horizontal position on a suitable platform meeting the approval of the Engineer. Concrete shall be placed according to the applicable provisions of 703. The forms shall be overfilled, the surplus concrete screened off, and the top surface finished to a uniform, even texture similar to that produced by the forms. Each pile shall be marked with its casting date. If required, portions of the piling exposed to view shall be finished as provided in 703.20.

**D. CURING** - Curing shall be performed as outlined in 703.19 except that the period of curing will be fourteen (14) days in lieu of seven (7) as specified. No piles shall be moved from their casting positions in less than seven (7) days nor be driven within twenty-one (21) days after casting.

**E. STORAGE AND HANDLING** - Removal of forms, curing, storing, transporting and handling precast concrete piles shall be done in such a manner as to avoid excessive bending stresses, cracking, spalling or other injurious results. Supports for handling cured piles shall not be more than 20 feet apart and computed stress in reinforcement shall not exceed 12,000 pounds per square inch, based on the calculated weight of the pile plus 100 percent of the same weight for impact and shock. During storage, piles shall be firmly supported at points not more than 4 feet apart throughout their length and shall be separated from each other at least 4 inches. When piles are stored in tiers, supports shall be placed directly over the supports for the lower piles. No tier shall contain more than 4 piles.

**F. CAPS** - When the nature of the driving is such as to unduly injure the heads of the piles, they shall be protected by caps of approved design.

Care shall be taken to insure full bearing of the driving cap on the pile for proper and uniform distribution of the hammer blow.

**G. SPLICES** - Extensions or splices shall be avoided wherever possible.

If required, the following procedures shall be met:

The concrete at the end of the pile shall be cut away, leaving the reinforcement exposed for a length of 30 diameters of the bars. The cut shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be lapped 30 diameters and fastened to the projecting steel. In placing the formwork for the extension, care shall be taken to avoid leakage along the pile. Prior to placing the concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of 1:2 cement mortar.

#### **701.09 PRECAST PRESTRESSED CONCRETE PILES**

**A. CONCRETE** - Precast prestressed concrete piles shall not be driven until the concrete has attained a compressive strength of not less than 5000 pounds per square inch, but in no case less than three (3) days from the date of pouring.

**B. PROTECTION** - Heads of the piles shall be protected in accordance with 701.08(F).

**C. PRESTRESSING STRANDS** - The prestressing strand shall have a minimum breaking strength for 7/16 inch strand of 31,000 pounds and a minimum load at 1 percent extension of 26,350 pounds with an initial load of 3100 pounds. The prestressing load applied to the strand shall be 21,700 pounds. Each reel of strand and all samples furnished to the Engineer for testing shall bear a tag identifying the strand as extra high strength.

**D. PILE ENDS** - Each end of the piles shall have extra reinforcement as shown on the Plans. All prestressing strands shall be ground flush with each end of the pile.

**E. FABRICATION TOLERANCE** - The piles shall be constructed to a tolerance of -0 to +1/2 inch of the cross sectional dimensions shown on the Plans. The tolerance from a straight line along the longitudinal axis shall be the same.

**F. SPLICES** - Extensions or splices of pre-cast prestressed concrete piles shall be avoided whenever possible. However, if these splices are required the following procedure shall be employed. After driving is completed, the concrete at the end of the pile shall be cut away, leaving the prestressing strand exposed for a minimum length of 24 inches for precast, prestressed concrete piles. Reinforcement as shown on the Plans shall be lapped a minimum of 24 inches with the projecting prestressing strands. In placement of formwork for the exterior, care shall be taken to avoid leakage along the pile. Prior to placing the concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of 1:2 cement mortar.

#### **701.10 TIMBER PILES**

**A. SPLITTING** - Metal collars, bands, or other approved devices to protect the piles against splitting or brooming shall be provided where necessary.

- B. PILE POINTS** - Piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes of a design satisfactory to the Engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.
- C. SPLICES** - Full-length piles shall always be used where practicable but, if splices cannot be avoided, an approved method of splicing shall be used. Piles shall not be spliced except by written permission of the Engineer.
- D. LENGTH** - The lengths of piles shall include ample allowance for fresh heading and for such depth as may be necessary to suit the Contractor's method of operation.
- E. SURFACE PROTECTION** - In the event that treated timber piles are specified, special care shall be taken to avoid breaking the surface. Cuts or breaks in the treated surface shall be repaired as per the recommendations of the pile supplier.
- F. PROTECTION** - The heads of piles shall be protected by caps of approved design.

#### 701.11 MEASURE AND PAYMENT

- A. PILING** - The unit of measure for Timber, Precast Concrete, Cast-In-Place Concrete with Steel Casting, Steel H, Prestressed or Test Piles will be the linear foot.

The number of feet measured will be the actual number of linear feet left in the completed structure of piles acceptably driven, as measured along the axis of the pile from the tip of the pile to the cutoff elevation shown on the Plans. No measurement or payment will be made of cutoffs, broken piles or piles driven out of position.

The number of linear feet of piling will be paid for at the Contract unit price per linear foot for the type and size specified, for which payment will include all labor, materials, tools, equipment and incidentals necessary to furnish and drive the piles completely in place for:

1. Untreated Timber Piles
2. Treated Timber Piles
3. Steel H Piles
4. Precast Concrete Piles
5. Cast-In-Place Concrete Piles
6. Pre-stressed Piles
7. Length Test Piles

Load test piles, whether or not they become permanent piles, will be paid at the Contract Price for regular piles of the type and size specified.

Payment for H Piles includes temporary and permanent pile splices and welding.

#### **B. LOAD TESTS**

- 1. Standard Load Tests** - The unit of measure for Standard Load Tests will be each. The number will be the actual number of standard tests performed.
- 2. Quick Load Tests** - The unit of measure for Quick Load Tests will be each.  
The number will be the actual number of quick load tests performed.
- 3. High-Strain Dynamic Test** - The unit of measure for High-Strain Dynamic Load Test will be each. The number will be the actual number of dynamic tests performed.



4. The number of load tests, as measured in 701.11(B), will be paid for at the Contract unit price per each, which payment will include furnishing and removing all testing materials, loading and unloading the piles, guide platforms and all other material, labor, equipment and incidentals necessary to complete the item as specified herein. Pile Load Test will not include cost of pile tested. Payment does include driving and removal of reaction and anchor piles, reaction and anchor piles left in place but not considered as permanent piles, backfilling holes left from pulled piles, jacking equipment and associated equipment necessary to complete each load test.

## 702 DRILLED SHAFTS (CAISSONS)

### 702.01 DESCRIPTION

Construct drilled shafts (caissons) as specified and indicated on the Contract Documents.

### 702.02 MATERIALS

Materials shall conform to the following requirements:

- 817: Concrete Mix Class B Structural Concrete, modified, with maximum size C.A. No. 67 crushed stone and a maximum slump of 7 inches with HRWR.
- 812: Reinforcing Steel
- ASTM A 252, Grade 2 or ASTM A 36: Steel Casings

### 702.03 CONSTRUCTION

- A. SUBFOUNDATION INVESTIGATION** - When the Contract Documents include an item for Subfoundation Investigation, the Contractor shall conduct a subfoundation investigation program prior to ordering or fabricating reinforcement for drilled shafts. This program shall determine the Elevation of suitable bearing stratum and the required depth of the drilled shafts. Approximately 1/3 of the drilled shaft locations spread over the total number of locations shall be selected, and test holes shall be drilled at least 5 feet below the estimated drilled shaft length. After drilling the test holes, the Engineer will evaluate the submitted data to determine the uniformity of the foundation materials. If the evaluation determines that more test holes are required, additional test holes shall be drilled at approved locations.
- B. SHAFT INSTALLER** – The Contractor shall obtain the services of a shaft installer with a proven record of experience and who has successfully completed at least 3 projects with similar subsurface conditions, shaft sizes, depths, and minimum volumes of work as contained in the Project. The Contractor shall submit evidence of pertinent experience to the Engineer and receive approval before proceeding with drilling shafts.

The Contractor shall furnish a Certified Drilled Shaft report containing the following information for each drilled shaft:

1. Top and bottom elevations
2. Final center line location at top
3. Variation of shaft from plumb
4. Results of tests performed
5. Levelness of bottom
6. Seepage of water
7. Top and bottom elevation of any casings left in place
8. Any unusual conditions
9. Variation of dimensions from planned
10. Dates of start and completion of excavation
11. Inspection, testing, and placement of concrete (including any delays in concreting and location of construction joints in shafts)
12. Reinforcing steel
13. Any additional information relevant to the as-built drilled installation

The report shall be submitted within forty-eight (48) hours after completion of the shaft and will be required before payment is disbursed for the Work.

The Contractor shall record and maintain information pertinent to each drilled shaft and provide required data to other testing and inspection personnel.

Provide all facilities required for the safe and convenient conduct of the Engineer's inspection and testing procedures.

- C. GEOTECHNICAL ENGINEER** - When specified, the Contractor shall employ the services of a qualified geotechnical engineer for inspection and testing for installation of drilled shafts. The geotechnical engineer shall be a professional engineer registered in the District of Columbia, with a demonstrated record of experience with similar drilled shaft installations, and approved prior to the beginning of auguring for the drilled shafts.

The Contractor shall submit the geotechnical engineer's plan containing the proposed methods to be used to inspect the drilled shafts as specified herein.

The geotechnical engineer shall visually inspect the bottom of each drilled shaft and perform tests as necessary to verify the bearing capacity. Drilled shafts shall be founded in material having the specified minimum design bearing capacity. The geotechnical engineer shall provide certification that the drilled shafts were properly drilled to a satisfactory depth and bearing.

- D. SHAFT REQUIREMENTS** – Shafts shall be excavated by auguring, drilling, or hand excavation as necessary to reach the required bearing strata. When Earth walls cannot be maintained without spilling into the shaft, casings or slurry shall be installed as excavation proceeds. Casings shall be full-length and watertight. The casings shall be of sufficient thickness to withstand compressive, displacement, and withdrawal stresses; and to maintain the shaft walls. Casings shall be withdrawn as concrete is placed unless otherwise specified.

The geotechnical engineer shall determine the final bottom elevation of drilled shafts when the services are required. All holes shall be inspected and approved.

Holes for successive drilled shafts shall not be excavated until adjacent holes are filled with concrete and allowed to set.

Drilled shaft tolerances:

1. Maximum permissible variation of center line locations is not more than 1/24th of the shaft diameter or 3 inches, whichever is less.
2. Maximum out of plumb is 1.5 percent of the depth, 12.5 percent of the shaft diameter, or 15 inches, whichever is less.
3. The top of the shaft or concrete cut-off elevation shall be within 1 inch of the design elevation.

If the specified tolerances are exceeded, the Contractor shall provide corrective construction to compensate for excessive eccentricity at no additional cost to the Engineer. Proposed methods of corrective construction shall be submitted for approval.

The bottom of drilled shafts shall be excavated to an undisturbed, level plane. All loose material shall be removed prior to placing concrete.

Drilled shafts shall be dewatered as required to facilitate excavation, inspection, and concreting.

Each drilled shaft shall be inspected before placing concrete.

- a. *Reinforcing Steel* - Reinforcing steel cages for each drilled shaft shall be fabricated and placed as 1 continuous unit. Reinforcement shall be placed accurately and symmetrically about the axis of the hole, and kept securely in position during concrete placement.

Exposed ends of extended reinforcement shall be protected from damage.

- b. *Concrete* - Drilled shafts shall be filled with concrete immediately after inspection and approval by the geotechnical engineer and the Engineer.

Concrete shall be placed in 1 continuous operation, in a smooth flow without segregating. Mechanical vibration shall be used for consolidation of at least the top 25 feet of each shaft. Concrete may be free dropped up to 5 feet provided that the procedures ensure that the concrete falls vertically without hitting the inside walls of the hole or falling directly on the reinforcing steel. When the Engineer determines that the concrete placement procedures are unsatisfactory, concrete shall be placed by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, tremie, or pumping. Use

chutes, tremies, or pumping where a drop of more than 5 feet is required.

Concrete shall be placed in the dry insofar as practicable. If excessive water occurs and it is not feasible to dewater the drilled shaft for concreting, concrete shall be placed by the tremie method. Tremie placement operations shall be controlled to ensure that tremie is not broken during continuous placing from bottom to top. If approved, other methods of depositing concrete underwater may be used.

A sufficient head of concrete shall be maintained to prevent any reduction in the diameter of the drilled shaft by earth pressure and to prevent extraneous material from mixing with the concrete. The withdrawal of temporary casings shall be coordinated with concrete placement operations to maintain a head of concrete approximately 5 feet above the casing bottom.

Concrete placement shall be stopped at the top cut-off elevations shown on the Contract Documents. The tops of drilled shafts shall be level and given a roughened surface finish. Where the cut-off elevation is above ground elevation, the top section shall be formed to extend the shaft to the required Elevation.

Construction joints are permitted in drilled shafts if concrete placement operations must be interrupted, as accepted by the Engineer. The surface of the construction joint shall be level and given a roughened surface finish. An approved bonding compound shall be applied prior to placing additional concrete.

The Engineer may require full-depth continuous coring of drilled concrete shafts where observations of temporary casing removal and concrete placement operations indicate cause for suspicion of quality of concrete, presence of voids, segregation, or other defects. This Work shall be performed at no additional cost to the Engineer.

- c. *Defective Drilled Shafts* – The Contractor shall repair or replace defective drilled shafts as directed.

#### 702.04 LOAD TESTS

The load tests shall be performed at locations indicated.

Tests shall be performed under the supervision of a registered Professional Engineer provided by the Contractor and in the presence of the Engineer.

Load test shall be performed in accordance with ASTM D 1143.

#### 702.05 CROSS-HOLE SONIC LOGGING (CSL) TESTING FOR DRILLED SHAFTS

- A. **DESCRIPTION** - This Work consists of evaluating the structural integrity of drilled shafts using the crosshole sonic logging (CSL) test method. The Work also consists of furnishing and installing access tubes required to conduct the testing, and core drilling of concrete to confirm possible defects.

CSL testing measures the time it takes for an ultrasonic pulse to travel from a signal source in 1 access tube to a receiver in another access tube. In uniform, good quality concrete, the travel time between parallel tubes will be relatively constant and correspond to a reasonable signal velocity from the bottom to the top of the drilled shaft. In uniform, good quality concrete, CSL testing will also measure strong signal amplitude and energy readings. Long travel times, low signal amplitude, or low energy readings indicate the presence of anomalies that may consist of poor quality concrete, voids, honeycombs or soil intrusions. The signal may be completely lost by the receiver and CSL recording system for severe defects such as voids and soil intrusions.

- B. **MATERIALS** - Furnish materials conforming to:

- 801.01: Portland cement
- 814.04: Chemical admixtures

Cement grout consists of a mixture of cement and water that provides a minimum twenty-eight (28) day compressive strength equal to, or greater than, the drilled shaft concrete. Determine the compressive strength of the cement grout according to ASTM C 39 or ASTM C 942. Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout if accepted by the Engineer. For grout, use water free from sewage, oil, acid, strong alkalis, vegetable matter, clay, and loam. Potable water is satisfactory for use in grout.

Furnish access tubes consisting of ASTM D 1785 Schedule 40 PVC pipe with a nominal diameter of 2.0 inches (50 mm). Access

tubes shall have round, regular inside surfaces free from defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage of the probes. Access tubes shall be free from contaminants to ensure a good bond to the concrete.

Submit the grout mix and the selected pipe for the access tubes with the Drilled Shaft Installation Plan for the Engineer’s acceptance. Also include for the Engineer’s acceptance the proposed method for joining the pipe and for attaching the pipe to the reinforcing steel cage.

- C. **NDT TESTING** - Retain an experienced Nondestructive Testing (NDT) supervisor to perform or supervise the CSL testing. The NDT supervisor shall have at least two (2) years experience in CSL testing. Submit to the Engineer for acceptance a resume of the credentials of the proposed NDT supervisor at least fourteen (14) Calendar Days before constructing the drilled shafts.
- D. **INSTALLATION OF ACCESS TUBES** - Install access tubes in all Contract drilled shafts to permit access for the CSL test equipment. Use Table No. 721.01 to determine the number of access tubes per shaft and the tube spacing. If the shaft diameter varies along the length of the shaft, use the largest diameter to determine the number of access tubes.

**TABLE NO. 721.01 CSL Tube Number and Spacings**

Shaft Diameter (feet)	Number of Tubes	Tube Spacing (degrees)
4.0 to 5.0	4	90
5.5 to 7.5	6	60
8.0 to 9.5	8	45
10.0 to 12.0	10	36

Provide watertight joints, a watertight cap on the bottom, and a removable cap at the top of the access tubes. Do not cover joints with tape or other wrapping material. Attach the tubes to the interior of the reinforcing steel cage so that the tubes are parallel and evenly spaced around the perimeter of the reinforcing steel cage. Provide a minimum concrete cover of 3 inches (75 mm). Install the access tubes so that the bottom of the tube is 6 inches (150 mm) or less from the bottom of the drilled shaft but does not touch the bottom of the shaft. Wire-tie or secure the access tubes to the reinforcing steel cage every 3 feet (1 meter). Extend the top of the access tubes at least 3 feet (1meter) above the top of the drilled shaft. If the top of the drilled shaft is below the surface, extend the top of the access tubes at least 2 feet (0.6 meter) above the ground surface. Ensure that the access tubes do not move during placement of the cage and concrete.

Within four (4) hours of placing the reinforcing steel cage but before placing the concrete, fill the access tubes with clean water and recap the tubes. After placing the concrete, exercise care when removing the caps from the access tubes so as not to apply excess torque, hammering, or other stresses which could break the bond between the tubes and the concrete. Label each access tube with a unique identifier at the top of the tube.

- E. **TEST PROCEDURE** - Before CSL testing, supply the Engineer and NDT supervisor with a record of the length, top elevation, bottom elevation, and date of concrete placement for all drilled shafts. Perform CSL tests in accordance with ASTM D 6760 except as modified by this specification. Perform CSL tests on all drilled shafts. Perform the CSL test after the concrete develops sufficient strength and before debonding of access tubes from the surrounding concrete. The Engineer may direct a longer minimum time if the drilled shaft concrete contains a retarding admixture or uses a mix design that results in a longer setting time for the drilled shaft concrete.

For shafts with 4 or 6 access tubes, obtain readings between all pairs of tubes. For shafts with 8 or 10 access tubes, obtain readings between adjacent pairs of access tubes around the perimeter, between pairs of access tubes across the diameter of the shaft, and between pairs of access tubes that are spaced at 2 times the spacing shown in Table No. 721.01. Obtain readings at depth intervals of 0.2 feet (50 mm) or less. If possible defects are detected, obtain additional readings to confirm the initial readings at no additional cost to the Department. Notify the Engineer of possible defects within twenty-four (24) hours of testing.

- F. **TEST REPORT** - Present the CSL test results in a written report. Supply the Engineer with 2 copies of the report within seven (7) Calendar Days after completion of the CSL testing. The Engineer may require separate reports for each Substructure depending on the number of drilled shafts or the length of the drilled shaft construction schedule. If separate reports for each Substructure are required by the Engineer, supply the report within seven (7) Calendar Days after completion of testing at that given Substructure.

In addition to the report requirements in ASTM D 6760, indicate all possible defects on the CSL logs and include a summary of all possible defects detected during the CSL testing. The summary shall indicate for each possible defect:

- A. the drilled shaft identification,
- B. test date,
- C. number of days between concrete placement and CSL testing,
- D. access tube pairs tested,
- E. depth below top of shaft,
- F. percent wave speed reduction, and
- G. an evaluation of the defect.

- G. **EVALUATION OF TEST RESULTS** - The Engineer will evaluate the CSL test results and determine if the drilled shaft construction is acceptable. If the CSL test results indicate possible defects in the drilled shaft, the Engineer may require coring of the drilled shaft to obtain samples in the area of the possible defect, or excavation of the drilled shaft to examine the condition of the concrete. The Engineer may require testing of the core samples. The Engineer will consider the CSL test results, the condition of the concrete as shown by core samples, results of testing on the core samples, and other information when determining the acceptability of the drilled shaft. The Contractor shall not proceed with construction of Substructures or Structures above a drilled shaft until the Engineer has accepted the drilled shaft.

If examination of the drilled shaft concrete confirms the presence of a defect in the drilled shaft, then the Engineer will not pay for coring, testing on the core samples, or excavation costs, even if the drilled shaft is accepted.

If the Engineer determines a drilled shaft is not acceptable, the Contractor shall submit a plan for remedial action to the Engineer for acceptance. Have a Professional Engineer registered in the District of Columbia prepare, sign, seal, and date calculations and Working Drawings for all foundation elements affected by the remedial action plan. Have a second Professional Engineer registered in the District of Columbia check, sign, seal and date the calculations and Working Drawings. The preparer and checker shall be 2 different Professional Engineers. Remedial actions shall not be started prior to the Engineer's acceptance of the plan, unless the Engineer provides written authorization.

The Contractor shall provide all labor, equipment, and materials required to design or remediate drilled shafts at no additional cost to the Department and with no extension of the Contract Time.

- H. **CORING OF DRILLED SHAFT CONCRETE** - If the CSL test results indicate possible defects in the drilled shaft, and if the Contractor elects to perform coring as a mean to investigate or remediate such possible defects, the Contractor shall submit a coring procedure to the Engineer for review and acceptance prior to the start of any coring activities.
- I. **GROUTING TUBES AND HOLES** - After CSL testing and coring of the drilled shaft concrete are complete and the drilled shaft is accepted by the Engineer, remove all water from the access tubes and any cored holes. If the tubes extend above the top of the drilled shaft reinforcing, cutoff the tubes below the top of the drilled shaft reinforcing. Fill the tubes and core holes with grout.

## 702.06 MEASURE AND PAYMENT

The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

- A. Drilled shafts including furnishing and setup of auguring equipment, auguring, drilling, excavating, dewatering, inspection, testing, services of the shaft installer and geotechnical engineer, sleeves, reinforcement, concrete, and disposal of excess and unsuitable material will be paid for at the Contract unit price per linear foot for the pertinent Drilled Shaft item.
- B. When subfoundation investigation is specified, it will be measured and paid for the actual total length of soil borings drilled. The payment will be full compensation for the geotechnical engineer services, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.
- C. The unit of measure for Cross-hole Sonic Logging (CSL) Tests will be each. The quantity will be the number of drilled shafts accepted for which cross-hole sonic logging tests were performed. Payment will be made at the Contract unit price per each and will include all labor, equipment, and materials costs related to the performance of the Work as specified, including tubes, grout, and water, incidentals to the CSL test set-up, and preparing reports.

## 703 CONCRETE FOR STRUCTURES

### 703.01 DESCRIPTION

Concrete for Structures shall consist of Portland cement concrete used in Structures constructed in conformity with the lines, grades and dimensions as shown on the Plans or as specified by the Engineer. This item shall also include, where applicable, furnishing and installing emblems and reference marks, setting of all necessary anchor bolts, and installing manhole frames and covers.

Ten (10) working days prior to the start of the concrete operation, the Contractor shall arrange for a concrete Pre-Pour Conference. The Contractor shall coordinate a meeting with the Engineer, or his representative, and all applicable Contractor Quality Control personnel. The Contractor should be prepared to discuss the following:

- Approved concrete mix designs for the Project
- Process control at the Plant
- Contractor quality control plan for delivery, sampling and testing
- Curing procedures
- Weather restriction and night work
- Proposed schedule of concrete pouring operations
- List all equipment i.e. Plants, concrete mixers, finishing machines, pumps and personnel used in the production and construction of the Work
- Maintenance of Traffic (MOT)

### 703.02 MATERIALS

Materials shall conform to the following requirements:

- 817, Class A or B: PCC Concrete Mixtures
- 814.01, 814.02(A), 814.02(B), 814.03: Curing materials
- 807.01(B): Preformed joint filler
- 807.05: Waterstop
- 822.08: Epoxy
- 806.05: Mortar

### 703.03 PROPORTIONING

- A. GENERAL** - Aggregates and Portland cement shall be proportioned by weight. Water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determinations performed by the Contractor as directed by the Engineer. These moisture determinations shall be made as frequently as deemed necessary by the Engineer.
- B. ADJUSTMENTS** - The Contractor shall submit a mix design conforming to 817.01 for the approval of the Engineer. The approved mix design shall not be changed except as provided below.
1. **Adjustment for variation in fineness modulus (FM)** - If the FM of the fine aggregate varies by more than 0.20 from the established value, the mix design shall be adjusted as provided in 817.01.
  2. **Adjustment for variation in workability** - If it is impossible to obtain PCC of the desired workability with proportions approved by the Engineer, the Contractor shall make such changes in aggregate weights as necessary, provided that in no case shall the cement content originally designated be changed except as provided below.

3. **Adjustment for variation in consistency** - If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content may be increased as approved by the Engineer so that the maximum allowable water-cement ratio will not be exceeded.
4. **Adjustment for variation in yield** - If cement content of the PCC determined by AASHTO T 121 varies more than plus or minus 2 percent from the approved design mix, the proportions shall be adjusted by the Contractor and approved by the Engineer to maintain a cement content within these limits. The water content shall not exceed the maximum approved.
5. **Adjustment for new materials** - Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.

Suitable means shall be provided for accurately determining the amount of moisture in the aggregates.

#### 703.04 HANDLING, MEASURING AND BATCHING MATERIALS

- A. GENERAL** - The supplier of the concrete shall have sufficient Plant capacity and transportation apparatus to provide delivery at the rate required to insure that the depositing of the concrete will be continuous.

Unless otherwise permitted by the Contract, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type.

Methods and equipment for adding air-entraining agent or other admixtures to the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixes within a tolerance of plus or minus 3 percent.

Batch plant equipment shall meet the requirements of 905.01.

- B. STOCKPILES** - Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to come down over the next lower layer. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated or mixed with Earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least twelve (12) hours before being batched. Rail shipment requiring more than twelve (12) hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of twelve (12) hours may be required by the Engineer.

- C. HANDLING FINE AGGREGATE** - The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts conforming to the approved mix design. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Batching shall be so conducted as to result in weights of each material required within tolerances of plus 4 percent for cement, +/- 2 percent for aggregates, and +/- 1 percent for water. The accuracy of measuring the water shall be within a range of error of not over 1 percent.

#### 703.05 MIXING CONCRETE

- A. GENERAL** - The concrete may be mixed wholly or in part in paving mixers, stationary mixers or truck mixers located at a central plant or at the Site. Ready-mixed concrete shall conform to the requirements of AASHTO M 157. Concrete mixed under these Specifications shall be of uniform consistency and such that the mortar will bond to the coarse aggregate. It shall not be sufficiently wet to flow readily or segregate, nor shall it be of a mealy or too dry consistency.

The interval between batches shall be such that the concrete in place does not partially harden and in no case shall this interval exceed thirty (30) minutes. The time interval between admission of cement to the aggregate and final discharge of the concrete shall not exceed one and one-half (1 ½) hours. The time interval shall not exceed one (1) hour for hot weather (85 degrees Fahrenheit or above) construction. Concrete which has developed an initial set shall not be used. Retempering of partially set concrete by mixing with additional water is prohibited.



Delivery of concrete materials shall be controlled by tickets issued to the driver at the Plant. These tickets shall contain information as directed by the Engineer. Upon arrival at the job Site, the tickets shall be given to the Engineer.

Concrete mixing and delivery equipment shall meet the requirements of 905.02

- B. TRUCK MIXING** - All wash water shall be dumped before reloading the truck with concrete or concrete materials. No truck shall be loaded which contains free water in the drum. In depositing aggregates into the mixer drum, and in fastening the charging gate, no free water in excess of that found in the moisture determinations shall be admitted into the mixer drum.

Mixing water and wash water for truck mixed PCC shall be stored in watertight tanks, separate from the mixing drum. Each tank shall be equipped with an approved, operable, calibrated gauge. Water tanks shall be completely filled at the Plant. If, on arrival at the job, inspection reveals a drop in the water level, the batch may be rejected. All mixing water, other than free moisture in the aggregates, shall be added to the mix in the presence of the Engineer. Prior to adding mixing water to the drum the mixing water gauge valve shall be set to show the water level in the tank, and the gauge shall be read and recorded in the presence of the Engineer. No wash water shall be used until all concrete in the drum has been discharged.

The Contractor shall provide a level area for all truck mixing.

After all materials, including water, have been added to the mixing drum, mixing shall be in accordance with latest recommendations of the mixer manufacturer for a minimum of 70 and a maximum of 100 revolutions excluding revolutions at the agitation speed. The mixing speed shall not be less than 4 rpm and not more than 18 rpm.

If the slump is less than that desired, additional water may be added if permitted by the Engineer. After addition of the water, the mixing drum shall be rotated 20 to 30 revolutions at the mixing speed before the discharge of the concrete. After the addition of water the number of revolutions shall not exceed 100, except for concrete mixes containing coarse aggregates which do not wear more than 25 as determined in accordance with Resistance to Abrasion of Small Size Coarse Aggregate, AASHTO T 96, for which the number of revolutions shall not exceed 130.

The rate of discharge of concrete from the mixer drum shall be controlled by the speed of rotation in the discharge direction with the discharge gate fully open.

- C. TRANSIT MIXING** - Transit mixing shall be in accordance with 703.05(B) except: Mixing water shall be accurately measured at the proportioning plant and added to the mixing drum at the Plant. Mixing may be done at the Plant or at the job Site, at the option of the Contractor. In either case, the mixer drum shall be rotated at the agitation speed from the time the truck leaves the Plant until it arrives at the job Site.

- D. CENTRAL MIXING** - When central mixing is used, the proportioning and mixing plant shall meet all the requirements governing the handling, proportioning and mixing of concrete materials in a stationary mixer in conformance with AASHTO M 157.

The mixed concrete shall be conveyed from the central mixing plant to the Site of the Work in agitator trucks conforming to 905.02. The time elapsing from the time cement is added to the mix until the concrete is deposited in place at the Site of Work shall not exceed ninety (90) minutes when hauled in truck mixers or truck agitators, except that in hot weather (85 degrees Fahrenheit or above) the time interval shall not exceed one (1) hour.

- E. PAVING MIXERS** - Paving mixers having a rated capacity of 27 cubic feet or over may be used when approved by the Engineer.
- F. HAND MIXING** - Hand mixed batches of concrete may be allowed only in an emergency. The total quantity of such batches shall not exceed 1/2 cubic yard. Hand mixing shall be subject to the immediate direction and approval of the Engineer.

### 703.06 TESTING AND ACCEPTANCE

- A. GENERAL** - The Contractor shall have at least 1 competent and experienced concrete technician certified by the Mid-Atlantic Region Technician Certification Program or ACI at the job Site and be responsible for concrete delivery, discharge operations and sampling for process control for all structural concrete placements including temperature of the mix.
- B. CONSISTENCY** - The consistency of the concrete will be checked by the slump test in conformance with AASHTO T 119. Maximum slump shall be as specified in 817.03(B). The first 4 loads shall be tested for consistency and thereafter, determination will be made when and as often as deemed necessary by the Engineer to check the consistency of the concrete. The Contractor shall provide 2 slump cones, rod and a flat, non-absorbent surface in conformance with AASHTO T 119, for each project.

**C. AIR CONTENT** - Every load of the wet concrete shall be tested for air content in conformance with AASHTO T 196 or AASHTO T 152. The entrained air shall be as specified in 817.03(B). The Contractor shall furnish and maintain 2 air meters in conformance with AASHTO T 152 Type B and 1 meter meeting the requirements of AASHTO T 196. The air meters shall be calibrated by an independent laboratory, a certification of which shall be provided to the Engineer.

**D. COMPRESSIVE STRENGTH** - Test cylinders will be made from each class of concrete, at the direction of the Engineer. Concrete for such specimens shall be furnished by the Contractor as directed. 1 set of concrete test specimens shall made for every 50 cubic yards or less of concrete placed.

Concrete test specimens for compression strength testing shall be made and cured in accordance with AASHTO T 23. Compressive strength shall be tested in conformance with AASHTO T 22. Unless otherwise specified, the minimum twenty-eight (28) day compressive strength shall be in accordance with 817.03(B). The Contractor shall provide cylinder-curing facilities at the Project Site in conformance with AASHTO T 23. Immediately after molding and finishing, the concrete specimens shall be stored up to forty-eight (48) hours in concrete curing box with pre-set temperature controls and in an environment to prevent moisture loss from the specimens. The cylinders should be placed in a thermostatically climate controlled storage chest with adjustable temperature controller for heating or cooling and the temperature shall be maintained between 60° F and 80° F.

Curing boxes shall be submitted to and approved by the Engineer prior to use.

The Contractor shall transport the PCC specimens to the Department testing facility in conformance with AASHTO T23 (Transportation of Specimens to Laboratory). The Contractor shall furnish the Engineer with 2 concrete thermometers meeting the requirements of AASHTO T 309.

**E. PUMPED CONCRETE** - When concrete is pumped, concrete will be sampled for conformance to the consistency requirements before pumping and before the addition of approved admixtures, which are added at the Site after initial mixing. Concrete will be sampled for air content before pumping. However, the air content will be adjusted to compensate for changes in the air content which occur during pumping.

Approved High Range Water Reducer (HRWR) may be added. After the addition of HRWR, the slump and percentage of air shall be measured at the point of delivery. The following criteria shall apply:

Class A Structural Concrete – Maximum slump: 5 inches

Class H1 and Class H2 Structural Lightweight Concrete – Maximum slump: 5 inches

Class B Structural Concrete – Maximum slump: 6 inches

Percentage of Air by Volume: 6 to 8 percent

Unit weight shall be measured. All PCC specimens shall be obtained from the end of the pump discharge.

**F. ACCEPTANCE** - Concrete acceptance shall meet the requirements of 817.03.

If the twenty-eight (28) day compressive strength of the concrete cylinders falls below the specified strength as per District of Columbia Standard Specifications for Highways and Structures, Table 817.03, a price reduction shall be made for the quantity of concrete represented by the non-conforming cylinders determined from the following:

**TABLE 703.06 CONCRETE PRICE REDUCTION**

Percent of Minimum Specified Strength (%MSS)	Percent Price Reduction of Contract Unit Price
≥ 98	0
95 ≤ %MSS < 98	10
90 ≤ %MSS < 95	20
<90	Reject

1. When a compressive strength test result of cylinders from concrete does not obtain at least 90% of the minimum design strength in twenty-eight (28) days, the concrete will be rejected. The Engineer may allow the Contractor to obtain cores to test and evaluate the strength of concrete in place. Consideration for acceptance may be based on cores removed from the in-place concrete. Obtaining and testing cores of concrete shall be entirely at the Contractor's expense.
2. Cores shall be obtained by an independent firm, accredited by AASHTO, in the presence of a District Department of Transportation representative and the Contractor. The sample location, number, and size of cores will be determined by the Engineer.
3. Cores shall be tested by the District Department of Transportation or an independent testing firm accredited by AASHTO in testing concrete.
4. All conditioning and testing shall be in accordance with AASHTO T 24. The testing laboratory shall provide a written report on the results to the District Department of Transportation and the Contractor. The test report shall be signed and sealed by a Professional Engineer.
5. If the strength of the cores is < 90% of the MSS, the concrete is deemed deficient and shall be replaced entirely at the Contractor's expense.

### 703.07 WEATHER RESTRICTIONS AND NIGHT WORK

- A. **HOT WEATHER CONSTRUCTION** - The maximum temperature of concrete for bridge decks, approach slabs and other structural slabs shall be 80 degrees Fahrenheit. The maximum temperature of concrete used for other Structures shall be 90 degrees Fahrenheit. If the required consistency cannot be maintained, the mix shall be adjusted in accordance with 703.03. The temperature of the cement at the time of batching shall not exceed 160 degrees Fahrenheit. All deck reinforcing steel that comes in contact with the plastic concrete shall be cooled to below 90 degrees Fahrenheit before concrete placement.
- B. **COLD WEATHER CONSTRUCTION** - When the forecast of the National Weather Service indicates that the temperature is expected to be less than 50 degrees Fahrenheit during the twenty-four (24) hour period following the placing of the concrete, a Type C accelerator meeting the requirements of 814.04(A) shall be incorporated in the concrete mix at the batching Plant.

No concrete shall be placed without permission of the Engineer when the ambient temperature reaches 40 degrees Fahrenheit and is descending or when the U.S. Weather Bureau forecasts that the temperature will drop below 40 degrees Fahrenheit during the twenty-four (24) hour period following the placing of the concrete. If the Engineer permits concrete placement at temperatures lower than those specified above, the following requirements shall be met:

1. The temperature of the mixed concrete shall not be lower than 50 degrees Fahrenheit and not more than 90 degrees Fahrenheit at the time of placement.
2. When directed by the Engineer, the Contractor shall enclose and heat the Structure in such a way that the concrete and air within the enclosure is kept above 55 degrees Fahrenheit for a period of seven (7) days after placing concrete. When dry heat is used, means of maintaining atmospheric moisture shall be provided.

In lieu of enclosing and heating the Structure, approved form insulation may be used for concrete other than deck slabs. Form insulation shall be completely enclosed in a waterproof material which shall be maintained in a good and serviceable condition at all times. The blanket shall be applied tightly against the forms in an approved manner so as to exclude air and moisture. Both horizontal and vertical surfaces shall be covered and care shall be taken to see that all edges and corners are properly covered. If necessary, the tops of placements shall be protected by a tarpaulin or other waterproof cover over the insulation. The insulation shall be capable of maintaining the temperature of the concrete in the forms between 55 degrees Fahrenheit and 100 degrees Fahrenheit for a period of at least seven (7) days. At the end of the protection period the temperature of the concrete within the forms shall be gradually decreased at a rate of cooling not to exceed 20 degrees Fahrenheit per twenty-four (24) hours by gradually loosening the forms or insulation.

3. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

No direct payment will be made for incorporating an accelerator in the concrete or for the insulated curing required for cold weather construction. The cost of this Work will be included in the Contract Price for the various Portland cement concrete Pay Items.

The Contractor will be held responsible for any defective work caused by freezing. Concrete damaged in any manner shall be removed and replaced without cost to the District of Columbia.

- C. WIND** - No deck concrete placement shall be scheduled or started when it is anticipated that the wind velocity, excluding gusts, will exceed 15 M.P.H. as measured on Site.
- D. NIGHT WORK** - Concrete for bridge decks, approach slabs and other structural slabs may be placed at night, when appropriate, from June 1 through September 15. Regardless of the date or time, no concrete placement shall be scheduled when it is anticipated that the temperature at an un-shaded location within the placement Site will exceed 80 degrees Fahrenheit.

No other concrete shall be placed during night hours unless specified in the Contract or permitted by the Engineer.

An adequate lighting system shall be provided during nighttime construction for both placement operations and inspection testing. A minimum of 20 foot-candles illumination at the slab elevation shall be provided at all areas within the placement Site. A suitable light meter shall be provided to measure the illumination. A lighting plan shall be submitted to the Engineer for approval. In addition, before any initial slab placement operation, a test run shall be made to insure that the specified illumination is provided. If a portable generator is used, an emergency backup generator shall be available at the job Site.

### 703.08 PLACING CONCRETE

- A. GENERAL** - The Contractor shall ascertain that a sufficient supply of concrete to completely fill the forms without interruption will be available before starting the placement of concrete. The concrete delivery and placement rate shall be approved by the Engineer and shall be such that no previously placed batch is allowed to partially harden before the placement of the subsequent, adjacent batch.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

- B. FORMS** - Struts, stays, and braces serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete. After the initial set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of reinforcing bars which project.

No concrete shall be placed until the depth and character of the foundation, the adequacy of the forms and false work, and the placing of reinforcing steel have been inspected and approved by the Engineer. Such approval shall not relieve the Contractor from responsibility for satisfactory performance of his Work.

- C. DELIVERY TO FORMS** - Open troughs and chutes shall be of metal or metal lined.

Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the Structure.

When placing operations would involve dropping the concrete more than 5 feet, it shall be deposited through sheet metal or other approved pipes. Pipes shall be so constructed so that concrete is not allowed to free-fall more than 5 feet. Pipes will not be required for walls 2 feet thick and under.

In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of the forms.

Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing the concrete as near the final position as possible. Working or flowing of concrete along the forms from the point of deposit will not be permitted.

- D. SPREADING MACHINES** - When approved for use by the Engineer spreading machines shall meet the requirements of 905.05.

- E. EMERGENCY SHUTDOWN** - In case of emergency shutdown, steps shall be taken, as required by the Engineer, to prevent detrimental effects on placing operations. For bridge deck concrete, the Contractor shall provide a suitable construction joint by use of a bulkhead to the satisfaction of the Engineer. Excess concrete shall be removed from the forms and disposed of properly.
- F. CLEANUP** - Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcing steel, anchor bolts and the surface of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcing steel.

### 703.09 CONSOLIDATION

- A. GENERAL** - Concrete, during and immediately after depositing, shall be thoroughly consolidated. Consolidation shall be done by mechanical vibration subject to the following provisions.

Each layer shall be placed and consolidated before the preceding layer has taken initial set to prevent the formation of a cold joint between layers.

- B. EQUIPMENT** - The vibration shall be internal unless special authorization of other methods is given by the Engineer, or as provided herein.

Vibrators shall be of a type and design approved by the Engineer and shall meet the requirements of 905.07. The intensity of vibration shall be such as to visibly affect a mass of concrete of 1 inch slump over a radius of at least 18 inches.

The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch immediately after it is placed in the forms. The size of the vibrator shall be governed by the space available for its use in the forms and between reinforcing bars.

Hand tools shall meet the requirements of 905.09.

- C. APPLICATION OF VIBRATIONS** - Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective, or not more than 3 feet apart throughout the mass of concrete. Vibrations shall be transmitted directly to the concrete and in no case shall they be transmitted through the forms.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms.

Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into corners and angles of the forms.

Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

### 703.10 PLACING CONCRETE BEHIND STONE MASONRY

No concrete shall be placed back of stone masonry for the first twenty-four (24) hours after the stone has been set and until the mortar in the masonry has set sufficiently to withstand the pressure of fresh concrete. The concrete shall be placed in such a manner as to avoid damaging pressures on the stone masonry.

Anchorage and bracing shall be outlined in 708.09 and 708.10(F). The requirements for bonding concrete to stone masonry shall be outlined in 708.10(E).

### 703.11 DEPOSITING CONCRETE UNDERWATER

- A. GENERAL** - Concrete shall not be exposed to the action of water before setting and shall not be deposited underwater except with the approval of the Engineer and under his immediate supervision, and, under his conditions, the method of placing shall be as designated herein.

Concrete deposited underwater shall be tremie concrete. Tremie concrete shall be carefully placed in a compact mass in its final position by means of tremie pipes in such manner as to produce a continuous, complete monolith of concrete without joints, of the full area of the foundation and of the thickness required, and concrete shall not be disturbed after being deposited. Concrete shall be deposited only under still water and in forms or cofferdams which are substantially watertight.

The cement content of concrete to be placed underwater shall be increased by 10 percent over that of comparable concrete placed above water.

Placement of underwater concrete by means of bottom dump buckets will not be permitted.

- B. PLACEMENT** - Concrete deposited as seal courses of foundation bases shall be placed in continuous operations without any cessation, and if necessary, both day and night without midday or other stops until the entire mass of the seal has been placed. Adequate plant and supplies of material shall be on hand to assure such continuous operation. The concrete plant shall be so arranged that breakdown of any piece of equipment will not necessitate complete shutdown. Depositing shall be so distributed in the area of placement that the surface of the concrete shall be kept as horizontal as practicable at all times.

- C. TREMIES** - Tremies shall consist of watertight tubes, preferably of steel pipe about 10 inches in diameter constructed in sections having screwed joints of flanged couplings fitted with gaskets, and fitted at the top end with a hopper. Tremie tubes shall be sufficiently long so that when set on the bottom of the excavation where concrete is to be deposited the hopper shall extend above the water. Tremies shall be supported so as to permit proper filling of the hoppers and so that the tremie can be raised vertically with a slow movement and lowered rapidly to retard the flow of concrete. The discharge end of each tremie tube shall, unless otherwise permitted by the Engineer, be equipped with an approved automatic check valve. At the start of the Work, the check valve shall be closed to prevent water from entering the tube and thereafter the discharge end shall be entirely sealed at all times by being set upon the bottom of the excavation or upon concrete already deposited and the tremie tube shall be kept full to the bottom of the hopper. When a batch of concrete is dumped into the hopper, the tremie shall be slowly raised but not out of the concrete at the bottom of the tremie and until the batch discharges to the bottom of the hopper; the tremie shall then be quickly lowered and the flow of concrete stopped.

A sufficient number of tremies shall be provided for each foundation so that the lateral flow from any tremie shall not exceed 10 feet unless otherwise approved by the Engineer. The sequence of depositing concrete in tremie pipes shall be as directed by the Engineer. The interval between depositing 1 batch of concrete in a given tremie and depositing the next batch therein in no case shall exceed fifteen (15) minutes and preferably shall be more rapid.

- D. FINISHING** - After concrete is placed and succeeding courses have properly hardened, the water shall be pumped out and any laitance which may have accumulated on the concrete or any defective concrete which is exposed shall be removed and the surface suitably prepared for additional concrete.

The Contractor's attention is directed to the fact that the Elevation of the completed surface on the top of the seal must be such that the required Elevations noted in the Contract Documents for the Substructure can be maintained. When necessary to maintain this Elevation, the Contractor shall be required to chip away the concrete, and any costs incidental thereto will be at the sole expense of the Contractor.

### 703.12 PUMPING CONCRETE

Placement of concrete by pumping will be permitted only if authorized by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. When concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the Work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipe line, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. Aluminum pipes shall not be permitted for placing concrete.

The slump of concrete to be pumped shall not be increased by the addition of water such that the slump exceeds the maximum limits of 817. In no case shall the maximum water-cement ratio be exceeded as allowed in the approved mix design. If approved by the mix design, the slump may be increased by the use of admixtures.

### 703.13 CONSTRUCTION JOINTS

Construction joints shall be made only where indicated on the Plans, unless otherwise approved by the Engineer. If not detailed on the Plans, or in case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined reinforcement shall be used, where directed, to transmit shear or to bond the 2 sections together.

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened as required by the Engineer in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance, and saturated with water. To insure an excess of mortar at the juncture of the hardened concrete and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be thoroughly covered with a coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained the initial set.

The placing of concrete shall be carried continuously from joint to joint. Whenever the Engineer so directs, the Contractor shall be required to place chamfer strips for vertical or horizontal construction joints so that the joint in the finished concrete will show as a V-notch. Such demarcation of construction joints shall be that produced by using 3/4 inch chamfer strips. All chamfer strips shall be milled lumber. Where construction joints are not notched as described above, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel to avoid irregularity in the joint on exposed faces.

Where a "featheredge" might be produced at a construction joint, as in the sloped top surface of a wall, an insert formwork shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 6 inches in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face.

### 703.14 WOOD CONCRETE FORMS

**A. GENERAL** - Concrete form drawings and calculations shall be prepared by or under the direction of a Registered Professional Engineer and shall bear his P.E. seal. Forms shall be designed in accordance with the criteria specified herein.

#### **B. FORM DESIGN**

1. **General** - All lumber shall be stress-graded and the grade shall be stamped or branded on the lumber. The supplier shall submit certifications for the grades of lumber supplied. Working stresses used in form design shall not exceed allowable stresses for the grade of lumber furnished.
2. **Loads** - Loads for design shall be in accordance with paragraph 2.2 of the American Concrete Institute Standard Recommended Practice for Concrete Formwork (ACI 347R).
3. **Unit stresses** - Unit stresses for lumber shall be in accordance with the National Forest Products Association Publication titled "Design Values for Wood Construction."
4. **Deflection** - Maximum deflections for each form member shall not exceed the following:
 

• Exposed walls, abutments, piers, parapets and curb	L/360
• Unexposed (stone-veneered) walls, etc.	L/270
• Decks and footings	L/180
5. **General design information** - Investigation of the strength and stiffness requirements of lumber components shall be made in accordance with the National Forest Products Association National Design Specifications and its manual titled "Wood Structural Design Data." Adjustment of working stresses shall be made in accordance with the NDS.

Plywood thickness and joist or stud spacing shall be in accordance with Table 703.14. Metal ties, hangers and other hardware

shall be designed in accordance with the manufacturer's recommendations.

**TABLE 703.14 MAXIMUM STUD OR JOIST SPACING (INCHES)**

Form Pressure (psi)	Plywood thickness					
	5/8-inch			3/4-inch		
	Allowable Deflection			Allowable Deflection		
	L/360	L/270	L/180	L/360	L/270	L/180
100 and less	22	24	26	24	28	32
200	18	20	22	20	23	26
300	16	17	18	18	20	22
400	14	15	16	16	18	19
500	13	14	15	15	16	17
600	12	13	14	14	15	16
700	11	13	14	13	15	15
800	11	12	13	13	14	14
900	10	11	12	12	13	13
1000	9	11	11	12	12	12
1100	use 3/4"	10	10	11	12	12
1200	use 3/4"	10	10	11	11	11
1300	use 3/4"	10	10	11	11	11
1400	use 3/4"	9	9	11	11	11
1500	use 3/4"	use 3/4"	use 3/4"	10	10	10

- Table assumes plywood is continuous over 2 or more spans. For simple spans, use 200: or the value of the computed form pressure.
- Table assumes plywood face piles are parallel to the span. If plywood face piles are parallel to supports use 200: or the value of the computed form pressure for 5/8-inch plywood. 133: for 3/4-inch plywood.
- Table is for plywood having stress values of  $f = 2000$  psi and  $E = 1,600,000$  psi.

**C. CONSTRUCTION METHODS** - All concrete shall be placed in suitable forms or against excavated Earth surfaces. The latter procedure will be allowed only if expressly permitted by the Engineer. Forms shall be of wood or metal and shall be built mortar-tight. Forms for exposed surfaces shall be so constructed that the surface of the concrete will be smooth and uniform in appearance.

Lagging for the bottom forms of rigid frames or arches shall be not less than 1-1/4 inch nominal thickness for joists spaced 21 inches to 24 inches, and not less than 1 inch nominal thickness for joists spaced 20 inches or less and shall be lined with 3 ply plywood. Curved surfaces shall accurately follow the required radii. Forms shall be mitered at all sharp corners and shall be given a bevel or draft for all projections, such as girders and copings, to insure easy removal.

Plywood sheets for form lining on exposed surfaces shall be placed symmetrically between joints, for symmetry in appearance of the concrete surface.

Temporary openings shall be provided at the bottom of the forms for narrow walls and piers where necessary to facilitate cleaning before depositing concrete.

Suitable milled triangular beveled moldings approximately 3/4 inch on the square sides of such size as directed, shall be placed in the angles for the forms to chamfer the exposed edges of the concrete, including the abutting edges of expansion joints.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 2 inches from the face without injury to the surface of the concrete by spalling or otherwise. In exposed surfaces or concrete, metal ties or anchorage shall not be fitted with any lugs, cones, washers or other device to act as a spreader within the forms, or which will leave a hole larger than 7/8 inch diameter or a depression. Ties designed to break off back of the surface of concrete will not be permitted. Wire ties will not be permitted. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size.

All forms shall be set and maintained true to the line designed until the concrete has sufficiently hardened. Forms shall remain in place for periods which shall be determined as specified herein. When forms appear to be unsatisfactory in any way, either before or during placing of concrete, the Engineer will order the Work stopped until the defects have been corrected.

The shape, strength, rigidity, water-tightness and surface smoothness of reused forms shall be maintained at all times. Any warped



or bulged lumber must be resized before being reused. Forms which are unsatisfactory in any respect shall not be reused.

The inside surface of forms shall be soaked with clean water and kept wet for twelve (12) hours before any concrete is placed. In case forms have been erected for some time and have become dry so that joints have opened then the forms shall be thoroughly soaked until the joints have closed. Forms for exposed surfaces and forms intended to be reused shall be treated with oil before erection of the forms or before placing reinforcing steel in the forms. The oil used for this purpose shall be clear, paraffin base oil which will not stain or discolor the concrete surface. Excess oil shall be wiped off with rags to leave the surface of the forms just oily to the touch.

### 703.15 TEMPORARY STEEL BRIDGE DECK FORMS

- A. GENERAL** – The use of temporary steel forms in constructing the new bridge deck shall be optional. These forms shall be considered temporary for construction of the deck and shall be promptly removed when the deck has obtained sufficient strength to support all anticipated loads. Stay-in-place forms may be used when allowed by the Engineer.
- B. MATERIALS** – Temporary steel bridge deck forms and supports shall be fabricated from steel conforming to ASTM Specification A 653 (Grade A through E) having a coating class of G 165 according to ASTM Specification A 653.
- C. DESIGN** – The following criteria shall govern the design of temporary steel bridge deck forms:
1. The steel forms shall be designed on the basis of form dead load, reinforcement and plastic concrete plus 50 pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not be more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 pounds per square inch.
  2. Deflection under the weight of the forms, the plastic concrete, and reinforcement shall not exceed 1/180 of the form span or 1/2 inch, whichever is less, but in no case shall this loading be less than 120 PSF total. The permissible form camber shall be based on actual load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.
  3. The design span of the form sheets shall be the clear span of the form plus 2 inches measured parallel to the form flutes.
  4. Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.
  5. Bottom reinforcement shall have a minimum concrete cover of 1 inch.
  6. The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.
  7. Temporary steel bridge deck forms shall not be considered as lateral bracing for compression flanges of supporting structural members.
  8. Temporary steel bridge deck forms shall not be used in panels where longitudinal deck construction joints are placed between stringers.
  9. Welding to structural steel shall not be permitted. Forms shall be attached to steel members by the use of clamps or other approved mechanical devices which make the forms easily removable without the application of heat.
  10. Fabrication, shop and erection drawings shall be submitted to the Engineer for approval. These Plans shall indicate the grade of steel, the physical and section properties for all temporary steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.
- D. CONSTRUCTION** – All forms shall be installed in accordance with approved fabrication and erection Plans.
- Form sheets shall not be permitted to rest directly on top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible bolts, clips, or other approved means. The attachments shall be designed to facilitate easy removal of the temporary steel deck forms. Welding shall not be permitted.
- E. PLACING OF CONCRETE** – Concrete shall be placed in accordance with the Contract Specifications. Particular emphasis should be placed on proper vibration of the concrete to avoid honeycombs and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Placement sequences, procedures and mixes shall be approved by the Engineer.
- F. INSPECTION** – The Contractor's method of construction shall be carefully observed during all phases of the construction of the Bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of

concrete items; mixing procedures; concrete placement, vibration and finishing of the bridge deck and removal of the forms. Should the Engineer determine that the procedures employed during concrete placement warrant inspection of the underside of the deck, the Contractor shall remove at least 1 section of the forms at locations and times selected by the Engineer for each span in the Contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the Contractor's procedures warranting additional inspection.

After the deck concrete has attained adequate strength, the forms shall be removed and disposed of properly. This removal is considered part of the required Work and shall be at no additional cost to the District.

As soon as the forms are removed, the concrete surface will be examined for cavities, honey-combing and other defects. If irregularities are found and it is determined by the Engineer that these irregularities do not justify rejection of the Work, the concrete shall be repaired as the Engineer may direct and shall be given an ordinary surface finish in accordance with the concrete Specifications.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient operation of the Engineer's inspection procedures.

### 703.16 FALSEWORK AND CENTERING

- A. DESIGN** – The Contractor shall engage the services of a Registered Professional Engineer (P.E.) registered in the District of Columbia, which P.E. shall have a minimum of five (5) years experience in falsework design for bridge construction and repair, to design the falsework for the Project.

In the event there is more than 1 Structure in the Project, each Structure shall require a separate falsework design analysis as specified herein. This requirement applies even when Structures appear to be identical.

All falsework shall be designed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework shall be set with the necessary camber so that the completed Structure will be true to the lines and grades shown in the Contract Documents. Suitable means shall be provided to take up any settlement in the falsework either before or during the placing of concrete.

Each falsework system shall be designed to have the capacity to support all vertical and horizontal loading with enough redundancy to prevent progressive failure. Vertical loading, differential settlement forces, live load where applicable and all horizontal lateral and longitudinal forces shall be taken into account. Unbalanced temporary loading caused by placement sequence shall be provided for in the design. Adequate diagonal bracing in all planes shall be employed. The falsework drawings shall contain information on materials to be used and on procedures for erection.

When falsework installations are to be erected adjacent to a highway, special design consideration and protection shall be taken to ensure that the falsework system is not disturbed by errant highway vehicles or by the vibration forces caused by passing vehicles. Designs shall provide for protection against accidental collision of a crane boom or other construction equipment and vehicles, flood waters, high winds and any other envisioned contingent situations.

All designs and drawings for falsework systems shall provide for possible settlement and shall have adequate foundations with bearings below the frost line, on rock or piling. If additional subsurface data is necessary, it shall be obtained by the Contractor and analyzed by the P.E. for proper design of the falsework assembly and performance of construction, all at no additional cost to the District.

- B. SUBMITTALS** – Prior to commencement of construction, designs for falsework shall be submitted for approval in accordance with 105.02. Work on the falsework shall not be started before approved Plans are available.

The design calculations and working and erection drawings for falsework submitted by the Contractor shall be signed by the registered Professional Engineer (P.E.) who prepared these calculations and drawings and shall bear the P.E.'s seal. The submittal of the design and falsework drawings shall include the P.E.'s resume showing evidence of the required experience as heretofore specified.

The P.E.'s Plans and design calculations shall evaluate and qualify all manufactured items for their intended service. Approval by the District of falsework systems shall not in any way relieve the Contractor of his/her responsibility for the safety and adequacy of the design and construction for the falsework systems and operations, including all components. The Contractor's contracts with his/her suppliers, Subcontractors and manufacturers shall state their complete responsibility for the design and quality of their products and components including manufactured products and proprietary items.

- C. **CONSTRUCTION** – The Contractor shall not proceed with construction of falsework until approval of Working Drawings, submitted in accordance with 703.16(B) has been obtained from the District.

The falsework shall be constructed and maintained in accordance with the approved Working Drawings. Subsequent to approval any changes to the falsework design proposed by the Contractor through his professional Engineer shall be resubmitted for approval in accordance with 703.16(B).

After assembly of the falsework system and before permitting any loads to be placed on falsework, the Engineer shall receive written certification by the Contractor’s professional Engineer that the falsework system has been erected according to the approved falsework drawings. This certification shall be accompanied by a certificate of compliance stating that all manufactured materials and assemblies fully comply with the falsework design and drawings. Upon inspection of the falsework system, the Engineer may require that testing be performed on any of the materials or assemblies. The costs of such testing shall be borne by the Contractor.

Falsework shall be set with the necessary camber so that the completed Structure will be true to the lines and grades shown on the Plans. A “telltale” or other approved type indicator shall be attached to the forms in a manner to indicate any settlement, movement or deflections in the forms or falsework. Should any indicator show settlement, movement or deflection in excess of the prescribed tolerance(s), the Work shall be stopped and the Contractor shall be required to rectify the problem to the full satisfaction of the Engineer at the Contractor’s expense.

In addition to protective measures shown on the falsework drawings, the Engineer may direct the Contractor to provide such further protection of falsework, which measures in the Engineer’s judgment are necessary for public safety and protection of the Work.

In the event falsework is moved from 1 Structure to another, the falsework shall be thoroughly inspected and approved by the Contractor’s professional Engineer, (P.E). The falsework shall not be moved until the P.E.’s certification is reviewed and approved by the Engineer.

**703.17 REMOVAL OF FALSEWORK AND FORMS**

Falsework for deck forms shall not be removed until the deck slab concrete has attained a minimum compressive strength of 4,500 psi.

In the determinations of the time for the removal of falsework and forms, consideration shall be given to the location and character of the Structure, the weather and other conditions influencing the setting of concrete, and the materials used in the mix. When stripping concrete forms is not controlled by means of cylinder strength, the following minimum periods, exclusive of days when the temperature drops below 40 degrees Fahrenheit, may be used as a guide for removal of forms and supports which shall not be removed without the approval of the Engineer.

**TABLE 703.17 FALSWORK AND FORM REMOVAL TIMES**

Walls, piers, footings, and side forms	12 hours
Floor slabs	8 days
Concrete superstructure, beams, arches	14 days
Rigid frames	14 days
Columns	3

Methods of form removal likely to cause overstressing of the concrete shall not be used. In general, forms shall be removed from the bottom upward. Particular care shall be taken in the removal of side forms before the concrete has attained considerable strength and hardness, to avoid breaking exposed edges or corners or spalling the surface.

**703.18 CONCRETE PARAPETS AND BARRIERS**

- A. **GENERAL REQUIREMENTS** – The Contractor may use fixed, removable form or slip-form construction methods provided concrete parapets and railings are constructed to the proper grade, alignment, and finish as indicated in the Contract Documents. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints and all corners in the finished work shall be true, sharp, and clean cut. Alignment of forms and grade of top chamfer strips shall be checked immediately after the placing of concrete in the forms.

Prior to beginning superstructure work, the Contractor shall submit to the Engineer, for approval, a detailed work plan describing equipment, materials, and procedures to be used in the proposed construction methods for parapets and median barriers. The work plan must be approved prior to starting any concrete parapet or barrier work. If the proposed construction methods require bridge decks to be widened or additional reinforcing steel placed in the railing, parapet, or median barrier to accommodate the extrusion machine, the Contractor shall submit all necessary details for approval. Widening the bridge deck, placing additional reinforcing steel, or any other additional work necessary for accommodating the extrusion machine shall be at the Contractor's expense.

- B. SLIP-FORM METHOD** - The slip-form machine shall have automatic horizontal and vertical grade control and be approved by the Engineer. The slip-form machine shall be equipped with internal vibrators to consolidate concrete along the face and adjacent joints in one complete pass of the machine. Additional reinforcement shall be placed to brace the parapet against displacement and the Contractor shall ensure the minimum clearances for reinforcing steel are maintained. The Contractor shall perform a dry run of the equipment, in the presence of the Engineer, after installation of all reinforcing steel, conduits, junction boxes, and any other elements of the work to be embedded within the concrete.

If the slip-form method is approved for cold weather concrete placement, a Type C accelerator is not required to be incorporated into the concrete mix. The work shall conform to all other cold weather construction requirements of 703.07 (B).

Concrete delivery to the slip-form machine shall be continuous. The slip-form machine shall remain in continuous motion from start to the proposed finish.

Joints shall be saw cut after initial concrete set, but within 8 hours of concrete placement.

Concrete curing shall be in accordance with 703.19(A), except that a resin-based pigmented liquid curing compound shall be applied immediately after the concrete is finished, regardless of ambient temperature. Immediately after each joint is saw cut, the concrete surfaces shall be wet cured for seven days as specified 703.19(A).

If the slip-form method does not provide acceptable results, in the opinion of the Engineer, the operation shall be stopped, unacceptable work shall be removed, and modifications to the work plan shall be submitted to the Engineer for approval. If the modified construction methods do not produce acceptable results, the fixed form method shall be used. No time extension or additional compensation shall be provided for modifications or changes to construction methods.

### 703.19 CURING CONCRETE STRUCTURES

- A. GENERAL REQUIREMENTS** - All concrete shall be cured and protected as specified herein. Before placing the concrete, the Contractor shall make all necessary arrangements for curing and protecting the concrete.

Concrete not covered by forms shall be cured using either of the following 2 systems for a period of seven (7) days:

1. 2 layers of burlap meeting the requirements of 814.01(A), covered with 1 layer of white polyethylene film, meeting the requirements of 814.01(B).
2. 1 layer of burlap covered with 1 layer of white burlap-polyethylene sheet meeting the requirements of 814.01(D).

The burlap and burlap portion of the white polyethylene film shall be saturated with water before it is placed in position, and maintained in a saturated condition by a continuous supply of water distributed by suitable means such as soaker hoses. The above described curing materials shall be placed as soon as it is determined by the Engineer that the concrete is hard enough to prevent marring during placement of the curing material. The curing materials shall be sufficiently secured to ensure that the entire area remains covered and wet for the required period.

Wood forms shall likewise be kept wet for the seven (7) day curing period.

At the ambient air temperature of 80° F (27 ° C) and below, the use of a resin-based pigmented liquid curing compound, meeting the requirements of 814.02, may be permitted immediately after final finishing of the concrete. Whether or not a curing compound is used, one of the abovementioned 2 curing systems shall be applied as specified.

At ambient air temperatures between 80° F (27° C) and 85° F (29° C), the use of the resin-based pigmented liquid curing compound shall be required immediately after the final finishing of the concrete. One of the above-mentioned 2 curing systems shall be applied as specified as soon as it is determined by the Engineer that the finished concrete is hard enough to prevent marring during placement of the curing system.

The pigmented liquid curing compound shall be applied at a minimum rate of 1 gallon per 200 square feet. Application shall be such that an even, continuous membrane is produced on the concrete surface.

When directed by the Engineer, the Contractor shall be required to take precautions as specified in Section 2.1.5 of ACI 305R to prevent plastic shrinkage cracking.

The requirements of this section relative to keeping concrete surfaces saturated at all times will be strictly enforced. The Contractor shall furnish a sufficient water supply and personnel on a twenty-four (24) hour basis to satisfy the requirements specified herein.

**B. CONCRETE BRIDGE DECK SLABS** - Concrete bridge deck slabs and other structural slabs shall be cured by using 1 of the following methods for a period of seven (7) days.

1. 2 layers of burlap meeting the requirements of 814.01(A), covered with 1 layer of white polyethylene film meeting the requirements of 814.01(B) shall be placed to assure that the entire deck surface is covered. The burlap shall be well secure at all times. A continuous supply of water will be required during the curing period to assure that the burlap and concrete surfaces are saturated at all times.
2. 1 layer of burlap covered by 1 layer of white burlap-polyethylene sheet meeting the requirements of 814.01(D) may be used. The burlap-polyethylene shall be well secured to ensure that the entire deck surface will be covered at all times. A continuous supply of water will be required to assure that the burlap and concrete surfaces are saturated at all times.

At an ambient air temperature of 80 degrees Fahrenheit and below, the use of clear liquid curing compound immediately after finishing may be permitted. Whether a curing compound is used or not, 1 of the above 3 curing methods shall be applied as soon as it is determined by the Engineer that the finished deck concrete is hard enough to prevent marring during placement of the curing methods.

In areas where continuous dripping water from the deck may create problems and/or hazards to the public, the Contractor shall be required to submit to the Engineer for approval alternate methods of curing or means of diverting the runoff water.

The requirements for keeping the concrete surfaces saturated at all times will be strictly enforced. The Contractor shall be required to furnish a sufficient water supply and personnel on a twenty-four (24) hour basis to satisfy these requirements.

## 703.20 FINISHING EXPOSED CONCRETE STRUCTURES

**A. GENERAL** - Forms of exposed surfaces shall be removed when permitted by the Engineer, without delay, to facilitate any necessary patching, cleaning or surface treatment as required herein to provide a satisfactory finished appearance.

After removing forms, all fins and irregular projections shall be removed from exposed surfaces. On all surfaces, cavities produced by form ties, and all other holes, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned and saturated with water for not less than three (3) hours immediately before repairs are made. They shall be filled with mortar composed of 1 part cement to 2 parts of fine aggregate by volume. The cement portion shall be composed of varying quantities of white cement mixed with the cement used on the job. Trial batches shall be made up and used for patching on concealed surfaces until a satisfactory matching color is obtained for use on exposed surfaces.

Any honeycombed concrete shall be chipped away to such depth that all voids have been entirely removed. The edges of the materials remaining in place shall be cut perpendicular to the finished surface to the average depth of the material removed, but not less than 1 inch. All surfaces of the cavity shall be thoroughly cleaned and saturated with water. The cavity shall then be filled with concrete composed of the same kind of materials and proportions as in the surrounding concrete and shall be properly compacted. The concrete shall be cured as specified in 703.19.

**B. GROUT CLEANING** - Unless otherwise specified in the Contract Documents, exposed concrete surfaces shall be grout cleaned as follows:

Grout made with 1 part Portland cement and 1-1/2 parts fine sand and sufficient water to produce a consistency of thick paint, shall be applied uniformly to the concrete surface with brushes or spray guns so as to completely fill air bubbles and holes. White Portland cement shall be used for all or part of the cement in the grout, as directed by the Engineer, to give the color desired. The surface of the concrete before applying the grout shall be sufficiently wet to prevent absorption of water from the grout. Immediately after applying the grout, the surface shall be floated with a cork float, scoring the wall vigorously. While the grout is still plastic, the

surface shall be finished with a sponge rubber float, removing all excess grout. This finishing shall be done at the time when the grout will not be pulled from the holes or depressions. The surface shall then be allowed to dry thoroughly and then rubbed vigorously with dry burlap to completely remove any dried grout. There shall be no visible film of grout remaining after this rubbing. Upon completion of the grout cleaning, any dark spots or streaks shall be wiped off lightly with a fine abrasive hose without using water.

- C. **ALTERNATE SURFACE FINISH** - Brushed on coatings may be used in lieu of the grout cleaning if approved by the Engineer. A test panel shall be finished to determine the color and texture characteristics.

### 703.21 MASONRY BEARING AREAS AND ANCHOR BOLTS

- A. **MASONRY BEARING AREAS** - At the option of the Contractor, masonry bearing areas may be grouted, as herein set forth and shown on the Plans; otherwise they shall be placed approximately 1/4 inch high and honed or ground level to within 1/16 inch (plus or minus) of proper Elevation. Unless otherwise shown on the Plans, when bearing plates are set on ground or honed surfaces, a sheet of 70 durometer neoprene 1/8 inch in thickness meeting the requirements of 822.02(C) or preformed fabric pads meeting the requirements of 822.02(A) with holes provided for anchor bolts, shall be placed between the masonry and the bottom of the plates.

If grouted, the bearing areas shall be set into the masonry surface 1 inch, so as to assure a pad edge thickness of at least 1 inch. Grouting methods shall be such that the entire space between masonry and plate is completely filled, and masonry bearing plates and shoes shall have full uniform bearing on the Substructure masonry. They shall be carefully located and rigidly held to correct alignment and Elevation during the grouting operation. With the permission of the Engineer, small holes may be drilled in the masonry plates to permit the escape of air trapped during grouting. The grout shall be non-shrink and the mix proportions shall be 1 part cement and 1-1/2 parts sand. Cement and sand shall first be thoroughly mixed dry before adding clean, fresh water to produce the required consistency. Grout shall be mixed only in those quantities required for immediate use. Grout that is not used within forty-five (45) minutes after water has been added shall be discarded. Re-tempering of grout will not be permitted. No superimposed load shall be placed on the bearing plates until the grout has set for at least forty-eight (48) hours. No grouting shall be done in freezing weather. Grout shall be protected and kept moist for at least three (3) days after grouting. After the grout has set sufficiently, the edges of the grout pad shall be finished to a slope of 45 degrees.

- B. **ANCHOR BOLTS** - All necessary anchor bolts in piers, abutments, or pedestals shall be accurately set in the concrete masonry as it is being placed, in holes formed while the concrete is being placed, or in holes drilled after the concrete has set. If set in the masonry as it is being placed, anchor bolts shall be positioned by means of a suitable template and otherwise held rigidly in place by means of wires, blocks or other means satisfactory to the Engineer. The template shall be so arranged that the concrete bearing area, if poured high as specified herein, may be readily accessible for proper finishing.

Holes, if drilled, shall be at least 1 inch larger in diameter than the bolts used, or in accordance with the manufacturer's recommendations. Holes shall be drilled utilizing a template to insure proper alignment. Holes shall be carefully cleaned after drilling to remove all drilling residue. Where dry drilling is employed, the holes shall be vacuumed or blown out using oil-free compressed air. Where the drilling process requires the use of water, holes shall be carefully washed out after drilling to remove any drilling slurry residue and then be permitted to dry prior to placing bolts. Provisions shall be made to protect unfilled holes against rupture in freezing weather.

The Contractor shall anticipate that reinforcing bars or utilities may be encountered while drilling holes in concrete. The use of diamond bit drilling or other special procedures necessary to drill through reinforcing bars shall be included as part of the Work. The Contractor shall be responsible for any damage to electrical conduits, utilities or the Structure. The repair of any damage shall be included as part of the Work. When drilled holes are utilized for new construction, the Contractor shall adjust the reinforcement prior to placing the concrete so that drilling through reinforcement will not be required.

Anchor bolts and bolt holes shall be thoroughly clean and dry at the time of bolt installation. Any grease encountered shall be removed with toluene. The bolts shall be set accurately as to location and projection and fixed with grout completely filling the holes. The grout shall conform to 806.05. Conditions and directions for use shall conform to the manufacturer's directions. Templates shall be used to hold the bolts in position until the grout cures. Temperatures at the time of installation shall be 35 degrees Fahrenheit or above and both holes and bolts shall be free of frost. Curing temperatures of above 25 degrees Fahrenheit shall be maintained.

Exposed portions of anchor bolts shall be thoroughly cleaned and painted within three (3) days, but not less than eight (8) hours after installation to protect the masonry from rust stains.

Anchor bolts for hand railing shall, unless otherwise required, be set in the masonry as it is being placed, positioned by means of templates and otherwise be held rigid as outlined herein.

Should the exposed portion of anchor bolts become dirty or rusty prior to setting the shoes, the Contractor shall thoroughly clean and paint the anchor bolts before setting shoes. All portions of anchor bolts and anchorage metal exposed after erection of shoes shall be painted as provided for in 707.

## 703.22 BRIDGE DECKS AND APPROACH SLABS

- A. GENERAL** - All bridge deck concrete shall be placed in conformance with 703.07 and cured in conformance with 703.19(B).
- B. MACHINE FINISHING** - Machine finishing of bridge decks and approach slabs is required. Equipment for finishing shall be in accordance with 905.06(B). A rolling bridge shall be located on the finishing machine rails behind the finishing machine for the use of the Contractor and for inspection and testing.

Prior to beginning concrete placement operations, the finishing machine shall be operated over the full area of the slab to be constructed. This test shall be made with the machine adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement measured and controlling dimensions of slab thickness checked. All necessary corrections shall be made at least four (4) hours before concrete placement and operations begin.

After the concrete has been placed, spread, and consolidated to provide a uniformly dense structural slab, the surface shall be struck off immediately by the passage of the finishing machine. A sufficient quantity of concrete shall be in place in front of the auger to preclude low and porous areas. The oscillating travel of the auger and cylinder device shall be repeated as necessary to produce a uniformly consolidated, dense, smooth surface of the required contour.

After passage of the finishing machine, any irregular or unsealed surface shall be floated with a float meeting the requirements of 905.09(C). No water shall be applied to the slab surface during the finishing process.

Immediately after floating, the surface shall be tested for irregularities with a straightedge per 903.03. All slab sections shall be tested with a straightedge parallel to traffic flow. The straightedge shall be used to test the surface for longitudinal trueness. All depressions and high spots of more than 1/8 inch in 10 feet must be corrected as directed by the Engineer. If a surface fails to meet these tolerances, the Contractor shall correct the deficiency at the Contractor's expense. In testing the surface, successive positions of the straightedge shall be lapped 1/2 its length.

All depressions and high spots of more than 1/8 inch in 10 feet which exist in the hardened concrete shall be corrected in a manner as directed by the Engineer at the Contractor's expense.

- C. TEXTURING** - Texturing is required for the entire concrete bridge deck and approach slab riding surfaces, except for a 12-inch wide gutter surface adjacent to the curb or face of traffic barrier. The purpose is to create a suitable skid resistant riding surface for the finished Structure.

The method of bridge deck texturing by saw cutting grooves shall be used.

The grooving operation shall not be started until the bridge deck has been cured in accordance with the Specifications and attained a minimum compressive strength of 3,000 psi. The bridge deck shall be grooved perpendicular to the center line.

The grooves shall be cut into the hardened concrete using a mechanical saw device which will leave grooves 1/8 inch wide,  $3/16 \pm 1/16$  inch depth and variably spaced from 5/8 to 7/8 inch apart.

The grooves shall extend across the slab to within 1 foot of the gutter lines. The transverse grooving shall not cut across joints, but shall stay clear by  $2 \pm 1$  inch on each side.

Slurry from the grooving operation shall not be permitted to accumulate on adjacent lanes to the extent that it would create a slippery or hazardous condition. Solid residue resulting from grooving operations shall be removed from pavement surfaces. The removal of all debris (slurry, etc.) resulting from the grooving operations shall be continuous. Pavement shall be immediately left in a washed clean condition, free of all slipperiness from the slurry, etc.

All debris and surplus material removed from the grooving operations shall be deposited in a truck or other conveyance and removed from the Project. The slurry shall not be disposed of in the existing drains or on the slopes of the Roadway, but shall be removed from the Project and disposed of by the Contractor.

### 703.23 SIDEWALK, MEDIAN AND CURB FINISH

Immediately after the concrete has been deposited in place, it shall be consolidated and screeded with a surface variation tolerance of 1/8 inch in 10 feet. The Sidewalk and median surfaces shall be troweled to a dense, smooth surface, after which it shall be broomed transversely with a broom meeting the requirements of 905.09(D)(2), to produce a slightly roughened surface which will not be slippery.

All scoring shall be done with a jointing tool having a blade projection of 1/2 inch and minimum borders of 1 and 1-1/2 inches.

The jointing tool for scoring the line back of the curb shall be 1 piece to include the edge radius at the top of the curb. All borders shall be removed in the brushing operation.

Forms for curbs shall be designed so that they will not deflect more than 1/16 inch at any point during concrete placement.

On island noses and other short radius curbs form work shall be lined with 1/4 inch plywood or masonite or other approved liners.

The curb forms shall remain in place a minimum of twelve (12) hours, and during periods of low temperatures (below 40° F), they shall not be removed in less than thirty-six (36) hours. The forms shall be removed within sixty (60) hours after the concrete has been deposited against them. After removal of the forms all fins and burrs shall be immediately removed and cavities produced by joints, projections and air pockets shall be filled by grout cleaning as specified in 703.20(B).

Curing of medians and curbs shall be as outlined for slabs in 703.19.

### 703.24 TOLERANCES

Where tolerances are not otherwise specified in the Contract Documents, deviations from the established dimensions will be permitted to the extent set forth below. The Contractor shall set and maintain concrete forms so as to insure completed work within the tolerance limits herein indicated.

#### A. FOOTINGS

1. Variations in dimensions in plan: minus 1/2 inch to plus 2 inches.
2. Misplacement or eccentricity: 2 percent of the footing width in the direction of misplacement but not more than 2 inches.
3. Reduction in thickness: minus 5 percent of specified thickness. Applies to concrete only, not to reinforcing bars or dowels.

#### B. WALLS, PIERS, COLUMNS

1. Variation from the plumb or the specified barrier: exposed, 1/2 inch in 10 feet; backfilled, 1 inch in 10 feet.
2. Variation in cross-sectional dimensions (also including beams): minus 1/4 inch to plus 1/2 inch.

#### C. BRIDGE SLABS

1. Variation in thickness: minus 1/8 inch to plus 1/4 inch.

### 703.25 CONCRETE BONDING WITH EPOXY

Where indicated on the Plans, epoxy adhesive, conforming to 822.08(B)(1), shall be used to bond new concrete to old concrete. A manufacturer's certification that the material conforms to the Specifications shall be submitted prior to use.

The application shall conform to the manufacturer's directions.

Concrete surfaces to be bonded shall be structurally sound and free from foreign materials. Sandblasting, either wet or dry, shall be used in preparing sound concrete surfaces for new concrete, and shall be performed in such a manner as to remove all dirt, grease, paint, loose and unsound concrete and other foreign material and expose a clean surface of sound concrete over the entire area to be treated. Suitable traps and filters shall be utilized with sandblast equipment to prevent oil from being deposited on surfaces.

Payment for epoxy bonding will be included in the price for the appropriate concrete Bid Item.

### 703.26 SELF-CONSOLIDATING CONCRETE

- A. **SCOPE** - The Work in this section shall consist of furnishing and placing self-consolidating concrete (SCC) as indicated on the Contract Plans and in accordance with this section.



American Concrete Institute - ACI 309R-96--- Guide for Concrete Consolidation.

**B. SUBMITTALS** - Mixture proportions.

**C. SHOP DRAWINGS** - Formworks; Fabrication and placing drawings for all reinforcing steel.

**D. CERTIFICATION** - Manufacturer's certification stating that the products delivered meet or exceed Project Specifications.

**E. PRODUCT DATA**

Ready-Mix concrete delivery tickets.

Test data from trial batch.

Method of concrete forming

Sample of the proposed cured concrete appearance shall be prepared for submission to the Engineer for approval prior to the preparation of the forms. The color of the proposed concrete encasements shall also be submitted to the Engineer for approval prior to the preparation of the forms.

**F. DEFINITIONS**

- *Self-Consolidating Concrete (SCC)* - A highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation or excessive bleeding without the need for vibration.
- *Passing Ability* - The ability of SCC to flow through tight openings such as the spaces between reinforcing bars without segregation or aggregate blocking.
- *J-Ring Test* - Test used to determine the passing ability of SCC, or the degree to which the passage of concrete through the bars of the J-Ring apparatus is restricted.
- *J-Ring Flow* - The distance of lateral flow of concrete using the J-Ring in combination with a slump cone.
- *Slump Flow* - Test method used to measure the unconfined flow and stability of SCC using a slump cone (upright or inverted).
- *Slump Flow Spread* - The numerical value in inches of flow determined as the average diameter of the circular deposit of SCC at the conclusion of the slump flow test.
- *T<sub>20</sub> Value* - Time (in seconds) the edge of the concrete mass takes to reach 20 inch diameter from the time the mold is first raised in the slump flow test.
- *Stability* - The ability of a concrete mixture to resist segregation of the paste from the aggregates.
- *Static Segregation (Segregation Factor)* - Segregation of the mortar from the coarse aggregate that occurs after placement while the concrete is still in a paste state.
- *Visual Stability Index (VSI) Rating* - An assessment of the homogeneity of concrete based on the visual inspection of the concrete sample at the end of the slump flow test.
- *Filling ability* - the ability of fresh concrete to flow into and fill all spaces within the formwork, under its own weight.
- *Viscosity modifying agent (VMA)* – An admixture that, when added to concrete, increases the plastic viscosity and improves the stability of the mixture at a constant fluidity.
- *Water to cementitious ratio (w/c)* - the ratio of the weight of free water to the weight of all cement and reactive powders such as slag, fly ash, silica fume, etc.
- *Water sensitivity* - the amount of free water variation within the mixture that causes the characteristics of an SCC mixture (primarily its stability) to change from an acceptable range to an unacceptable range.
- *Moisture control of aggregates* - A critical factor in production of SCC, in that variation in moisture content accounted for in normal concrete by Plant or Site adjustment can cause SCC to vary in filling ability and segregation resistance by more than acceptable amounts.

**G. QUALITY ASSURANCE** - Conform to ACI 309R for concrete consolidation.

**H. DELIVERY, STORAGE AND HANDLING** - The ready-mix concrete truck driver shall provide the batch ticket to the Engineer at the time of concrete delivery. The ticket shall summarize the following information:

Weight in pounds of all materials, excepting the admixtures, which shall be in fluid ounces.

Cubic Yards batched.

Water to cementations materials ratio (w/c).

Time of batching.

Free moisture in the fine and coarse aggregates in percent of weight of aggregate.

**I. MATERIALS**

**1. Admixtures** - Furnish from 1 manufacturer.

- High-Range Water-Reducing Admixture shall conform to ASTM C 494/C 494M Type F and/or ASTM C 1017/C 1017 M Type I.
- Accelerating Admixture shall conform to ASTM C 494/C 494M Type C or E.
- Retarding Admixture shall conform to ASTM C 494/C 494M Type B or D.
- Hydration Control Admixture shall conform to ASTM C 494/C 494M Type B or D.

**2. Concrete mixtures: mixture Specifications** - Water-to-cementitious materials ratio shall not exceed 0.44 by weight.

**3. Supplementary cementitious materials (scm)** - The weight of SCM shall not exceed the percentages listed in the following Table 703.26 :

**TABLE 703.26 TOTAL CEMENTITIOUS MATERIALS MAXIMUM PERCENTAGE**

Material	Maximum percent of SCM by weight of total cementitious materials
Fly ash or other pozzolans	25
Slag cement	50
Silica Fume	10
Total of fly ash or other pozzolans, slag cement and silica fume	50 <sup>a</sup>
Total of fly ash or other pozzolans and silica fume	35 <sup>a</sup>

a ACI 301 (ACI 301 M) requirements for concrete exposed to deicing chemicals

Fly ash or other pozzolans and silica fume shall not constitute more than 25% and 10%, respectively, of the total weight of cementitious material

**4. Slump flow** - Slump flow shall be measure in accordance with ASTM C 1611/C 1611M.

**5.** The ranges of slump flow spread of SCC shall be 24-33 inch.

**6.** T<sub>20</sub> value shall be in a range of two to five (2-5) seconds.

**7. Visual stability index (vsi)** - VSI Rating shall not exceed 1.

**8. J-ring flow** - Difference between slump flow and J-Ring flow (as measured by ASTM C 1621/C 1621M) shall not be more than 2 inches.

**9. Stability** - The stability of the concrete shall be determined in the Laboratory prior to approval of the SCC mixture using test method ASTM C 1610M. All mixtures shall have a maximum static segregation (segregation factor) of 15 percent.

10. **Color of Concrete** - The concrete color shall be adjusted by the addition of concrete coloring admixtures to sample concrete mixtures to produce a finished an acceptable concrete color.
11. **Coarse aggregate** -
  - a. Maximum size of coarse aggregate shall be not larger than 3/4 inch.
  - b. Coarse aggregates with high aspect ratios should be avoided if possible.
  - c. Coarse aggregates (and blends) having the lowest possible water demand should be used.
12. **Mix design** - All mix designs shall be proportioned in accordance with ACI 318-05. All mix designs to be used in Project shall be approved by the Engineer prior to use in Project. (Contractor/Sub-Contractor) shall be responsible for incorporating concrete of minimum strengths specified as shown on the Contract Plans.
13. **Hardened concrete property** - The compressive strength of SCC at twenty-eight (28) days shall be in accordance with the Contract Plans.

### 703.27 MEASURE AND PAYMENT

The unit of measure for the various items of concrete listed in the Schedule of Prices will be the cubic yard. The number of cubic yards will be the volume determined from the dimensions shown on the Plans.

The volume of emblems, reinforcement, chamfers, conduits, boxes, metal pipe sleeves, scuppers, manholes, piling and other inserts will not be deducted from the gross volume measured.

The number of cubic yards of concrete measured will be paid for at the Contract unit price per cubic yard for the various items of concrete listed in the Schedule of Prices, which payment will include emblems, reference marks, water stops, preformed joint filler, poured joint seals, dove-tailed slots for stone anchors, bearing pads, and other similar materials, except for reinforcing steel. Also included will be all the labor, materials, tools, equipment and incidentals necessary for proportioning, mixing, forming, placing, finishing and curing the concrete. Included in the cost of Superstructure Concrete will be the setting of manhole frames and covers but not the furnishing of these items. Texturing of the surfaces of bridge decks and approach slabs is included in the cost of these items. Anchor bolts will be furnished and paid for under Structural Steel, Section 706. The setting of anchor bolts will, however, be included in the Contract unit price for the respective class of concrete in which they are located.

## 704 REINFORCING STEEL

### 704.01 DESCRIPTION

This Work shall consist of furnishing and placing uncoated or epoxy coated reinforcing steel.

### 704.02 MATERIALS

Reinforcing steel shall meet the requirements of 812.02 or 812.03. The use of only 1 grade of steel will be allowed for bar reinforcement unless otherwise permitted in writing by the Engineer. All mill tests for reinforcing steel shall be certified for each heat of steel not only as to test results but also to physical and chemical requirements of these Specifications. Extra bars shall be furnished for field sampling and tests. A sample is required for each 25 tons or fraction thereof for each size of bar used. Samples shall be cut from the steel after delivery, as directed by the Engineer.

### 704.03 SHOP DRAWINGS

Shop drawings, including placement drawings and bending diagrams, shall be submitted in accordance with 105.02. No materials shall be ordered until such drawings are approved. Bar lists, including weights shall be submitted to the Engineer.

### 704.04 FABRICATION

Bent-bar reinforcement shall be cold bent to the shapes shown on the Plans, and unless otherwise provided on the Plans or by authorization of the Engineer, the bends shall be made in accordance with the following requirements:

- A. **BENDS** - Hooks and stirrups shall be bent using dimensions and diameters defined by "ACI Standard Hooks" in the Manual of Standard Practice or CRSI.
- B. **EMBEDDED BARS** - Bars partially embedded in concrete shall not be bent except as shown on the Plans or as approved by the Engineer.
- C. **MARKING** - Bar reinforcement shall be shipped in bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcing Steel Institute.

### 704.05 PROTECTION OF MATERIALS

Bars, after placement, shall be free of damage, oil, loose mill scale and loose rust. Bars with thin powdery rust, tight rust, mill scale or a combination thereof will be acceptable without cleaning provided that upon removal of all loose rust and scale by wire brushing, bars meet both minimum weight and deformation requirements. The Contractor shall bear any expense associated with cleaning, testing or replacement of damaged bars as directed by the Engineer.

Upon delivery to the Project Site, epoxy-coated reinforcing steel shall be covered with an opaque covering. In addition, epoxy-coated reinforcing steel that has been partially embedded in concrete or placed in formed work and not covered with concrete shall have the exposed surfaces covered with an opaque covering after seven (7) days exposed to sunlight. The opaque covering shall be placed in a manner to provide air circulation and prevent condensation on the reinforcing steel.

### 704.06 PLACING AND FASTENING

Placement and reinforcing steel shall conform to the requirements of CRSI "Recommended Practice for Placing Reinforcing Bars" except as modified herein.

- A. **TIES** - All steel reinforcement shall be accurately placed in the positions shown on the Plans and firmly held during the placing and setting of concrete. Reinforcing bars in the top mat of bridge decks and sidewalks shall be tied at all intersections. Reinforcing bars in the bottom mat of bridge decks and sidewalks shall be tied at alternate intersections. Other reinforcement shall be tied at all intersections where the spacing is 9 inches or more in any direction. Where the spacing is less than 9 inches in each direction, reinforcement shall be tied at alternate intersections.

- B. BOLSTERS** - Distances from the forms and layers of bars shall be maintained by means of manufactured metal spacers, bolsters, chairs or other approved supports. Metal spacers, bolsters, or chairs which are in contact with the forms shall be galvanized, plastic coated, stainless steel or other approved material. Catalog cuts of spacers, bolsters, or chairs intended for use shall be submitted to the Engineer for approval. Blocks for holding reinforcement from contact with forms or Earth shall be suitably cured precast mortar blocks of approved shape and dimensions. The use of pebbles, stone, bricks, metal pipes, wooden blocks, or other unsuitable materials will not be permitted.
- C. INSPECTION** - Reinforcement in any member shall be inspected and approved by the Engineer before the placing of concrete begins. Ample time, as determined by the Engineer, shall be provided for the inspection of reinforcement prior to concrete placement. Concrete placed before inspection and approval of the reinforcement by the Engineer shall be cause for rejection and removal of the concrete.
- D. DOWEL BARS** - Dowel bars shall be securely supported prior to the start of concrete placement and shall not be stuck into the concrete after the concrete is placed.
- E. BAR COVER** - The minimum clear distance from the face of concrete to any reinforcing bar shall be maintained as specified herein or as shown on the Contract Drawings.

In superstructures, the cover shall be at least 2 ½ inches except as follows:

1. Bottom of Slab – 1-1/2 inches.
2. Stirrups and Ties in T-beams – 1-1/2-inches.
3. Rails, Rail Posts, Curbs, and Parapets - 1 inch.

In Substructures, the minimum cover shall be at least 3 inches except as follows:

1. Abutment neat work and Pier Caps – 2-1/2- inches.
2. Spirals and Ties - 2 inches.

#### 704.07 SPLICING

All reinforcement shall be furnished in the full lengths indicated on the Plans or approved Shop Drawings unless otherwise permitted. Splicing of bars, except where shown on the Plans or approved Shop Drawings, will not be permitted without approval. Splices shall be staggered as much as possible. Unless otherwise shown on the Plans, bars shall be lapped 30 diameters to make the splice. In lapped splices; the bars shall be placed and wired in such a manner as to maintain the minimum distance to the surface of the concrete shown on the Plans. Lapped splices shall not be used for Nos. 14 and 18 bars. Welding of reinforcing steel and other positive connections shall be used only if detailed on the Plans or if authorization is made by the Engineer in writing. Welding shall conform to “Structural Welding Code - Reinforcing Steel” AWS D 1.4, latest edition, and applicable Special Provisions. In bars required for compression only, the compressive stress may be transmitted by bearing of square cut ends held in concentric contact by a suitable device. Ends shall terminate in flat surfaces within 1-1/2 degrees of right angles to the axis of the bars and shall be fitted within 3 degrees of full bearing after assembly. End bearing splices shall not be used except in members containing closed ties, closed stirrups, or spirals.

#### 704.08 SUBSTITUTIONS

Substitution of different size reinforcing bars will be permitted only with specific authorization by the Engineer. If a substitute is authorized, it shall have an area equivalent to the design area, or larger.

#### 704.09 EPOXY COATED BARS

- A. CERTIFICATION** - The coating applicator shall furnish to the Engineer, at the time of shipment, written certification that the coated reinforcing bars were cleaned, coated, tested, and repaired in accordance with ASTM A 775.
- B. FABRICATION** - The Contractor shall notify the Engineer of the date and location of fabrication and coating to allow inspection and testing of epoxy coated reinforcing steel before shipment to the Project Site.

All systems for handling coated bars shall have padded contact areas. Nylon strapping or padded bundling bands shall be used. The bars or bundles shall not be dropped or dragged.

Drive rolls on shear beds and back-up barrels on benders shall be protected with a suitable plastic covering to minimize damage during the fabrication process.

Coated bars shall be stored on wooden or padded cribbing.

The fabricator shall maintain the identity of the coated bars, and shall assure that the coated, fabricated bars are identified with proper tags for final shipment to the job Site.

Repair will be required within each fabricated area of the reinforcing bar when bond loss and damage exist. When repair is required, all damage within each area shall be cleaned and repaired. The cleaning shall remove loose or deleterious material or both. In case where rust is present, it shall be removed by blast cleaning prior to repair. Repair material shall conform to ASTM A 775.

Hairline cracks without bond loss or other damage need not be repaired.

The repairs shall be performed as soon as possible and before oxidation appears.

**C. INSTALLATION** - All systems for handling coated bars shall have padded contact areas.

The bars or bundles shall not be dropped or dragged. Coated bars shall be stored on wooden or padded cribbing.

Coated bars shall be tied with coated tie wire or any suitable material acceptable to the Engineer that will not damage or cut the coating.

The coated bars shall be installed on plastic coated or epoxy coated wire supports.

If welded splices are required or permitted, suitable ventilation shall be provided. Welding of epoxy coated reinforcing bars must be approved in writing by the Engineer.

After completion of welding on coated reinforcing bars, coating damage shall be repaired in accordance with 704.09(D). All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damage.

When required or permitted, mechanical connections shall be installed in accordance with the splice device manufacturer's recommendations.

After installing mechanical connections on coated reinforcing bars, coating damage shall be repaired in accordance with 704.09(D). All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

Reinforcing bars partially embedded in concrete shall not be field bent, except as indicated on the Contract Documents or permitted by the Engineer. When heat is used to field bend coated reinforcing bars, suitable ventilation shall be provided. When coated reinforcing bars are field bent, coating damage shall be repaired in accordance with 704.09(D).

Unless permitted by the Engineer, reinforcing bars shall not be cut in the field. When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

**D. REPAIR** - Repair material shall conform to ASTM A 775.

Damage caused during shipment of epoxy bars or by installation procedures or both need not be repaired in cases where the damaged area is 1/4 inch by 1/4 inch or smaller and the sum of all damaged areas in each 1-foot length of bar does not exceed 2 percent of the bar surface area. All damaged areas larger than 1/4 inch square shall be repaired and all bars with total damage greater than 2 percent of bar surface area shall be rejected and removed. The total bar surface area covered by patching material shall not exceed 2 percent, including patching performed by the fabricator. All bars cut at the Site shall be repaired.

**E. REJECTION** - Coated bars which do not meet the requirements of this specification shall be rejected. At the Contractor's option, coated bars having defects shall be replaced or alternately, stripped of coating, re-cleaned and recoated in accordance with the requirements of this specification.

**704.10 MEASURE AND PAYMENT**

The unit of measure for Reinforcing Steel, coated or uncoated, will be the pound. The number of pounds will be the actual number of

pounds of reinforcing steel complete in place as computed from bar lists and will be based on the theoretical weight per linear foot for the particular size of reinforcement used. Should the Engineer, upon request of the Contractor, permit the substitution of larger and heavier bars than are required by the Plans, measurement will be made only for the sizes required by the Plans. In case short bars are used when full-length bars might reasonably be provided, measurement will be made as if full-length bars were used. No allowance will be made for epoxy coating or for ties, wires, braces, clips, spacers, supports, chairs, or other similar devices used to support the reinforcement during construction.

The number of pounds of Reinforcing Steel placed, coated or uncoated, will be paid for at the Contract unit price per pound, which payment will include all reinforcing steel incorporated in the concrete which is not specifically included in another item or items of the Schedule of Prices. This payment will also include all labor, plant, materials, cleaning and all other expenses necessary for furnishing and placing of steel complete in the Work, including the cost of furnishing extra bars as herein specified for sampling.

## 705 PRESTRESSED CONCRETE UNITS

### 705.01 DESCRIPTION

Prestressed concrete units shall be prestressed either by pretensioning or post-tensioning. Pretensioning is defined as any method of prestressing concrete members in which the reinforcement is tensioned before the concrete is placed. Post-tensioning is defined as any method of prestressing in which the reinforcement is tensioned after the concrete is placed.

Unless otherwise specified in the Contract Documents, the method of prestressing to be used and fabrication Site shall be optional with the Contractor, subject to all requirements as outlined in 815.02 and as specified herein.

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. At the Contractor's option, in lieu of PCI certification, the manufacturer shall, at no cost to the District, meet the following requirements.

- A. Retain an independent testing or consulting firm approved by the Engineer.
- B. The basis of inspection shall be the Prestressed Concrete Institute's "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," MNL-116 and "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products," MNL-117.
- C. This firm shall inspect the precast plant at two (2) week intervals during production and issue a report, certified by a registered Professional Engineer, verifying that materials, methods, products and quality control meet all the requirements of the Specifications, drawings, and MNL-116 and/or MNL-117. If the report indicates to the contrary, the Engineer will inspect and, at the Engineer's option, may reject any or all products produced during the period of non compliance with the above requirements.

The Engineer should visit the precast plant shortly after the start-up of production in order to inspect the actual quality Control Plant operations, materials, testing facilities, and production pieces. The Contractor will be responsible for all costs incurred by the Department to inspect the actual production and quality control as often as necessary as determined by the Engineer.

### 705.02 MATERIALS

Materials shall conform to the following requirements:

- 815.02: Prestressing Reinforcement
- 817: Class D Concrete
- 812.02: Reinforcing Steel

### 705.03 EQUIPMENT

The Contractor shall provide all equipment necessary for the construction and the prestressing. Prestressing shall be done with approved jacking equipment. Hydraulic jacks shall be equipped with accurate pressure gauges. The Contractor may elect to substitute screw jacks or other types for hydraulic jacks. In that case, proving rings or other approved devices shall be used in connection with the jacks. All devices, whether hydraulic jack gauges or otherwise, shall be calibrated and, if necessary, recalibrated so as to permit the stress in prestressing steel to be computed at all times. A certified calibration curve shall accompany each device.

Safety measures shall be taken by the Contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

### 705.04 CONCRETE CONSTRUCTION

Necessary formwork, concrete placing, exposed surface finishing and other construction requirements shall conform to 703 unless otherwise stipulated.

The units shall be constructed on a rigid base which will not deflect or settle unevenly, to prevent any vertical distortion, and shall be braced transversely so as to prevent any buckling sideways. No concrete shall be deposited in the forms until the formwork, reinforcing,



conduits, anchorages, prestressing steel and other appurtenances have been inspected and approved by the Engineer. Approval, however, does not relieve the Contractor of his responsibility to produce a satisfactory unit, and any unit not meeting the requirements as specified herein will be rejected and the Contractor will be required to replace the unit at his expense.

If the Engineer so directs, the Contractor will be required to vibrate the concrete externally as well as internally. Vibrating shall be done with extreme care and in such a manner as to prevent displacement, crushing or damaging of reinforcement, conduits, wires or any other appurtenances which are a part of the construction.

In post-tensioned construction, connections between end anchorages and conduits or other appurtenances shall be carefully sealed with friction tape or mastic or other satisfactory material, to exclude mortar from such appurtenances during concreting. The prestressing reinforcement shall be moved backward and forward a few inches several hours after pouring concrete to loosen any mortar which might have entered the conduit or other appurtenances.

Curing of concrete shall be per 703.19 except as follows:

- A. STEAM CURING** - Steam curing will be permitted and shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall commence two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If the use of retarders is approved, the waiting period before application of the steam shall be from four (4) to six (6) hours. The steam shall be at least 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam, the temperature of the member shall increase at a rate not to exceed 40°F per hour until a maximum temperature of from 140°F to 160°F is reached. The maximum temperature shall be held until the concrete has reached the desired strength. Suitable probes shall be inserted into the members for monitoring the temperature.
- B. RADIANT HEAT CURING** - Precast members may be cured by the radiant heat method provided that the members are enclosed in approved rubberized canvass tarpaulins or other approved enclosures. The application of heat shall be as specified for steam curing.

The Contractor shall submit a curing plan which includes procedures to be used for approval by the Engineer before curing may begin.

#### 705.05 PRETENSIONING

The prestressing elements shall be accurately held in position, and stressed by jacks. A record shall be kept of the jacking force and the elongations produced thereby. Several units may be cast in 1 continuous line and stressed at 1 time. Sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to the concrete, nor end anchorages released, until the concrete has attained a compressive strength, as shown by tests on standard cylinders, made and cured identically with the members, of at least the minimum strength shown in the Contract Documents. The elements shall be cut or released in such an order that lateral eccentricity of pre-stress will be a minimum. If several strands are tensioned simultaneously, the jacking system shall provide for uniform stress in all strands. Pre-stress in the strands shall be transferred gradually to the concrete upon release.

When units are pre-tensioned, the Contractor shall notify the Engineer a sufficient time in advance on any Work to be performed on the units in order that the Engineer or his representative can arrange for inspection.

#### 705.06 POST-TENSIONING

- A. GENERAL** - Prestressing elements will be accurately placed in the position in the Contract Documents, and firmly held during the placing and setting of the concrete.
- B. ENCLOSURES** - All enclosures shall be metallic and shall be mortar-tight, with the exception that the Contractor, at his option, may form the enclosures by means of cores or ducts composed of rubber or other suitable material which can be removed prior to installing the prestressing reinforcement. Enclosures shall be strong enough to maintain their shape under such forces as will come upon them. They shall be between 2 and 2 and (1/2) times larger in internal diameter than the bar, cable, strand, or group of wires which they enclose. Cores or ducts shall be provided with pipes or other suitable connections for the injection of grout after the prestressing operations have been completed.

- C. TENSIONING** - Tensioning of the prestressing reinforcement shall not be commenced until tests on standard cylinders, made and cured identically with the members, show that the concrete has attained at least the minimum strength shown in the Contract Documents.

After the concrete has attained the required strength, the prestressing reinforcement shall be stressed by means of jacks to the desired tension and the stress transferred to the end anchorage.

The tensioning process shall be so conducted that the tension being applied and the elongation of the prestressing elements may be measured at all times. The friction loss shall be estimated as provided in the AASHTO Standard Specifications for Highway Bridges.

A record shall be kept of gage pressure and elongation at all times and submitted to the Engineer for his approval.

- D. BONDING** - All prestressing reinforcement shall be bonded to the concrete and shall be free of dirt, loose rust, grease, or other deleterious substances. Before grouting, the ducts shall be free of water, dirt or any other substance. The ducts shall be blown out with compressed air until no water or other substance comes through the duct. For long members with draped strands, an open tap at the low point of the duct may be necessary.

The annular space between the perimeter of the enclosure and the steel shall be pressure grouted after the prestressing process has been completed.

The grout shall be made to a consistency to permit adequate flow into the ducts. Proportions of the materials used to prepare the grout shall be based on tests made on the grout before operational grouting is begun, or may be selected based on prior documented experience with similar material and equipment under comparable field conditions. The water content shall be the minimum necessary for proper placement, and when Type I or Type II cement, as per 817, is used, shall not exceed a water-cement ratio of 0.45 or approximately 5 gallons of water per sack (94 lbs) of cement.

The pumpability of the grout may be determined by the Engineer in accordance with the U.S. Corps of Engineers Method CRD-C611.80. When this method is used, the efflux time of the grout sample immediately after mixing shall not be less than eleven (11) seconds.

Aluminum powder of the proper fineness and quantity may be used to obtain 5 to 10 percent unrestrained expansion of the grout.

During placement, grout shall be allowed to flow from the first vent after the inlet pipe until any residual flushing of water or entrapped air has been removed, at which time, the vent shall be capped or otherwise closed in sequence in the same manner.

The pumping pressure at the tendon outlet shall not exceed 250 psig.

If the actual grouting pressure exceeds the maximum recommended pumping pressure, grout may be injected at any vent which has been, or is ready to be, capped as long as a one-way flow of grout is maintained. If this procedure is used, then the vent which is to be used for injection shall be fitted with a positive shutoff.

When one-way flow of grout cannot be maintained, the grout shall be immediately flushed out of the duct with water.

Grout shall be pumped through the duct and continuously wasted at the outer pipe until no visible slugs of water or air are ejected and the efflux time of the ejected grout shall not be less than the injected grout. To insure that the tendon remains filled with grout, the outlet and/or inlet shall be closed. Plugs, caps or valves thus required shall not be removed or opened until the grout has set.

In temperatures below 32°F, ducts shall be kept free of water to avoid damage due to freezing.

The temperature of the concrete shall be 35°F or higher from the time of grouting until job cured 2 inch cubes of grout reach a minimum compressive strength of 800 psi.

Grout shall not be above 90°F during mixture or pumping. If necessary, the mixing water shall be cooled.

## 705.07 TRANSPORTATION AND STORAGE

Extreme care shall be exercised in handling and moving precast prestressed concrete members. Lifting hooks or other devices of approved design may be cast into the units. Precast girders and slabs shall be transported in an upright position and the points of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position. If the Contractor deems it expedient to transport or store precast units in other than this position, it shall be done at his own risk and after notifying the Engineer of his intention to do so.

Care shall be taken during storage, hoisting and handling of the precast units to prevent cracking or damage. Units damaged by improper storing or handling or in any other manner, shall be replaced by the Contractor at his expense.

**705.08 MEASURE AND PAYMENT**

The unit of measure for Prestressed Concrete Units will be each. The actual number of the several types and sizes of prestressed concrete units installed in place, completed and accepted, will be paid for at the Contract unit price per each, which payment will include the concrete, reinforcing steel, prestressing reinforcement, enclosures for prestressing reinforcement, anchorages, plates, nuts, anchor dowels, bearing pad and plates, and other such material within or attached to the unit, including transverse diaphragms and transverse prestressing elements, and also, all labor, equipment, tools and incidentals necessary to complete the Work as specified.

## 706 STRUCTURAL STEEL

### 706.01 DESCRIPTION

Work consists of furnishing all labor, materials, equipment, tools, and incidentals necessary to furnish, fabricate, store, assemble, shop paint, transport, erect, and place all structural steel, exclusive of bridge deck drainage and electrical conduit, pull boxes or other steel fabricated elements related to wet or dry utilities or ITS field devices, , but including roadway and sidewalk joints, anchor bolts, castings, pins, rockers, shoes, alloy steels, weld metal, rivets, bolts, washers, nuts, bearing pads and other material, and also including all necessary galvanizing and the furnishing of notices, certificates, orders, statements, drawings and diagrams herein required.

Metal fabricators shall be certified in accordance with the AISC Quality Certification Program in Simple Steel Bridge Structures (SBR) , or Major Steel Bridge (CBR) with endorsements for Sophisticated Paint and/or Fracture Critical, as appropriate. A copy of a valid certificate, along with the current annual endorsement, shall be submitted to the Engineer before any metal fabricator will be approved to perform the Work.

Anchor bolts shall be furnished as part of Structural Steel and set as part of the applicable PCC items.

Before submitting a proposal, the Contractor shall become familiar with all the local conditions affecting the erection work and hauling requirements, confer with railroad officials for work within railroad rights-of-way, or other interested parties, as the case may be, and determine the method to be followed.

### 706.02 MATERIALS

The materials shall be those which are specified on the Plans and shall conform to the requirements of 815.01 and 822.02, and as specified herein. Requirements of AASHTO M 160 shall be met at all times. Failure to meet the requirements under this section will be cause for the rejection of the material. Galvanizing, when specified, shall meet the requirements of 811.06.

- A. IDENTIFICATION OF STEELS DURING FABRICATION** - Each piece of steel to be fabricated shall be properly identified. Individual pieces furnished in tagged lifts or bundles shall be marked with the ASTM A 6/A 6M color code immediately upon being removed from the bundle or lift. Pieces which prior to assembly will be subject to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting which might obliterate color code marking, shall be marked for grade by steel die stamping or by a substantial tag firmly attached. All die stamps used shall be of the low stress type. If during fabrication the original identifying number is hidden, cut off, or otherwise obliterated, the fabricator may, with the Engineer's approval, repaint the number on the material at a conspicuous location.
- B. IDENTIFICATION BY CONTRACTOR** - The Contractor may furnish, from stock, material that he can identify by heat number and mill test report. Any excess material placed in stock for later use shall be marked with the mill test report number. Individually marked pieces of steel used in furnished size, or reduced from furnished size only by end or edge trim that does not disturb the heat number or color code or leave any usable piece may be used without further color coding provided the heat number or color code remains legible. Pieces to be cut to smaller size pieces shall be legibly marked with the ASTM A 6/A 6M color code before cutting.
- C. THREADS FOR BOLTS AND PINS** - Threads for all bolts and pins for structural steel construction shall conform to United Standard Series UNC-ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that the pin ends having a diameter of 1-3/8 inch or more shall be threaded 6 threads to the inch.

### 706.03 WORKMANSHIP

- A. WORKMANSHIP AND FINISH** - Workmanship and finish shall be equal to the best general practice in modern bridge shops. All portions of the Work shall be neatly finished. Shearing, flame cutting, and chipping shall be done neatly and accurately. Ends of all structural members shall be chipped after cutting to remove burrs.
- B. SEALANT** - Pockets or depressions which would hold water shall have efficient drain holes, or be sealed with polyurethane, or other approved sealant, conforming to FS TT-S-00230C, Type II, Class A, prior to painting. When the sealant is used in conjunction with weathering steel, the sealant shall be integrally pigmented to a dark bronze color.

**706.04 SHOP DRAWINGS**

- A. GENERAL** - The Contractor shall prepare all Shop Drawings, erection diagrams, camber diagrams, and lists of bolts from general drawings of the structural steel as shown on the Plans. All drawings shall be submitted in accordance with the requirements of 105.02. Unless otherwise specified herein, all detailing shall be in accordance with the requirements of the current AASHTO Standard Specifications for Highway Bridges. The Contractor shall compare and verify all dimensions shown before proceeding with the Work. If any discrepancies or omissions are noticed, the Engineer shall be immediately notified and a correction obtained. All layout measurements shall conform to the Plans.
- B. IDENTIFICATION** - Shop drawings shall specifically identify each piece to be made of steel other than ASTM A 36. Pieces made of different grades of steel shall not be given the same assembling or erecting mark, even though they are of identical dimensions and detail. The Contractor’s system of assembly-marking individual pieces and the issuance of cutting instructions to the shop shall be such as to maintain identity of the mill test report number.

**706.05 INSPECTION**

- A. GENERAL** - The Inspector shall have full access at all times to all parts of mills or shops where material to be inspected is being manufactured or fabricated.

The Inspector shall have the authority to reject any or all material or Work which does not meet the requirements of the Specifications. In case of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

The acceptance of any material or finished members by the Inspector will not bar their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced and/or repaired to the satisfaction of the Engineer.

- B. MILL INSPECTION** - The Contractor shall furnish the Engineer, in duplicate, certified mill test reports and written certification that the material of each heat of steel meets the requirements.

Only material properly checked, sorted, and stored shall be used.

- C. SHOP INSPECTION** - Shop inspection will be performed by the District or an authorized agent of the District. The Engineer shall be notified well in advance of the start of the Work in the shop in order that arrangements may be made for shop inspection of material and workmanship. The fabricator shall furnish necessary facilities for inspection of workmanship and physical tests. The District must approve shop facilities to be used for fabrication prior to start of the fabrication process.

Only 1 reinspection for each instance of corrective action will be allowed at no cost to the Contractor. All costs associated with further re-inspections will be charged to the Contractor.

- D. NOTCH TOUGHNESS REQUIREMENTS** - Structural steel within the tension zone for members such as stringers, girder webs and flanges, including cross girder and bracket webs and flanges, girder splice plates and box column plates, conforming to AASHTO M 270 Grade 50 and AASHTO M 270 Grade 36, shall meet the longitudinal Charpy V-notch test specified in Table 706.05 below. Sampling and testing shall be in accordance with AASHTO T 243(ASTM A 673-72). The (H) frequency of heat transfer shall be used.

**TABLE 706.05 NOTCH TOUGHNESS REQUIREMENTS**

<b>AASHTO Designation</b>	<b>Thickness In Inches</b>	<b>CVN In Foot Pounds</b>
M 270 Grade 36	ALL	15 at 40°F
M 270 Grade 50, 50W	Up to 4” mechanically fastened	15 at 40°F
	Up to 2” welded	15 at 40°F
	Over 2” welded	20 at 40°F
M 270 HPS Grade 70W	ALL	25 at -10°F
M 270 Grade 100, 100W	Up to 4” mechanically Fastened	25 at 0 °F

AASHTO Designation	Thickness In Inches	CVN In Foot Pounds
	Up to 2 ½" welded	25 at 0 degrees F
	Over 2 ½" welded	35 at 0 degrees F

#### 706.06 SHOP STORAGE OF MATERIAL

Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter, and shall be protected as far as practicable from corrosion.

#### 706.07 STRAIGHTENING MATERIAL

Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by approved methods that will not injure the metal. Sharp kinks and bends shall be cause for rejection of the material.

Straightening main stress carrying members may only be done when permitted in writing by the Contracting Officer. When permitted by the Engineer, straightening of shapes, plates, and built-up members which are not primary members, shall be done by methods that will not produce fracture or other structural defects. Distorted members shall be straightened by mechanical means or, if approved, by carefully planned and supervised application of a limited amount of localized heat. Heat shall not be applied directly on weld metal. The heat straightening of the AASHTO M 270 (ASTM A 709) Grades 70W, 100 and 100W steel members shall be done only under rigidly controlled procedures, with each application subject to the approval of the Engineer. In no case shall the maximum temperature in degrees Fahrenheit exceed values in the following table.

**TABLE 706.07 MAXIMUM TEMPERATURES**

Grade 70W > 6" from weld	1050°F
70W < 6" from weld	900°F
Grade 100 or 100W > 6" from weld	1100°F
Grade 100 or 100W < 6" from weld	950°F

In all other steels, the temperature of the heated area shall not exceed 1200 degrees Fahrenheit (a dull red) nor 950 degrees Fahrenheit at the weld metal and within 6 inches of weld metal, as controlled by temperature indicating crayons, liquids or bimetal thermometers. After heating, the metal shall be cooled as slowly as possible. Quenching is prohibited.

Parts to be heat straightened shall be substantially free from stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal will be inspected at the Contractor's expense by methods as directed. Metal with evidence of fracture will be rejected.

#### 706.08 FLAME CUTTING

Steel and weld metal shall be oxygen cut per AASHTO/AWS D 1.5M/1.5, latest edition, as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, provided a smooth and regular surface free from cracks and notches is secured, and provided an accurate profile from cracks and notches is secured, and provided an accurate profile is secured by use of a mechanical guide. Hand cutting shall be done only where approved.

Mill scale and extraneous material shall be removed from the torch side of ASTM A 514/A 517 steel plates along the lines to be flame cut, when necessary to obviate excessive notches.

#### 706.09 BENT PLATES

Un-welded, cold-bent, load-carrying, rolled-steel plates shall conform to the following:

- A. They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling, except that cold-bent ribs for orthotropic deck bridges may be bent in the direction of rolling if permitted by the Engineer.
- B. Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are shown in the following table:

**TABLE 706.09 THICKNESS IN INCHES**

	Up to 1/2	>1/2 to 1	>1 to 1-1/2	>1-1/2 to 2-1/2	>2-1/2 to 4
All grades of structural steel in this specification	2.5 t	2.5 t	3 t	3.5 t	4 t

Note: Low alloy steel in thicknesses over 1/2 inch may require hot bending for small radii.

Allowance for spring back of ASTM A 514 and ASTM A 517 steels should be about 3 times that for structural carbon steel. For brake press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1200° F, except for ASTM A 514/A 517 steel. If ASTM A 514/A 517 steel plates to be bent are heated to a temperature greater than 1125° F, they must be re-quenched and tempered in accordance with the producing mill's practice. Hot bent plates shall conform to requirement one, above.

- C. Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.

### 706.10 ANNEALING AND STRESS RELIEVING

Structural members to be annealed or normalized shall have finished machining, boring, and straightening done subsequent to heat treatment. Normalizing and full annealing shall be per AASHTO/AWS D1.5. The temperatures shall be maintained uniformly throughout the furnace during the heating and cooling so that the temperature at no 2 points on the member will differ by more than 100° F at any one time.

Members of ASTM A 514/A 517 steels shall not be annealed or normalized and shall be stress relieved only with the approval of the Engineer.

Pieces in each furnace charge, temperatures and schedule used shall be recorded. Proper instruments including recording pyrometers shall be used to determine at any time the temperatures of members in the furnace. Treatment records shall be submitted on request. The holding temperature for stress relieving ASTM A 514/A 517 steel shall not exceed 1125° F.

Members, such as bridge shoes, pedestals and other parts which are built up by welding sections of plate together shall be stress relieved per AASHTO/AWS.

### 706.11 HOLES FOR BOLTS

This specification applies to bolt holes for bolted connections specified in 706.16 and 706.17.

- A. HOLES FOR HIGH STRENGTH AND UNFINISHED BOLTS** - All holes for bolts shall be either punched or drilled. Flame cutting is prohibited. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the bolts whenever the thickness of the material is not greater than 3/4 inch for structural steel, 5/8 inch for high-alloy steel, or 1/2 inch for quenched and tempered alloy steel, unless sub-punching and reaming are required. When there are more than 5 thicknesses or when any of the main material is thicker than 3/4 inch for structural steel, 5/8 inch for high strength steel, or 1/2 inch for quenched and tempered alloy steel, all holes shall either be sub-drilled or drilled full size.
- B. HOLES FOR RIBBED BOLTS, TURNED BOLTS OR OTHER APPROVED BEARING BOLTS** - All holes for ribbed bolts and other approved bearing-type bolts shall be sub-punched or sub-drilled 3/16 inch smaller than bolt nominal diameter and reamed assembled or to a steel template or, after assembly, drilled from the solid. In any case the finished holes shall provide a driving fit as specified.
- C. PUNCHED HOLES** - Die diameter shall not exceed the diameter of the punch by more than 1/16 inch. If any holes must be enlarged to admit bolts such holes shall be reamed. Holes shall be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.
- D. REAMED OR DRILLED HOLES** - Reamed and drilled holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs on outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. Assembled parts shall be taken apart for removal of burrs

and shavings caused by drilling and reaming. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match marked before disassembly.

#### E. PREPARATION OF FIELD CONNECTIONS

1. **Sub-punching and Reaming of Field Connections** - Holes in all field connections and field splices shall be sub-punched or sub-drilled (sub-drilling if thickness limitations govern) 3/16 inch smaller as required and then reamed 1/16 inch larger while assembled or reamed to a steel template. All holes for floor beam and stringer field end connection holes through a steel template shall be done after the template has been located as to position and angle and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match marking.

#### 2. Numerically controlled drilled field connections

- a. *General* - Alternately, for any connection or splice, in lieu of sub-sized holes and reaming while assembled, the Contractor shall have the option to drill bolt holes full-size in unassembled pieces and/or connections including templates for use with matching sub-sized and reamed holes by means of suitable numerically controlled (N/C) drilling equipment. If N/C drilling equipment is used, the Engineer may require the Contractor, by means of check assemblies to demonstrate that this drilling procedure consistently produces holes and connections meeting the requirements of Subsections 706.11(F) and 706.14. The Contractor shall submit to the Engineer for approval a detailed outline of the procedures that he proposes to follow in accomplishing the Work from initial drilling through check assembly.
- b. *Holes* - Holes drilled by N/C drilling equipment shall be drilled to appropriate size either through individual pieces, or any combination of pieces held tightly together.

F. **ACCURACY OF REAMED AND DRILLED HOLES** - All holes punched full size, sub-punched or sub-drilled shall be accurately punched so that after assembly and before reaming, a cylindrical pin 1/8 inch smaller in diameter than the punched hole nominal size may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. Members with holes failing to meet this requirement will be rejected. Members shall be rejected with a hole through which a pin, 3/16 inch smaller in diameter than punched hole nominal size will not pass. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thicknesses of metal. All steel templates shall have hardened steel bushings in holes accurately dimensioned from the center lines of the connection as inscribed on the templates. The center lines shall be used in locating accurately the template from the milled or scribed ends of the members.

### 706.12 FINISHING AND FITTING

- A. **GENERAL** - Finished members shall be true to line and free from twists, bends and open joints.
- B. **EDGE PLANING** - Sheared edges of plates more than 5/8 inch thickness and carrying calculated stress shall be planed to a depth of 1/4 inch. Re-entrant corners shall be filleted to a radius of 3/4 inch before cutting.
- C. **FACING OF BEARING SURFACES** - The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with PCC shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

**TABLE 706.12 FACING OF BEARING SURFACES**

Bearing Surfaces	ANSI Finish
Heavy plates in contact in shoes to be welded	1,000
Milled ends of compression members, stiffeners and fillers	500
Bridge rollers and rockers	250
Pins and pin holes	125
Sliding bearings	125



- D. ABUTTING JOINTS** - Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/4 inch.
- E. FABRICATION OF MEMBERS** - Unless otherwise shown on the Plans, steel plates for main members, not secondary members, shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.
- F. END CONNECTION ANGLES** - Floor beams, stringers, and girders having end connection angles shall be built to exact length shown on the Plans measured between heels of the connection angles, with a permissible tolerance of plus zero inch to minus 1/16 inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than 3/8 inch nor less than that shown on the detail drawings, after facing.
- G. LACING BARS** - The end of lacing bars shall be neatly rounded unless another form is specified.
- H. WEB PLATES** - At web splices, the clearance between the ends of the web plates shall not exceed 3/8 inch. The clearances at the top and bottom ends of the web slice plates shall not exceed 1/4 inch.
- I. FIT OF STIFFENERS** - Unless otherwise shown on the Plans, end stiffeners of girders and stiffeners intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flanges. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within 1/4 inch at each end.

Welding will be permitted in lieu of milling or grinding if noted on the Plans. Welding on the tension flanges of beams and girders will not be permitted unless shown on the Plans.

### 706.13 CAMBER

When specified cambers for rolled beams are shown on the Plans, the beams shall be cambered in the rolling mill, either while hot or else in the straightening gag after cooling. Cambers for rolled beams shall conform to standard mill practices as specified by AISC. During mill operations and fabrication of splices, beams shall be so supported that the camber is maintained. When camber is not specified, rolled beams shall be fabricated with standard mill camber with convex flange up. All built-up main girders and other members shall be cambered as nearly as practicable to conform to the dead load deflection shown on the Plans. Camber diagrams showing the cambers required for the dead load deflections shown on the Plans shall be submitted for approval. A tolerance of plus 1/2 inch to minus zero inches will be allowed.

### 706.14 SHOP ASSEMBLING

The field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing, and then shall have their sub-size holes reamed to specified size while the connections are assembled. Assembly shall be Full Truss or Girder Assembly, unless a Progressive Truss or Girder Assembly, Full Chord Assembly, Progressive Chord Assembly, or Special Complete Structure Assembly is specified in the Special Provisions.

Each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, shall be approved by the Engineer before reaming is commenced. A camber diagram shall be furnished the Engineer by the Fabricator showing the camber of each panel point of each truss, arch rib, continuous beam line, plate girder or rigid frame. When the shop assembly is Full Truss or Girder Assembly or Special Complete Structure Assembly, the camber diagram shall show the camber measured in assembly. When any of the other methods of shop assembly is used, the camber diagram shall show calculated camber. Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformations.

Preparatory to the shop bolting of full-sized punched material, the holes, if necessary, shall be spear-reamed for the admission of the bolts. The reamed holes shall not be more than 1/16 inch larger than the nominal diameter of the bolts. End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until bolted. Parts not completely bolted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

- A. FULL TRUSS OR GIRDER ASSEMBLY** - Full Truss or Girder Assembly shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.
- B. PROGRESSIVE TRUSS OR GIRDER ASSEMBLY** - Progressive Truss or Girder Assembly shall consist of assembling initially for each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at least 3 contiguous shop sections or all members in at least 3 contiguous panels but not less than the number of panels associated with 3 contiguous chord lengths (i.e., length between field splices) and not less than 150 feet in the case of Structures longer than 150 feet. At least 1 shop section or panel or as many panels as are associated with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end, so that the assembled portion of the Structure is never less than that specified above.
- C. FULL CHORD ASSEMBLY** - Full Chord Assembly shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then reaming their field connection holes while the members are assembled and reaming the web member connections to steel templates set at geometric (not cambered) angular relation to the chord lines.
- Field connection holes in web members shall be reamed to steel templates. At least 1 end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.
- D. PROGRESSIVE CHORD ASSEMBLY** - Progressive Chord Assembly shall consist of assembling contiguous chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.
- E. SPECIAL COMPLETE STRUCTURE ASSEMBLY** - Special Complete Structure Assembly shall consist of assembling the entire Structure, including the floor system. (This procedure is ordinarily needed only for complicated Structures such as those having curved girders, or extreme skew in combination with severe grade or camber.)
- F. DRIFTING OF HOLES** - The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the bolts, they shall be reamed.
- G. MATCH-MARKING** - Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

#### 706.15 PINS AND ROLLERS

- A. GENERAL** - Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than 9 inches in diameter shall be forged and annealed. Pins and rollers 9 inches or less in diameter may be either forged and annealed or cold-finish carbon-steel shafting.
- In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling, and before being annealed.
- B. BORING PIN HOLES** - Pin holes shall be bored true to the specified diameter, smooth, and straight, at right angles with the axis of the member, and parallel with each other unless otherwise specified. The final surface shall be produced by a finishing cut. The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary more than 1/32 inch from that specified. Boring of holes in built-up members shall be done after assembly is completed. The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches in diameter, or 1/32 inch for larger pins.
- C. PIN CLEARANCES** - 2 pilot nuts and 2 driving nuts for each size of pin shall be furnished for use in driving pins. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be drawn up right and the threads burred at the face of the nut with a pointed tool.

#### 706.16 BOLTS AND BOLTED CONNECTIONS

The Specifications of this article do not pertain to the use of high strength bolts. Connections fabricated with high strength bolts shall

conform to 706.17.

**A. GENERAL** - Bolts shall be unfinished, turned, or ribbed bolts per ASTM A 307, Grade A. Bolted connections shall be used only as indicated. Bolts shall have single self-locking nuts or double nuts. Beveled washers shall be used where bearing faces have a slope of more than 1/20 with respect to a plane normal to bolt axis.

**B. UNFINISHED BOLTS** - Unfinished bolts shall be furnished unless other types are specified.

**C. TURNED BOLTS** - The surface of the body of turned bolts shall meet ANSI 125 finish.

Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

**D. RIBBED BOLTS** - The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 inch greater than the nominal diameter specified for the bolts. Ribbed bolts shall be furnished with round heads per ANSI B 18.5. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an oversized bolt used as a replacement.

**706.17 HIGH-STRENGTH STEEL BOLT CONNECTIONS**

**A. GENERAL** - This specification applies to all structural steel connections using ASTM A 325 or ASTM A 490 high strength bolts.

1. All high strength bolts, nuts and washers shall be furnished in accordance with the appropriate AASHTO materials Specifications as amended and revised herein.
2. Additional requirements for field or shop installation of high strength bolts are also included. These additional requirements supplement AASHTO Division II, Section 11.

**B. SPECIFICATIONS** - All hardware covered by this specification shall meet the following requirements:

1. All bolts shall meet the requirements of ASTM A 325 or ASTM A 490 and these revisions.
2. All nuts shall meet the requirements of AASHTO M 292 (ASTM A 194), as applicable or AASHTO M 291 (ASTM A 563) and these revisions.
3. All washers shall meet the requirements of AASHTO M 293 (ASTM F 436), as applicable or ASTM F 959 and these revisions.

**C. MANUFACTURING**

1. **Bolts** - The hardness for bolt diameters 1/2 inch to 1 inch inclusive shall be as noted below:

**TABLE 706.17 (A) BOLT HARDNESS**

Bolt Size	Hardness Number			
	Brinell		Rockwell C	
	Min	Max	Min	Max
1/2 to 1 inch	248	311	24	33

**2. Nuts**

- a. Nuts to be galvanized shall be heat treated grade 2H, DH, or DH3.
- b. Plain (un-galvanized) nuts shall be grades 2, C, D or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell hardness 180 HB), or heat treated grades 2H, DH or DH3. (The hardness requirements for grades 2, C, D and C3 exceed the current AASHTO/ASTM requirements).

- c. Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of over-tap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291 (ASTM A 563) and the rotational capacity test herein (the overtapping requirements of AASHTO M 291 [ASTM A 563], paragraph 7.4 shall be considered maximum values instead of minimum, as currently shown).
  - d. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.
3. **Marking** - All bolts, nuts and washers shall be marked in accordance with the appropriate AASHTO/ASTM Specifications.
  4. **Galvanizing** - ASTM 490 bolts, nuts and washers shall be plain (uncoated) and ASTM 325 Type 1 bolts, nuts and washers shall be mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50. High strength bolts used with unpainted weathering steel shall conform to ASTM A 325, Type 3 or when specified, ASTM A 490, Type 3.

#### D. TESTING

##### 1. Bolts

- a. Proof load tests (ASTM F 606 Method 1) are required. The minimum frequency of tests shall be as specified in ASTM A 325 and ASTM A 490.
- b. Wedge tests on full size bolts (ASTM F 606, paragraph 3.5) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. The minimum frequency of tests shall be as specified in ASTM A 325 and ASTM A490.
- c. If galvanized bolts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats or top of bolt head.

##### 2. Nuts

- a. Proof load tests (ASTM F 606, paragraph 4.2) are required. The minimum frequency of tests shall be as specified in AASHTO M 291 (ASTM A 563), paragraph 9.3 or AASHTO M 292 (ASTM A 194), paragraph 7.1.2.1. If nuts are to be galvanized, tests shall be performed after galvanizing, over-tapping and lubricating.
- b. If galvanized nuts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

##### 3. Washers

- a. If galvanized washers are supplied, hardness testing shall be performed after galvanizing. (The coating shall be removed prior to taking hardness measurements).
- b. If galvanized washers are supplied, the thickness of the zinc coating shall be measured.

4. **Assemblies** - Rotational capacity tests are required and shall be performed on all black or galvanized (after galvanizing) bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. The use of washers is required as part of the test even though they may not be required as part of the installation procedure.

The following shall apply:

- a. Except as modified herein, the rotational capacity test shall be performed in accordance with the requirements of ASTM A 325.
- b. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.
- c. A rotational capacity lot identification number shall be assigned to each combination of lots tested.
- d. The minimum frequency of testing shall be 2 assemblies per rotational capacity lot.
- e. The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device (note - this requirement supersedes the current ASTM A 325 requirement that the test be performed in a steel joint). For bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator, see Section C.4.i.
- f. The minimum rotation, from a snug tight condition (10 percent of the specified proof load), shall be:

- 240 degrees (2/3 turn) for bolt lengths less than or equal to 4 diameters
- 360 degrees (1 turn) for bolt lengths greater than 4 diameters to less than or equal to 8 diameters
- 480 degrees (1 1/3 turn) for bolt lengths greater than 8 diameters

(Note: These values differ from the ASTM A 325 Table 6 Specifications.)

- g. The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown below:

**TABLE 706.17 (B) NUT TENSION**

Diameter (inches)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Required Installation Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	14	22	32	45	59	64	82	98	118

- h. After the required installation tension listed above has been exceeded, 1 reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

Torque is less than or equal to 0.25 PD where:

$$\text{Torque} = \text{measured torque (foot-pounds)}$$

$$P = \text{measured bolt tension (pounds)}$$

$$D = \text{bolt diameter (feet)}$$

- i. Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Section D.4.g. shall be computed using a value of P equal to the turn test tension shown in the table in Section D.4.g.

**5. Reporting**

- a. The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO Specifications shall be recorded on the appropriate document.
- b. The location where tests are performed and the date of the tests shall be reported on the appropriate document.

6. **Witnessing** - The tests need not be witnessed by an inspection agency; however, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate.

**E. DOCUMENTATION**

**1. Mill Test Report(s) (MTR)**

- a. MTR shall be furnished for all mill steel used in the manufacture of the bolts, nuts and washers.
- b. MTR shall indicate the place where the material was melted and manufactured.

**2. Manufacturer Certified Test Report(s) (MCTR)**

- a. The manufacturer of the bolts, nuts and washers shall furnish test reports (MCTR) for the item furnished.
- b. Each MCTR shall show the relevant information required in accordance with Section D.5.
- c. The manufacturer performing the rotational capacity test shall include in the MCTR:
  - i. The lot number of each of the items tested.
  - ii. The rotational capacity lot number as required in Section D.4.
  - iii. The results of the tests required in Section D.4.
  - iv. The pertinent information required in D.5.a.

- v. A statement that MCTR for the items are in conformance with this specification and the appropriate AASHTO Specifications.
- vi. The location where the bolt assembly components were manufactured.

**3. Distributor Certified Test Report(s) (DCTR)**

- a. The DCTR shall include MCTR above for the various bolt assembly components.
- b. The rotational capacity test may be performed by a distributor (in lieu of a manufacturer) and reported in the DCTR.
- c. The DCTR shall show the results of the tests required in Section D.4.
- d. The DCTR shall also show the pertinent information required in Section D.5.b.
- e. The DCTR shall show the rotational capacity lot number as required in Section D.4.c.
- f. The DCTR shall certify that the MCTR are in conformance with this specification and the appropriate AASHTO specification.

**F. SHIPPING**

- 1. Bolts, nuts and washers (where required) from each rotational capacity lot shall be shipped in the same container. If there is only 1 production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational capacity lot number such that identification will be possible at any stage prior to installation.
- 2. The appropriate MTR, MCTR or DCTR shall be supplied to the Contractor or Owner as required by the Contract Documents.

**G. INSTALLATION** - The following requirements for installation apply in addition to the Specifications in AASHTO Division II, Section 11 when high strength bolts are installed in the field or shop.

- 1. Bolts shall be installed in accordance with AASHTO Division II, Article 11.5.6. During installation, regardless of the tightening method used, particular care should be exercised so that the snug tight condition as defined in Article 11.5.6 is achieved.
- 2. The rotational capacity test described in Section D.4. above shall be performed on each rotational capacity lot prior to the start of bolt installation. Hardened steel washers are required as part of the test although they may not be required in the actual installation procedures.
- 3. A Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device shall be required at each job Site during erection. Periodic testing (at least 1 each working day when the calibrated wrench method is used) shall be performed to assure compliance with the installation test procedures required in AASHTO Division II, Article 11.5.6.4 for Turn-of-Nut Tightening, Calibrated Wrench Tightening, Installation of Alternate Design Bolts and Direct Tension Indicator Tightening. Bolts that are too short for the Skidmore-Wilhelm Calibrator may be tested using direct tension indicators (DTIs). The DTIs must be calibrated in the Skidmore-Wilhelm Calibrator using longer bolts. The tests shall be performed by the Contractor and witnessed by the Engineer.
- 4. **Lubrication**
  - a. Galvanized nuts shall be checked to verify that a visible lubricant is on the threads.
  - b. Black bolts shall be "oily" to the touch when delivered and installed.
  - c. Weathered or rusted bolts or nuts not satisfying the requirements of (a) or (b) above shall be cleaned and re-lubricated prior to installation. Re-cleaned or re-lubricated bolt, nut and washer assemblies shall be retested in accordance with (b) above prior to installation.
- 5. Bolt, nut and washer (when required) combinations as installed shall be from the same rotational capacity lot.

**H. CONDITION OF BOLTED PARTS**

1. **Slope and Fit** - The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.
2. **Contact surfaces** - When assembled, all joint and bolt assembly surfaces shall be free of scale, except tight mill scale, and shall also be free of dirt, burrs, foreign material, and other defects that may prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, and rust inhibitor. Galvanized surfaces shall be wire-brushed or brush-off blasted.

**I. BOLT INSPECTION** - The Contractor shall furnish all labor, materials, equipment, and rigging and perform shop and field bolted connection inspection in a safe and convenient manner. The inspection shall be witnessed by the Engineer. Regardless of the method of bolt installation, bolts in each connection shall be inspected as specified under this sub-section.

1. **Wrench** - The Contractor shall furnish, for the Engineer's use, dependable and approved hand torque wrenches and/or torque multiplier wrenches that can be accurately adjusted to specified limits, and bolt tension calibrators as required. Pneumatic wrenches are prohibited for bolt inspection and testing. Wrench calibration certification, by an approved agency equipped to perform torque wrench testing, shall accompany the wrenches and shall include identity of wrenches and date of calibration.
2. **Inspection procedure**
  - a. To determine job inspection torque, 3 test bolts of the same grade, size and condition as those under inspection shall be placed individually in a calibration device furnished by the Contractor and capable of indicating required bolt tension. There shall be a washer under the part turned in tightening each bolt.
  - b. The job inspecting torque shall be determined by a torque wrench. Each test bolt specified shall be tightened in the calibration device by any convenient means to the minimum required tension. The torque wrench then shall be applied to the tightened bolt and the torque necessary to turn the nut or head 5 degrees (approximately 1 inch at 12 inch radius) in tightening direction shall be determined. The average torque measured in the test of 3 bolts shall be taken as the job inspecting torque to be used for bolts under inspection.
  - c. The wrench and its job inspecting torque then shall be applied to 15 percent of the bolts, but no less than 3 bolts, selected at random in each connection, whether tightened by wrench or turn of nut method. If no nut or bolt head is turned by application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolt head is turned by application of the job inspecting torque, the Contractor shall have this torque applied to all bolts in the connection, and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and re-inspected.
  - d. When a bolt is properly tightened in place, at least 3 but not more than 5 threads shall be visible above the nut.

**706.18 WELDING**

- A. **GENERAL** - Structures shall be welded in accordance with the Plans, Special Provisions, and the current editions of the AASHTO "Standard Specifications for Welding of Structural Steel Highway Bridges" and the American Welding Society "Structural Welding Code AASHTO/AWS D1.5M/1.5:2002".
- B. **QUALIFICATIONS OF PROCEDURES** - Pre-qualified welding procedures and welding procedures to be qualified shall be submitted to the Engineer for approval using the forms shown in AWS D1.1, Appendix E. No welding shall be done prior to the Engineer's approval of the welding procedures. No unspecified temporary or permanent weld shall be made without specific written approval.
- C. **QUALIFICATION OF WELDERS** - Properly documented evidence of successful completion of qualification tests under the supervision of an approved testing agency and as prescribed in AASHTO shall be submitted for all welders, welding operators, and tackers. Approval by the Engineer shall be obtained prior to any welding. Qualified welders shall be retested if they have not practiced welding for six (6) months preceding the start of welding work. Evidence of such welding practice shall be satisfactory to the Engineer.

**D. WORKMANSHIP AND TECHNIQUE**

1. **Electrodes** - Electrodes per AWS, A5.5, shall be dried one (1) hour, plus or minus fifteen (15) minutes, before being used. If flux is used from an opened package or dispensing system inoperative for four (4) hours or more, the top 1 inch shall be discarded. The first weld pass shall be given special attention to ensure proper fusion and penetration of the base metal at root of joint.
2. **Tolerance** - In addition to AWS D1.5, Section 3.5, Dimensional Tolerances, the combined warpage and tilt offset of flanges of welded box girders shall not exceed 1/100 of flange width between 2 adjacent webs, or 1/4 inch, whichever is greater.
3. **Deficient welds** - Additional work and revised approved design required due to correction of deficient welds shall be at the Contractor's expense.
4. **Peening** - Peening, when approved, shall be done preferably while the weld is hot and with a hand or pneumatic tool whose point or edge is rounded sufficiently to avoid damage to weld metal.
5. **Electroslag** - Electroslag welding is prohibited.
6. **Electrogas** - Electrogas requirements under AWS D1.1, Appendix C, apply. When evidence of record is accepted in lieu of required tests for electrogas weld metal properties, the Contractor shall furnish the manufacturer's certification that the filler metal and shielding being used on the Project were manufactured with the same material and process requirements as the filler and shielding used for the evidence of record procedure.

**E. WELDING INSPECTION** - The Contractor shall furnish proper equipment and qualified personnel to make radiographic, ultrasonic, magnetic particle and other tests of shop and field welds.

1. **Personnel** - Personnel performing non-destructive tests shall be qualified per the American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A. Only persons qualified for NDT LEVEL I and supervised by a person qualified for NDT LEVEL II, or persons qualified for NDT LEVELS II or III may perform nondestructive tests. Prequalification certification shall be furnished on request.
2. **Inspection acceptance** - Radiographs, ultrasonic and magnetic particle tests shall be made only in the presence of the Inspector. Test results shall be approved before members will be accepted.
3. **Inspection timing** - Inspection of welds in all steel shall begin after the welds have reached ambient temperature, except welds in ASTM A 514/A 517 steels which shall be inspected not less than forty-eight (48) hours after they are completed. However, at junctions of intersecting welds subject to nondestructive tests, inspection and test shall be conducted after welded junction is complete.
4. **Cracks** - In addition to inspection per AASHTO and criteria listed below under Radiographic and Magnetic Particle Tests, all welds shall be visually inspected for cracks. Procedures, techniques and standards of acceptance shall be per AASHTO.
5. **Reports** - All radiographs, ultrasonic test reports, and magnetic particle test reports, including those of defective welds, shall become District property.

**F. RADIOGRAPHY AND ULTRASONIC TESTS** - The following groove welds forming butt, tee, or corner joints on girders, beams, stringers, brackets, truss members or the members shall be examined in accordance with AASHTO by the radiographic or ultrasonic method as determined by the Engineer. The weld thickness shall be a minimum of 1/2 inch for ultrasonic testing.

1. 100 percent of all shop welded flanges and flange splices plus 25 percent of all shop welded web splices adjacent to the top flange and 25 percent adjacent to the bottom flange.
2. 100 percent of all shop splice welds when more than 10 percent of radiographs or ultrasonic tests indicate rejectable defects until accumulated rejection level falls to 10 percent or less, then the original percent level specified above shall again govern.
3. 100 percent of all field welded flange splices except box girder longitudinal flange seam splices.
4. 100 percent of all field welded web splices.

**G. MAGNETIC PARTICLE TESTS** - The following shop and field fillet welds shall be examined by the magnetic particle method per ASTM E 109.



1. At least 1 foot of every 10 feet of weld and 1 foot of each weld less than 10 feet of each size weld. Test shall be located at random so as to be typical for each size weld.
2. The full length of the weld, or 5 feet on 1 side of the test length, whichever is less, when test indicates a rejectable defect in any test length of weld.
3. Areas on each side of a rejectable defect to determine extent of defect.
4. 100 percent of repaired welds for welds found defective by magnetic particle tests.

**H. DYE PENETRANT TESTS** - In field welded girder and beam groove weld splices without the aid of backing, the joint shall be chipped, gouged or ground to sound metal on the root side after sufficient welding has been done on 1 side, and the root areas then examined by the dye penetrant method per ASTM E 165. Edges of flange butt welds shall be examined by the dye penetrant method. The dye penetrant method may be substituted for magnetic particle testing for shop welds only.

### 706.19 SHEAR DEVICES

**A. SHEAR STUDS** - Studs for shear devices shall conform to the requirements for the respective materials as provided in 815.01(F). They shall be attached to the beams as shown on the Plans. Welding shall conform to the requirements outlined herein. Special patented devices, and connections therefore, if specified, shall be constructed according to the manufacturer's recommended practice or as shown on the Plans.

**B. PROCEDURE** - Stud welding shall conform to the requirements of AASHTO and the following:

1. Before any stud welding operation is begun, or after the welding equipment has remained idle for one (1) hour, trial studs shall be welded to a structural steel plate for testing. After being welded to the plate and the weld has cooled, each stud will be bent down to the plate by striking with a hammer. This test will be continued until there is no failure of trial stud.
2. Longitudinal and lateral spacing of stud shear connectors with respect to each other and to edges of beam or girder flanges may vary a maximum of 1 inch from the location shown on the drawings, provided the adjacent studs are not closer than 2-1/2 inches center to center. The minimum distance from the edge of a stud base to the edge of a flange shall be the diameter of the stud plus 1/8 inch, but preferably not less than 1-1/2 inch. The accuracy of location of other types of studs shall be such as to permit a workmanlike assembly of attachments without alterations or reaming.
3. All structural steel in a particular span of a bridge must be erected and have deck forming complete in place before shear devices are attached in that span.
4. After stud welding is completed, a visual inspection of the studs and welding will be made by the Engineer for approval prior to placing of the concrete slab.
5. If during the progress of the Work, testing and inspection indicate, in the sole judgment of the Engineer, that the type of studs, equipment, etc., being furnished are not in accordance with AWS requirements, the Contractor will be required to change equipment and/or change to another type of stud or shear developer at no additional cost to the District.

### 706.20 PAINTING

Structural steel shall be shop painted in conformance with the requirements of 707.

### 706.21 MARKING AND SHIPPING

**A. ERECTION MARKS** - Each member shall be painted or marked with an erection mark for identification and erection diagrams shall be furnished with erection marks thereon, as outlined in 105.02.

**B. SHIPPING** - The Contractor shall furnish the Engineer with 2 copies of shipping statements. The weights of the individual members shall be shown on the statements. Members weighing more than 5 tons shall have the weight marked thereon. Bolts of 1 length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts and packages of bolts, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each package.

- C. STORAGE** - Material to be stored shall be placed on skids above the ground and protected from conditions that promote corrosion. Storage should be under shelter if possible but in any event members shall be placed where least likely to be marred or subject to contamination of any sort. Members shall be stored so as to avoid formation of water-holding pockets and kept properly drained. If storage is outdoors for several months, the shop coat shall be inspected periodically for integrity and any chalking surfaces cleaned and repainted with a shop coat. Girders and beams shall be placed upright and shored. Long members shall be supported on skids placed near enough together to prevent injury from deflection. All material shipped in containers, drums, pallets, boxes, etc. such as bolts, washers, splice plates, etc. must be kept dry at all times and free of any accumulation of water, dirt, grease, oil, or any other matter the Engineer deems deleterious to the material.
- D. DAMAGE** - The loading, transportation, unloading, and field storage of fabricated and rolled material shall be conducted so as to avoid injury and deformation of the metal. The Contractor shall make the necessary arrangements for the transportation, unloading and hauling of the steel to the point of placement. The Contractor shall be responsible for the loss and/or damage of any material delivered and/or stored for the Work under Contract. Damaged material shall be repaired or replaced by the Contractor at his sole expense.

### 706.22 BEARINGS AND ANCHORAGE

- A. BEARING AREAS** - Masonry bearing plates, shoes and pedestals shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Unless otherwise specified on the Plans, or directed by the Engineer, bearing plates, shoes and pedestals shall be set by 1 of the methods outlined in 703.21. Bridge bearings shall be set level, in exact position and shall have full and even bearing on the masonry. Care shall be taken that full, free movement of the superstructure at the movable bearings is not restricted by improper setting or adjustment of bearings or anchor bolts and nuts.

### 706.23 ERECTION

- A. METHODS AND EQUIPMENT** - Before start of erection, the Contractor shall submit for approval all necessary erection diagrams, the amount and type of erection equipment he proposes and other details as requested. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out the Work in full accordance with the Plans and Specifications. No Work shall be done until such approval by the Engineer has been obtained.
- B. FALSEWORK.** - All Work for falsework design, submittals of design calculations and working and erection drawings for falsework and construction and maintenance of falsework shall be performed in accordance with the requirements of 703.16. These requirements also apply when it is necessary to make changes to an existing Structure for maintaining traffic. Approval of the Contractor's Plans shall not be considered as relieving the Contractor of any responsibility.
- C. ASSEMBLING STEEL** - The parts shall be accurately assembled as shown on the Plans and any match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.
- 1. Grade and Alignment** - Before start of field bolting or welding, the Structure shall be adjusted to correct grade and alignment and the Elevations of panel points and other points as needed adjusted. Re-bolting and re-welding due to incomplete and incorrect structure adjustments beforehand shall be at Contractor expense.
  - 2. Bolted connections** - After hoisting steel members into position and prior to releasing weight to the member or releasing hoisting devices, each field bolted connection shall have 25 percent of the holes filled with erection bolts and 25 percent with cylindrical erection pins before high strength bolting. Each field bolted connection carrying superimposed loads during erection shall have 38 percent of the holes filled with bolts and 38 percent with pins before high strength bolting.
  - 3. Fitting-Up Bolts and Erection Pins** - Fitting-up bolts shall be the same diameter as high strength bolts, and cylindrical erection pins shall be 1/32 inch larger.
- D. MISFITS** - The correction of minor misfits involving non-harmful amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming

and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The Contractor shall be responsible for all misfits, errors, and injuries, and shall make the necessary corrections and/or replacements.

- E. REMOVAL OF FALSEWORK AND CLEANUP** - Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of this Work, and shall leave the Bridge Site and adjacent highway or street in a neat and presentable condition satisfactory to the Engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor as soon as practicable.

**706.24 MEASURE AND PAYMENT**

Structural Steel will be measured by 1 of the methods as specified herein. The Pay Item Schedule will indicate which method is applicable. This Work will be paid for as Structural Steel as measured in 706.24(A) or 706.24(B), and the Pay Item Schedule will indicate which method is applicable.

- A. LUMP SUM** - The unit of measure for Structural Steel will be the job. No actual measurement will be made. Payment for Structural Steel will be at the Contract lump sum price, which payment will include all materials, labor, equipment, tools, supporting structures, falsework, and incidentals necessary to complete the specified Work as shown on the Contract Drawings or as indicated in the Contract Documents.
- B. PER POUND** - The unit of measure for the various items of Structural Steel as listed in the Schedule of Prices will be the pound. Payment for Structural Steel will be at the Contract unit price per pound, which payment will include all materials, labor, equipment, tools, supporting structures, falsework, and incidentals necessary to complete the specified Work in place as shown on the Contract Drawings or as indicated in the Contract Documents. The number of pounds will be the actual number of pounds of Structural Steel complete in place as computed from approved Shop Drawings.

The weights of plates shall be computed on the basis of 0.2833 pounds per cubic inch of steel. No allowance will be made for overrun.

Weights shall be computed on the basis of the net finished dimensions of parts as shown on approved Shop Drawings, deducting for copes, cuts, clips, and all open holes, except bolt holes.

The weight of castings will be computed from the dimensions shown on approved Shop Drawings, deducting for holes. To this weight will be added 5 percent allowance for fillets and overrun.

The following unit weights in pounds per cubic foot shall apply:

**TABLE 706.24 (A) UNIT WEIGHTS IN POUNDS PER CUBIC FEET**

Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper-alloy	536.0
Copper sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Lead, sheet	707.0
Steel, cast, copper bearing, silicon, nickel and stainless	490.0
Zinc	450.0

Certified scale weights may be substituted for computed weights if approved by the Engineer. In computing on the basis of certified scale weights, fabricated members shall be weighed on approved scales in the presence of the Inspector. If shop paint has been applied to the completed member when weighed, 0.004 of the member's weight shall be deducted from the scale

weights to compensate for weight of shop paint.

The weight of field and shop bolts heads, nuts, washers and shank length in excess of grip will be included as follows:

**TABLE 706.24 (B) WEIGHTS OF FIELD AND SHOP BOLTS**

Diameter of Bolt (inches)	Bolts-weight per hundred (pounds)
1/2	19.7
5/8	31.7
3/4	52.4
7/8	80.4
1	116.7
1-1/8	165.1
1-1/4	212.0

The weight of temporary erection bolts, shop and field paint, boxes, crates, and other containers used for shipping, and materials used for supporting members during transportation and erection, shall not be included. No measurement will be made for the weight of weld metal.

The Contractor shall compute the weights of all structural steel from his approved Shop Drawings and shall submit this information to the Engineer in suitable form for verification. Weights shall be suitably classified, conforming to various items of structural steel listed in the Schedule of Prices.

For each member, there shall be given a complete shop bill, listing all plates, shapes, and other parts, with the weights thereof, a notation of the amount deducted for clips and other cutoff parts, and the net remaining weight. The tabulations shall include summaries identifying and combining the weights of all individual members, and a general recapitulation giving the total weight under each division and the total pay quantity. 3 copies of these data shall be supplied to the Engineer.

## 707 PAINTING

### 707.01 DESCRIPTION

Work consists of the surface preparation and shop and field painting of new and existing steel structures. Surface preparation shall conform to SSPC-SP 10, Near White Blast Cleaning. Reference will be made to Steel Structures Painting Council (SSPC) Steel Structures Painting Manual, Volume II, Systems and Specifications and other relevant SSPC publications. Painting of materials other than steel will be addressed specifically either in 707 or in the Contract Documents. All paint systems shall meet the approval of the Engineer.

- A. PRE-PAINTING CONFERENCE** – At least fourteen (14) days before the start of painting operations a pre-painting conference should be arranged. Coordinate attendance with Contractor and all applicable Subcontractors. Submit and be prepared to discuss the following:
1. Propose operation, included personnel, equipment, proper access, inspection, and safety.
  2. Enclosures, containment systems, and debris handling.
  3. Surface Preparations, abrasive materials.
  4. Paint system, ambient temperature, surface temperature, dew point, relative humidity, wind, and wet and dry film thickness.
  5. Manufacturer's certifications and Quality Control Plan.
  6. Measurement and payments.

### 707.02 MATERIALS

- A. GENERAL** - All paints, coatings, component materials, submittal of material samples, laboratory and field tests, and the labeling and shipping of paint containers shall conform to the requirements of 811 unless otherwise specified below.

Solvent used for solvent cleaning shall be in accordance with 811.05.

#### **B. PERFORMANCE TESTS AND PRODUCT CERTIFICATION**

1. The Contractor shall submit manufacturer certifications that the appropriate ASTM tests have been successfully performed on the coating system by an independent testing laboratory. The certification shall show specific test results. In addition, the certified test report shall contain the manufacturer's name and brand name of paint, and the lot numbers of sample from which data is compiled.
2. The following information shall be submitted as a complete package for approval for each coat in the system selected at least two (2) months prior to the anticipated beginning of painting operations, as applicable to the paints specified for the Project:
  - A 1 quart sample of each coat (or component, if multiple component paint) in the system
  - Infrared curves (2.5 to 15.0 microns) to include curves for the dry film of the vehicle (binder) of each component and for the mixed paint
  - Weight per gallon at 77° F.
  - Percent solids by weight and volume
  - Percent of metallic zinc by weight in the cured IOZR primer
  - Percent of metallic zinc by weight in the zinc pigment component of the IOZR primer
  - Certification from the manufacturer that the zinc dust pigment component of the IOZR primer conforms to ASTM D 520, Type II and that the IOZR primer contains no more than 0.02% lead by weight in the dried film
  - Certification from the manufacturer that the material supplied for use as field and repair primer and intermediate and finish coats contain no more than 0.005% lead

- Certification, including a copy of the test report, to the effect that the IOZR primer has been tested and is qualified as Class B (Slip Coefficient 0.50) in accordance with the requirements of the most recent edition of AASHTO Standard Specifications for Highway Bridges.
  - The manufacturer's recommended method for determining that the IOZR primer has cured sufficiently for bolting of shop connections and application of the intermediate coat
  - Technical data sheets, application instructions and material safety data sheets for each coat
  - A color chip of the finish coat, of minimum size 8-1/2 inches by 11 inches
  - Viscosity in Krebs units at 77° F for each coat.
  - Volatile organic compounds, measured in pounds per gallon
3. All quantitative parameters shall be expressed either as +/- or as maximums and minimums. Test methods used for all parameters shall be quoted.
  4. All products, including thinners, for the complete system shall be supplied by the same manufacturer and shall be certified as compatible.
  5. All paints shall be packaged in substantial containers with each bearing a label on which shall be written instructions and precautions for use. Each container shall contain the date of manufacture, the batch number and the product designation.
  6. The Contractor shall submit product and material safety data sheets and application guides for his proposed system to the Engineer for material approval.
  7. The Contractor shall supply detailed written instructions from the coating manufacturer on repair procedures, including surface preparation, repair primer, repair intermediate coat, application methods, and any time restrictions. No painting or repair work will be allowed until these written procedures are submitted to the Engineer. The written procedures shall be followed.
  8. The manufacturer shall also certify that the coating system has been used successfully for a period of three (3) years in similar service and environment and that the material was applied in coats within manufacturer's recommended dry film thickness. Successful performance shall include sustained adhesion to structural steel. Specific locations, preferably in the mid-Atlantic region or areas of similar climates, shall be given.
  9. The manufacturer shall have a technical service representative on hand to assist the Contractor the first time that these products are used by the Contractor and shall be available for consultation should any difficulties arise in the use of the products.

### C. LABELING AND PACKAGING

1. All containers shall be listed in accordance with ANSI Standard Z129.1.
2. Label Requirements – The following information shall be listed in clear, legible type on the label of each container, for each product.
  - a. Product name including component type if applicable.
  - b. Color name or number of the particular product and component.
  - c. The lot number or batch number of the product and component.
  - d. The date of manufacture of the product and component.
  - e. The manufacturer's name and complete address.
  - f. Shelf life expiration date.
3. Summary mixing instructions shall be listed on the label of each component or reference the appropriate component which lists the mixing ratio.
4. Any materials hazardous according to OSHA/EPA regulations shall be listed on the label if they exist in the product in amounts greater than 1/10 of a percent if carcinogenic.

**707.03 JOB PERFORMANCE**

- A. GENERAL** - The painting of new or existing structural steel and other metalwork shall include complete preparation of the metal surfaces, application and protection of the drying paint coatings, removal and proper disposal of existing paint, rust, mill scale and hazardous waste, protection of workers and the environment and furnishing all labor, materials, tools, scaffolding and other equipment, and incidentals necessary for proper execution of the Work.

Elements to be coated include the new and existing structural steel members, cross frames, diaphragms, shapes, plates, their connection components and steel bearings. Also included shall be all steel components of the bridge deck drainage system and their supports. Excluded from painting shall be light standards, sign structures, electrical equipment and galvanized steel.

For new steel, the Contractor shall apply a 3-coat paint system as specified herein or in the Contract Documents. All coatings shall be in accordance with Section 811.

For maintenance recoating of existing painted metal surfaces in the field, the Contractor shall apply the type and number of paint coatings as specified in the Contract Documents. All coatings shall be in accordance with Section 811.

- B. CAPABILITY OF WORKERS** – All shop and field painting shall be performed by a Contractor/ Subcontractor certified by the Steel Structures Painting Council (SSPC) Painting Contractors Certification Program (PCCP) for Class 2 work and meeting the requirements of:

1. SSPC-QP 1 Contractor qualification for surface preparation and coatings application in the field and,
2. SSPC-QP 2 for hazardous paint (lead or other) removal and,
3. SSPC-QP fabrication shop qualification for surface preparation and protective coating application in a fixed shop facility
4. The SSPC certification shall be obtained and evidence submitted to the District as part of the required submittals for this Work. Failure to provide the required SSPC certification(s) shall be grounds for disqualification of the painting Contractor or fabrication shop.

**C. WEATHER CONDITIONS FOR SURFACE PREPARATION AND PAINT APPLICATION**

1. With the exception of the inorganic zinc-rich primer (IOZR), no outdoor or field painting shall be performed between December 1 and March 15 without prior approval of the Engineer.
2. Surface preparation shall not be performed when the steel surface is below 32° F, within 5° F of the dew point or when anticipated weather conditions would preclude application of the primer on the same day.
3. Inorganic zinc-rich (IOZR) primer shall not be applied when the ambient, surface and material temperatures are below 40° F, nor when the Engineer anticipates temperature will drop below 40° F within twenty-four (24) hours. All other coatings shall not be applied at temperatures below 50° F. No painting shall be done when the steel surfaces are above 110° F, when the air is misty or foggy or within 5° F of the dew point, nor when rain is anticipated, nor when relative humidity exceeds, or is expected to exceed, 85 percent within eighteen (18) hours, nor when frost or ice exists on the surfaces to be painted, nor when any other conditions are unsatisfactory for painting as determined by the Engineer.
4. Should the manufacturer's requirements for a particular material be more stringent than this specification, the manufacturer's requirements shall prevail. Application of coatings outside of normal temperature/humidity recommended ranges as established by the manufacturer shall be subject to the Engineer's approval on a daily basis.
5. If, in the opinion of the Engineer, traffic or construction equipment produces an objectionable amount of dust, the Contractor, at his expense, shall allay the dust for the necessary distance and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or other surfaces to be painted.

- D. PAINTING SCHEDULE AND CONTRACTOR'S SUBMITTALS** - Before any painting operations begin the Contractor shall submit in writing to the Engineer his proposed Work schedule which shall include:

1. A systematic procedure or plan for all cleaning and painting operations.
2. A plan for the capture, containment, collection and storage of the waste generated by the Work, which includes blasting residue, spent blasting medium, rust, mill scale, paint particles, dust, etc. Included shall be the recovery system for recycling the blasting media. The system shall be capable of adequate removal of dust particles and continuously keeping the grit dry and free of oils, grease and other harmful materials.

3. A plan of action, submitted by the Industrial Hygienist, indicating the procedures for monitoring air, soil and water. The plan shall include the type of equipment to be used and the approximate locations of monitors and test samples for the Project area. The Contractor shall also submit a written program for worker protection.
4. The type and method of protection against paint spatters drippings, and other disfiguring elements while cleaning and painting over roadways, waterways and areas in vicinity of abutments and piers. Methods of meeting requirements of 707.06 shall also be submitted.
5. Drawings and computations showing the type and size of scaffolding, rigging and negative pressure containment systems to be used showing all dimensions, sizes of members, types of materials, required negative pressure and capacity of the specified blasting system with a procedure clearly stating how it will be erected.

The drawings and computations shall be certified in writing by a Professional Engineer registered in the District. All portions of the outline and drawing are subject to the Engineer's approval. Any deviation from approved procedures will be allowed only with the Engineer's approval. Approval does not relieve the Contractor of the responsibility for the safety of his methods and equipment, or from carrying out the Work in full accordance with specification requirements. Work shall not commence until approval of the Engineer has been obtained.

6. The Contractor shall provide adequate, portable lighting equipment in good working order, of a design approved by the Engineer, and at no cost to the District, to supply adequate illumination to the underside of Structures while cleaning and painting and for any inspection.

#### E. INSPECTION

1. All Work shall be inspected by authorized personnel representing the District. As each operation (cleaning, blasting, spot painting and each coat of painting) is completed and prior to any succeeding operation on a section, the Contractor shall notify the Engineer for approval before the next operation may begin.
2. Any Work not meeting approval of District Inspectors shall be rejected and redone until it meets their approval. The method of correction shall be approved by the Engineer prior to proceeding. Should any Work be done which proceeds past the point where Inspector approval is required, the Contractor shall, at the option of the Engineer, remove said Work back to that point at no additional cost to the District. The Contractor shall correct Work or replace material which is found defective. The method of correction shall be approved by the Engineer.
3. Cleaning and surface preparation of each section shall be entirely completed and accepted before painting commences in that section. All paint shall be suitably dry throughout a full section and accepted before any succeeding coat of paint is applied in that section. Any paint applied without the prior approval of the Engineer to begin painting shall be removed by sandblasting to bare metal. This corrective Work shall be at the sole expense of the Contractor.
4. When surface preparations are complete, surfaces shall be checked for cleanliness, smoothness, anchor profile height and dryness. Cleanliness shall meet the job sample previously established. Anchor profile height shall be measured using replicate tape in accordance with ASTM D 4417, "Field Measurement of Surface Profile of Blast Cleaned Steel," Method C – Composite Plastic Tape. Dryness shall be determined by dew point measurement. The Contractor shall perform these determinations, using his own approved test equipment, in the presence of the Engineer. Prepared areas shall be painted as soon they are accepted by the Engineer.
5. Dry paint film shall be randomly measured for thickness, and shall be inspected for non-uniform areas, holidays, runs or sags. Areas not meeting specification requirements shall be corrected to the satisfaction of the Engineer.
6. Film thickness on edges, welds, rivets, etc. shall be checked by cutting off a paint chip at representative points with a knife and visually comparing with chip taken from an area of known thickness.
7. Adhesion and flexibility of the paint film on the metal shall be checked by cutting loose a narrow strip of the thoroughly dried film from the surface with a knife. Flat side of the blade should make an angle of about 30 degrees with the coated surface. Films of good flexibility and adhesion should come off under the knife in a ribbon and edges of the cut should show a beveled appearance without evidence of flaking.
8. To facilitate the inspection, the Contractor shall perform the following:
  - a. The Contractor shall provide the Engineer with 1 copy each of the following documents, which will become the property of the District upon completion of the Work:



- SSPC Volume 2 of Steel Structures Painting Manual, Systems and Specifications.
- SSPC-Vis Standard for Abrasive Blast Cleaned Steel Surfaces.
- SSPC-Vis, Color Photographic Standards for Evaluating Degree of Rusting on Painted Steel Surfaces.

b. The Contractor shall supply, maintain and replace as necessary, for the use of the Engineer, the following:

- 2 electronic noise level measuring devices that meet EPA Standards
- 2 Positector 2000(in) Dry Film Coating Thickness Gauges or approved equal
- 2 Psychro-Dyne Humidity indicators providing wet and dry bulb temperatures for establishing relative humidity and dew point
- 2 National Weather Service Psychrometric Tables
- 2 Magnetic thermometers for measuring the surface temperature of metalwork
- A sufficient supply of Keane-Tater Surface Profile Comparator or Testex Replica Tape for measuring the anchor profile height of the cleaned steel surface.

Upon completion of the Contract, the equipment shall remain the property of the Contractor. Additional methods and equipment may be used for inspection procedures by and at the discretion of the Engineer.

9. The Contractor shall furnish all necessary apparatus such as ladders, scaffolds, platforms and lighting as required for the Inspector to have reasonable and safe access to all Work at times deemed necessary by the Engineer for inspection. Rigging shall meet OSHA requirements.

When blast cleaning is performed, the Contractor shall also supply 1 set of disposable, protective coveralls, daily, for use by the Inspector and shall be responsible for proper disposal after they are used. The Contractor shall also supply half face respirators and a sufficient number of cartridges for District inspection purposes as needed by the Engineer. Appropriate cartridges for particulates and organic vapors shall be supplied. The Contractor shall be responsible for disposal of the cartridges after they are used.

- F. PAINT REPRESENTATIVE** - The representative shall be a technical representative of the paint manufacturer and shall be present during the initial execution of the Work to approve with the Engineer and degree of cleanliness prior to painting, and the method of application of the coating system. The Engineer may stop paint operations for failure to meet this requirement regardless of the reason for the failure. Areas cleaned prior to ceasing paint operations shall be re-cleaned if required.

#### **G. REPAIRS**

1. All defective or damaged areas shall be repaired, at the Contractor's expense. Said areas shall be coated with the full system as required in these Specifications. Repair may be limited to touch up of damaged areas but in no way shall the number of coats, the required coating system, or the dry film thickness of each coat be modified because of the repair procedure. Should an area be damaged through to the steel substrate, said area shall receive the specified degree of surface preparation as well as the full coating system as a repair remedy.
2. Defects in the paint film, including damage such as scratches and areas of non-adherent paint, and rusting in excess of Rust Grade 8, as determined using SSPC-Vis 2, shall be repaired.
3. Prior to shipment of steel to the Project Site, all areas of non-adherent paint and damaged areas which exhibit rusting shall be re-blasted to the SSPC-SP10 standard and reprimed with the IOZR primer on the same day.
4. Subsequent to shipment of steel to the Project Site:

All damage to the paint film, including rusting, which occurs prior to erection of the steel, shall be repaired before steel is erected.

Minor damaged areas such as scratches, not exceeding 1 square foot in area, shall be reblasted to the SSPC-SP 6 standard, or may, at the Contractor's option, be prepared in accordance with SSPC-SP 11, Power Tool Cleaning to Bare Metal, after which they shall be reprimed on the same day using the field primer. Larger areas of defects, if directed by the Engineer, shall be re-

blasted to the SSPC-SP 6 standard and re-primed the same day using the field primer.

In no case shall the field primer be applied to any faying surfaces prior to field erection and installation of the fasteners. Necessary repairs to the faying surfaces shall be made as directed by the Engineer.

5. All damaged areas shall receive the full system of either the IOZR or field primer and intermediate and finish coats as specified elsewhere in this Specification.

#### **H. MAINTENANCE AND PROTECTION OF HIGHWAY AND PEDESTRIAN TRAFFIC AND ADJACENT PROPERTY -**

The Contractor shall be responsible for any disfigurement by splatters, smirches and splashes of paint on vehicular traffic and pedestrians, adjacent property and on any portion of the Structure or area under the Structure. The Contractor shall also be responsible for damage to the Structure and adjacent property through the use of scaffolding and other equipment.

Proper drop cloths shall be required to minimize splatters of paint on concrete surfaces. Any damage or disfigurement shall be replaced or cleaned at the sole expense of the Contractor.

### **707.04 ENVIRONMENTAL PROTECTION**

#### **A. PROTECTION OF WORKERS AND THE ENVIRONMENT**

1. Protection of workers and of the environment shall be provided by the Contractor as an integral requirement of the performance of the Work. The Contractor shall employ the best current methodology for protection of the worker/employee and the environment by containment of all hazardous material in consideration of the following:
  - The release of volatile organic compounds (VOC's) and isocyanates during painting.
  - Protection of workers to prevent exposure to hazardous waste, VOC's, isocyanates, and any other compound deemed hazardous by the jurisdictional agencies.
  - U.S. Environmental Protection Agency (EPA), U.S. Occupational and Health Administration (OSHA), and District of Columbia Department of Health (DOH) requirements and guidelines pertaining to all of the above.
2. The VOC regulations on bridge projects in the District of Columbia are subject to the Federal Rules for National Volatile Organic Compound Emissions Standards for Architectural Coating, current publication by the Environmental Protection Agency, and its subsequent amendments. The D.C. Department of Transportation will not restrict the application of coatings for architectural, industrial and maintenance purposes on bridge structures to the limits of Section 700 of 20 DCMR. Coatings and paints with VOC contents that comply with the Federal Standards would not be subject to the limits of Section 700, 20DCMR.

The Contractor shall obtain all recent Federal Regulations and shall follow the restrictions therein for painting operations.

The Contractor, with the assistance of the D.C. Department of Transportation, shall obtain a permit from DOH to engage in blast cleaning and painting operations. Applicable portions of DCMR Title 20 Section 605 are as follows:

#### *605 CONTROL OF FUGITIVE DUST*

*605.1 Reasonable precautions shall be taken to minimize the emission of any fugitive dust into the outdoor atmosphere. The reasonable precautions shall include, but not be limited to, the following:*

*(g) ...and in the case where dry sandblasting or dry abrasive cleaning is necessary: Use of enclosed areas or hoods, vents, and fabric filters.*

#### *700 ORGANIC SOLVENTS*

The Contractor is encouraged to minimize organic solvents discharged by using low VOC rated coatings for the specified paint system.

It is recommended that the Contractor obtain a complete copy of DCMR 20 prior to preparation of bids. Publications may be purchased by mail or in person from the D.C. Office of Documents and Administrative Issuances.

**B. MONITORING**

- 1. Industrial hygienist** – When existing structural steel is blast cleaned, the Contractor shall employ the services of an Industrial Hygienist certified by the American Board of Industrial Hygiene. The hygienist shall have errors and omissions insurance coverage and shall be experienced in this type of work.

The hygienist shall monitor worker exposure and ambient air and analyze the soil before, during and after cleaning operations at locations selected by the hygienist and approved by the Engineer. All sampling and testing shall be performed by the industrial hygienist or an employee of that firm under the direct supervision of the hygienist.

Due to the results of these analyses, adjustments to the containment system may be required by the Engineer. The Contractor shall provide a copy of all reports and analyses, including calibrations of all instruments, to the Engineer in a timely manner.

- 2. Lead/chromium exposure monitoring** – The Contractor shall institute a monitoring program for all employees who occupy a position where they may be exposed to lead and/or chromium. Blood lead/chromium levels shall be taken prior to beginning Work and at least every month for the first six (6) months and every two (2) months, thereafter. Blood lead/chromium tests shall be performed by a clinical laboratory certified by OSHA.

If blood analysis shows a blood lead level of 40mg/dl, blood samples shall be collected every month until 2 consecutive tests indicate a blood level of less than 40 mg/dl. An employee shall be removed from exposure to lead if his/her blood lead level is at or above 60 mg/dl and/or if the average of the last 3 blood tests or the average of all blood tests in the previous six (6) months is at or above 50 mg/dl. A follow-up blood test shall be taken within two (2) weeks after any test which exceeds the numerical criteria for medical removal.

The medical removal of workers is intended to protect the employees' health and shall not penalize the worker by loss of earnings, seniority or other employment rights and benefits. An employee can be returned to his/her former position when 2 consecutive blood lead levels are at or below 40 mg/dl.

The Contractor shall provide the employee with a copy of all blood lead/chromium results. Each employee shall receive a written notice of his/her blood lead level within five (5) days after receipt of the results. It is recommended that a permanent record be kept by the Contractor of employee's blood lead/chromium results.

- 3. Soil Sampling and Testing** – The industrial hygienist shall test for lead contamination in the vicinity of the Project by conducting periodic soil sampling and testing. Soil samples shall be taken at a minimum of 6 locations at locations determined by the hygienist as approved by the Engineer. At least 3 sets of soil samples shall be taken; 1 prior to the start of Work, 1 at the midpoint of construction and 1 at the completion of all cleaning operations. Soil analyses shall be performed in accordance with SSPC-Guide 6(CON), paragraph 5.5.5, "Method E" as directed by the hygienist.
- 4. Air monitoring** – The industrial hygienist shall monitor the quality of air within the vicinity of the Project. Work exposure monitoring tests shall be performed outside the face mask and inside the hood of workers and outside and downwind of the containment system. Air monitoring shall begin one (1) week prior to beginning Work, during the first two (2) weeks of blast cleaning operations and one (1) month later unless otherwise directed by the Engineer. The number of tests required shall be determined by the Contractor's industrial hygienist and approved by the Engineer. If the data measured is acceptable as determined by an industrial hygienist, additional monitoring will only be required when problems arise as determined by visual assessments of the Contractor's operations. Visible residue on the ground or visible dust shall not be acceptable.

The method for assessing the quantity of emissions shall be in accordance with SSPC-Guide 6(CON), paragraph 5.5.1(a)(2), "Level Emissions". Air monitoring in accordance with paragraph 5.5.3 "Method C" shall be performed to insure compliance with National Ambient Air Quality Standards according to 40 CFR, Part 50, which is 150 mg/m<sup>3</sup> over a twenty-four (24) hour time period.

The Contractor shall provide dust collectors and air flow systems capable of satisfying ambient air and worker exposure requirements. The containment Structure shall be checked constantly for holes, rips or tears during cleaning and painting operations. Should any leaks be found, the Contractor shall immediately cease all cleaning or painting operations until such defects are repaired.

### C. BLAST CLEANING OF EXISTING STEEL

1. **Hazardous waste** – The Contractor is cautioned that the existing paint coatings may contain lead and/or other hazardous elements and compounds and that all residues resulting from blast cleaning, including paint, rust, mill scale and blasting media may be classified as hazardous waste as defined by SSPC-Guide 7 and all applicable Federal or District regulations. The Contractor is required under this Contract to dispose of these materials as hazardous waste as required by the applicable regulations. The Contractor shall obtain an EPA hazardous waste generator identification number from the District.
2. **Containment systems** – Materials resulting from blast cleaning in the field shall not be allowed to fall on the ground or become airborne outside the immediate Work area. A negative air pressure containment system meeting the requirements of SSPC-Guide 6, Class 3, shall be required to prevent the escape of fugitive dust into the environment. All rust, scale, loose paint, grease, oil and materials used in blast cleaning shall be stored and disposed of as hazardous waste in conformance with District, EPA and OSHA requirements, as applicable.

The containment system shall be capable of maintaining no visible discharge when blast cleaning is performed in the center of the containment. Only slight or minor airborne discharge will be permitted when Work is being performed near the end or sides of the containment. Air flow shall be established in the containment such that fugitive dust is directed away from the Work area. The abrasive recovery/recycling system shall have adequate filters and controls so no visible discharge occurs during recovery, recycling or handling of the abrasive.

3. **Worker protection** – Workers performing abrasive blast cleaning shall wear full body protective clothing with a continuous flow, airline, abrasive blasting respirator for protection from lead and/or silica dust or fumes. The garment material shall permit the passage of air and shall be impermeable to lead fumes, mist or dust. All respirators must be an approved type, certified by the National Institute for Occupational Safety and Health (NIOSH).

The Contractor shall ensure that all protective clothing is removed at the completion of a work shift only in designated change areas which are sufficiently separated from other facilities. All contaminated protective clothing which is to be cleaned, laundered or disposed of shall be placed in a closed container, located in the designated change area, which prevents dispersion of lead. The container shall be labeled as containing clothing contaminated with lead. Provisions shall be made for the cleaning, laundering or disposal of protective equipment and repair or replacement of equipment as needed to maintain their effectiveness. Adequate washroom and shower facilities shall be located adjacent to the designated change area.

4. **Temporary Storage of Hazardous Waste** – The Contractor shall obtain a temporary storage Site for hazardous wastes meeting the requirements of SSPC- Guide 7. This Site shall be a fenced and locked area where the public does not have access, and is not in a flood plain. The area shall be marked as containing hazardous waste. The material shall be kept in closed containers while in temporary storage. No hazardous waste shall be kept longer than ninety (90) days in the temporary storage Site before shipment. The Contractor shall prepare all manifests for transportation and disposal of the waste. The completed manifest containing all required signatures shall be submitted to the Engineer. The hazardous waste shall then be transported to an approved hazardous waste disposal Site.
5. **Field repairs** – If blast cleaning is required during field repair of damaged paint surfaces, the Contractor shall also be subject to Section 707.04, for control of fugitive dust. The Contractor is liable for all expenses and time delays in performing this repair work. Included in this Work is prior approval of detailed procedures with types of equipment to be used.

**D. PAINTING OPERATIONS** - For painting operations, full ventilated enclosures are required to prevent overspray into the atmosphere and onto private property. Workers engaged in spray painting operations shall be provided with full body protection with either a powered air purifying respirator or an air supplied respirator. Drop cloths shall be intended to be used only as a secondary (backup) system to prevent paint from falling on the ground.

**E. CONTRACTOR'S METHODS** - The methods proposed by the Contractor shall be approved by the Engineer before Work may proceed. Approval by the Engineer does not relieve the Contractor of any responsibility for meeting all Federal, State and local regulations on air quality, water quality, hazardous materials, hazardous waste, public health or the laws of any regulatory agency.

**F. MEETINGS** - The Contractor, with the Engineer in attendance, shall hold meetings to inform all workers of the potential safety and health hazards of this Work and what steps are being taken to reduce the risk of contamination, and to give instructions in the use of

protective equipment. The protection of the workers and the environment and the recovery, transportation and disposal of hazardous waste shall be of the utmost importance.

#### 707.05 COATING SYSTEMS

**A. NEW STRUCTURAL STEEL** - New structural steel shall receive the following coatings selected from the list of paint systems found in the Contract Documents:

1. **Stripe coat** – All edges, including flanges, shop-installed nuts and bolts, and welds, shall receive a stripe coat of primer just prior to application of the primer coat. The stripe coat shall be brush applied. The paint shall either be constantly agitated, or stirred just prior to application.
2. **Primer** – 1 shop coat of inorganic zinc-rich (IOZR) primer conforming to the requirements as specified herein to a dry film thickness (DFT) in accordance with the manufacturer's recommendations. This coat shall be applied the same day of blast cleaning.
3. **Intermediate** – 1 coat of epoxy paint conforming to the requirements specified herein, with a minimum DFT in accordance with the manufacturer's recommendations.
4. **Finish** – 1 or more coats of urethane topcoat, tinted as specified in the Contract Documents, conforming to the requirements specified herein with a minimum DFT in accordance with the manufacturer's recommendations to the total DFT specified for the Project.
5. The color of the finish coat for painting of new and existing metalwork should conform to Federal Standard 595 B, No. 26408, Light Gray unless otherwise noted.

Following installation in the field, new steel shall receive touch-up coats on damaged areas as specified in 707.03(F), REPAIRS.

**B. EXISTING STRUCTURAL STEEL** - All existing metal surfaces, except those specifically excluded, shall receive the following coatings selected from the list of paint systems found in the Contract Documents.

1. **Primer** – 1 coat of organic-zinc field primer conforming to the requirements specified herein with a minimum dry film thickness (DFT) in accordance with the manufacturer's recommendations.
2. **Intermediate** – 1 coat of epoxy paint conforming to the requirements specified herein with a minimum DFT in accordance with the manufacturer's recommendations.
3. **Finish** – 1 or more coats of urethane paint, tinted as specified in the Contract Documents, conforming to the requirements specified herein with a minimum DFT in accordance with the manufacturer's recommendations to a total DFT specified for the Project.

**C. APPROVED PAINT SYSTEMS** - The listing of all paint coating systems found in section 811 of these Specifications have been given conditional approval, subject to meeting composition, physical properties, performance criteria and environmental criteria.

Alternate systems, selected from the current approved lists of the Maryland State Highway Administration and the Virginia Department of Transportation, may be submitted for approval. Said systems shall be accompanied by full documentation, including the state's list of approved systems. All products, including thinners, for the complete system shall be from the same manufacturer.

**D. PREPARATION OF PAINT** - All paint shall be used directly from original shipping containers without any additions or thinning except lampblack. Lampblack shall be added only as directed by the Engineer.

All ingredients in any container of paint shall be thoroughly field mixed before use and agitated often enough during application to keep the pigment in suspension. In cool weather paint may be warmed by slowly heating the paint containers in warm water. When warming paints their temperature shall not be permitted to exceed 100°F.

Paint first shall be mixed in the original container and not transferred until all settled pigment is incorporated into the vehicle. However, a portion of the vehicle may be poured off temporarily to simplify mixing.

Mixing shall be done by mechanical methods except that hand mixing will be permitted for original containers up to 5 gallons in size. Mixing in open containers shall be done in a well ventilated area away from sparks or flames. Paint shall not be mixed or kept in suspension by means of an air stream bubbling under the paint surface.

Where a skin has formed in the container, the skin shall be cut loose from the sides of the container, removed and discarded. If such skins are thick enough to have a detrimental effect on the composition and quality of the paint, the paint shall not be used.

The paint shall be mixed in a manner which will insure breakup of all lumps, complete dispersion of settled pigment and a uniform composition. When mixing is done by hand, most of the vehicle first shall be poured off into a clean container. The pigment shall be lifted from the bottom of the container with a broad, flat, clean paddle, lumps shall be broken up and the pigment thoroughly mixed with the vehicle. The poured off vehicle then shall be returned to the paint with simultaneous stirring, or pouring repeatedly from 1 container to another until composition is uniform. The bottom of the container shall be inspected for unmixed pigment.

All pigmented paint shall be strained after mixing; strainers shall consist of cheesecloth or a medium mesh screen (No. 6 mesh) and shall show only a trace of skins and un-dispersed lumps.

Lampblack pastes shall be wetted with a small amount of paint and thoroughly mixed. The thinned mixture shall then be added to the large container of paint and mixed until color is uniform.

Paint which does not have limited pot life or does not deteriorate on standing may be mixed at any time before using. If settling has occurred the paint must be remixed immediately before using. Paint shall not remain in spray pots, painter's buckets, etc., overnight, but shall be gathered into the original container or a central container and remixed before use.

Paint not meeting the strainer test, or with thick skins detrimental to composition, or not meeting the test requirements in accordance with 811.01, shall be rejected on this basis alone and removed from the Work area to the satisfaction of the Engineer.

All varsol, turpentine and any other solvents shall be stored at least 300 feet away from any paint being stored in previously opened containers, paint being mixed, and paint operations. Any paint which becomes mixed or contaminated with any such varsol, turpentine, solvents, or any other foreign substance shall be rejected on this basis alone and immediately removed from the Work area to the satisfaction of the Engineer.

## 707.06 SURFACE PREPARATION

### A. STANDARDS FOR SURFACE PREPARATION

1. The degree of preparation attained will be determined by the use of SSPC-Vis Standard for Abrasive Blast Cleaned Steel. Abrasive blasting of structural steel shall be performed using recyclable abrasives in the form of steel shot, steel grit, or a combination of the two, in a size or combination of sizes sufficient to impart the specified surface profile. Abrasives that contain greater than 110 ppm chloride, sulfate or other similar corrosives shall not be used. Dehumidification equipment shall be used to protect the abrasive from atmospheric corrosion.
2. After blast cleaning, the surface of existing steel shall have an anchor profile height of a minimum of 1 mil, and the surface of new steel shall have an anchor profile height of 1 to 3 mils in a dense uniform pattern of depressions and ridges as determined by the Keane-Tator Surface Profile Comparator or Testex Replica Tape. If necessary, the area shall be re-blasted to give the specified anchor profile height.

### B. INITIAL SURFACE PREPARATION - Prior to blast cleaning, the following operations shall be performed:

1. All weld spatter and slag shall be removed and all sharp corners on the bottom flanges and cross frame members shall be rounded to a 1/8+ inch radius or equivalent flat surface.
2. All fins, tears, slivers and burred edges that are present on any steel member, or that appear during the blasting operation, shall be removed by grinding and the area re-blasted to provide the specified surface profile.
3. All drilling and reaming of holes in the steel shall be completed and free of burrs or other imperfections, such as torn or ragged edges prior to blast cleaning.
4. Remove rust scale from all surfaces of the Bridge prior to surface preparation. Pay particular attention to any crevice areas at steel connection points. Exercise care to avoid nicking or gouging the steel during removal.
5. Steel defects requiring repair may be apparent before or after abrasive blast cleaning begins. Advise the Engineer of any areas exhibiting defects such as excessive metal loss or pitting. Provide access for the Engineer as required to conduct an inspection of areas that may require repair.
6. Prior to using any of the methods of surface preparation specified herein, remove visible grease and oil from the surface.

- a. SSPC-SP 1 Solvent/Detergent Cleaning
  - i. Clean the surface in accordance with SSPC-SP 1 to remove grease, oil, and other similar surface material. Only use solvents or detergents that will not damage the substrate, and that are acceptable to the coating manufacturer and the Engineer.
  - ii. Contact the Engineer for approval prior to disposing residue from degreasers or detergents into the drain system. If clearance is not provided, collect, properly handle, and dispose of the materials.
  - iii. Use clean cloths for the final wiping.

7. Provide compressed air that is free from moisture and oil contamination

- a. Verify the cleanliness of the compressed air by the white blotter test in accordance with ASTM D 4285 at least once per shift for each compressor system. Sufficient freedom from oil and moisture is confirmed if soiling or discoloration is not visible on the paper.
  - b. If air contamination is evident, change filters, clean traps, add moisture separators or filters, or make such adjustments as necessary to achieve clean, dry air.
8. Do not conduct final surface preparation which exposes bare steel under damp environmental conditions or when the surface temperature is less than 5 °F greater than the dew point temperature of the surrounding air.
9. Use clean, dry, uniformly graded recyclable steel abrasives for blast cleaning that are free of oil, soluble salts and other similar substances which could contaminate the blast cleaned surface. For abrasive blast cleaning provide an abrasive that is sized to produce a 2 to 3 mils surface profile depth or as specified by the paint manufacturer.

Do not reuse abrasive unless the abrasive is specifically designed for that purpose (e.g., recyclable steel grit) and ample equipment is available at the Project Site for the safe, controlled cleaning of the abrasive.

**C. BLAST CLEANING OF NEW STEEL** - Surfaces of new steel shall be prepared for shop painting in accordance with SSPC Steel Structures Painting Manual, Volume 2, Surface Preparation No. 10, Near-White Metal Blast Cleaning.

**D. BLAST CLEANING OF EXISTING STEEL** - Surfaces of existing steel shall be prepared for repainting by blast cleaning, except those which are considered inaccessible for this procedure, in accordance with the requirements of SSPC Steel Structures Painting Manual, Volume 2, Surface Preparation No. 10, Near-White Metal Blast Cleaning. As an alternative, inaccessible areas shall be prepared in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal.

Special attention shall be given to the procedures described in SSPC- SP 10 which describe required surface preparation before and after blast cleaning. Soil, concrete splatter, oil, grease, salts, dirt film, or other foreign matter shall be removed by brushing with stiff wire brushes, scraping and washing with cleaning solutions before blast cleaning. All fins, tears, slivers, sharp edges, weld spatter and burning slag shall be removed by grinding and the area re-blasted to achieve required surface profile as described above.

If directed by the Engineer, an additional blast cleaning of the surface shall be done in all areas subject to chloride contamination, such as expansion joints. The appearance of the prepared surfaces shall be compared with the appropriate photographs in SSPC-Vis standards. The Contractor shall describe the proposed method(s) of soluble salt remediation in the surface preparation/painting plan.

The Engineer will be the sole-approving authority of the adequacy of the surface preparation.

The Contractor is cautioned that if the surfaces of existing structural steel are believed to be coated with mill scale, the removal of the mill scale is included in the required work.

Sand-blast and water-blast techniques will not be permitted.

After the prepared surfaces of existing steel have been inspected and accepted, the surfaces, except for faying areas, shall be primed the same day. Should surface rust-back occur before primer application, the affected area shall be blast cleaned at no extra cost to the District.

The Contractor shall take the necessary measures to protect previously painted surfaces adjacent to blast cleaning operations from damage resulting from these activities. These measures shall not relieve the Contractor of the responsibility of repairing all damage to newly painted surfaces as a result of the blast cleaning operations.

- E. WOOD SURFACES** - Wood surfaces shall be prepared by scraping with wood scrapers or sanding with coarse and/or fine sandpaper and dusting the surfaces, or a combination of these methods, until surfaces are smooth and un-splintered.

#### 707.07 GENERAL REQUIREMENTS FOR PAINT APPLICATION

- A. GENERAL** - All paint shall be applied in accordance with SSPC-PA1, Shop, Field and Maintenance Painting and as hereafter specified.
- B. PAINT COATINGS** - All new structural steel shall be painted at the fabrication shop with 1 coat of inorganic zinc rich primer (IZOR) as specified in 707.05(A). All existing structural steel shall be painted with 1 coat of field primer as specified in 707.05(B). All structural steel, except for dam assemblies, surfaces in contact with concrete and faying surfaces shall then receive intermediate coat conforming to 811.03 and a finished coat conforming to 811.04 (B) or (C).
- C. GALVANIZED STEEL** - Unless otherwise specified, galvanized surfaces shall not be painted. Machine finished surfaces or portions thereof which are to bear and slide on other surfaces shall not be painted, but shall be coated prior to shipping with a corrosion inhibiting multipurpose grease or other specified coating.
- D. STORAGE AND MIXING OF PAINT** - All paint shall be stored, mixed, thinned, and applied in accordance with the manufacturer's recommendations. In cases when the manufacturer's recommendations differ from the requirements specified herein, those which are more stringent shall govern. In cases where manufacturer's recommendations are more lenient than the requirements in this specification, they shall govern only if specifically authorized by the Engineer.

All paint shall be mixed using power mixers of the type recommended by the manufacturer. Only complete kits of the inorganic zinc-rich (IOZR) primer shall be mixed. IOZR primer which exceeds its pot life shall be discarded. Paints shall be frequently mixed during application. IOZR primer shall be continuously agitated and shall be applied from containers equipped with a mechanical agitator which shall be in constant use during application. Paints shall be frequently remixed during application. Paints shall be thinned only with prior approval of the Engineer.

- E. CLEANING OF PREPARED SURFACES** - Prior to application of each coat, the surfaces to be painted shall be cleaned as necessary so as to be dry and free of dirt, grease and oil contamination. All residues of abrasives, paint and dust remaining after blast cleaning or other operations shall be removed using a commercial grade vacuum cleaner equipped with a brush type cleaning tool or by double blowing with clean air. If the double blowing method is used, the top surfaces of all steel shall be vacuumed after the double blowing operation is complete. Compressed air used in this operation shall be clean and free of oil, grit and moisture.
- F. COMPRESSED AIR** - Compressed air used for all operations, including abrasive blasting, cleaning and painting shall conform to ASTM D 4285. All compressed air supply lines shall be provided with oil traps and moisture separators, which shall be emptied and/or changed, as appropriate, on a regular basis. Separators and traps shall be located at the abrasive pots and material containers instead of at the compressors.
- G. APPLICATION METHODS** - IOZR primer shall be applied by spraying, except that brushes may be used to facilitate coating of and around fasteners. Other paint coatings may be applied by any combination of methods or equipment that are recommended by the manufacturer. If rollers are used, they shall be of a type which does not leave a stippled texture in the paint film. Rollers shall be used only on flat, even surfaces and shall be followed by a brush to level off any bubbles.

Application of paint shall result in a tight film of specified thickness, well bonded to the metal or underlying coatings, including all crevices and corners and shall be free from laps, streaks, sags, bubbles, runs, overspray, dry spray, shadow-through, skips, excessive film buildup, misses and other defects. If required by the Engineer, edges shall be striped with a longitudinal motion and fastener components with a rotary motion immediately prior to the application of the full coat.

- H. DRY FILM THICKNESS REQUIREMENTS** - IOZR shall be applied to a minimum DFT of 4 mils above the surface profile on the interior surfaces of box beams not receiving intermediate and finish coats.

DFT's shall be determined in accordance with SSPC-PA 2, Measurement of Dry Paint Thickness with Magnetic Gages, except that the 80% tolerance will not be allowed.



## I. APPLICATION METHODS

- 1. Conventional air spray application** - Spraying shall be done with a suitable spray gun of a type and with a method of operation approved by the paint manufacturer for the paint used, without thinning, and acceptable to the Engineer. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. Air from the spray gun impinging against the surface shall show no condensed water or oil. Proper uniform air pressure shall be maintained so as to secure even operation.

Spraying operations shall be carried out so as to secure an even paint film of uniform thickness over all areas to be painted. Thickness of paint film by spray painting shall be equivalent to that secured by approved brush painting and that specified, as measured by a magnetic film thickness gauge. When necessary to secure uniform coverage and to eliminate wrinkling, blistering and air holes, spray painting shall be followed immediately by brush painting.

- 2. Airless spray application** - The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The equipment shall be maintained in proper working condition.

Paint ingredients shall be kept uniformly mixed in the spray pots or containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

Fluid tips shall be of proper orifice size and fan angle, and the fluid control gun of proper construction, as recommended by the manufacturer of the material being sprayed and the equipment being used. Fluid tips shall be of the safety type with shields to prevent penetration of the skins by the high pressure stream of paint.

The air pressure to the paint pump shall be adjusted so that the paint pressure to the gun is proper for optimum spraying effectiveness. This pressure shall be sufficiently high to properly atomize the paint. Pressures considerably higher than those necessary to properly atomize the paint should not be used.

Spraying equipment shall be kept clean and shall utilize proper filters in the high pressure line so that dirt, dry paint, and other foreign material are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint.

The trigger of the gun shall be pulled fully open and held fully open during all spraying to insure proper application of paint.

Paint shall be applied in a uniform layer with overlapping at the edges of the spray pattern. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

All runs and sags shall be brushed out immediately or the coating shall be removed and the surface repainted.

Cracks, crevices, blind areas of all rivets and bolts, and all other inaccessible areas shall be painted by brush, daubers, or sheepskins.

Paint shall be suitable for the particular spray application method used.

Particular care shall be observed with respect to paint temperature and operating techniques in order to avoid deposition of paint which is too viscous, too dry, or too thin.

Airless paint spray equipment shall always be provided with an electric ground wire in the high pressure line between the gun and the pumping equipment. Further, the pumping equipment shall be suitably grounded to avoid the build-up of any electrostatic charge on the gun. The manufacturer's instructions shall be followed regarding the proper use of the equipment.

- 3. Brush application** - Brushes shall be of a style and quality that will enable proper application of paint. Round or oval brushes shall be used for painting rivets, bolts, irregular surfaces, and rough or pitted steel. Wide, flat brushes, not having a width over 5 inches, shall be used for large flat surfaces.

The brushing shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. Paint shall be worked into all crevices and corners where possible. All runs or sags shall be brushed out. There shall be a minimum of brush marks left in the applied paint. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskins.

- 4. Roller application** - Roller application may be used on flat or slightly curved surfaces and shall be in accordance with the recommendations of the paint manufacturer and roller manufacturer. Paint rollers shall be of a style and quality that will enable proper application of paint having the continuity and thickness required.

Roller application shall not be used on irregular surfaces such as rivets, bolts, crevices, welds, corners, or edges.

#### 707.08 SHOP PAINTING

- A.** The Contractor has the option to apply the intermediate coats at the fabrication shop, but all finish coats shall be applied after final erection of the member. In this case, all requirements that apply to the application of intermediate and finish coats stated elsewhere in this specification shall apply. Choice of this option shall not relieve the Contractor of the obligation to exercise all reasonable care to protect the surface coatings in the storage, shipping and erection of structural steel and during the placement of concrete.
- B.** If the Contractor exercises the option to apply the intermediate and/or finish coat at the fabrication shop, the faying surfaces shall be masked off. Intermediate and finish coats shall be applied to the exposed surfaces at bolted connections only after installation of the fasteners has been completed.
- C.** The following restrictions apply to application of the IOZR primer
1. The primer shall be applied the same day that the surface is blast cleaned. Surfaces that are not primed the same day they are blast cleaned shall be reblasted to the specified degree of surface preparation prior to application of the primer.
  2. The primer shall be continuously agitated during mixing and application. After mixing, the primer shall be strained through a 30 to 60 mesh screen.
- D.** After application of the IOZR primer
1. Zinc salts shall be removed by water blasting.
  2. Dry overspray shall be removed by rubbing with a wire screen. Where such an operation results in deficient DFT, the area affected shall be re-blasted to the specified degree of surface preparation and the primer reapplied.
  3. Primer which exhibits mud cracking shall be re-blasted to the specified degree of surface preparation and the primer reapplied.
  4. The dry film thickness (DFT) of the primer shall be measured. Areas exhibiting deficient or excessive DFT shall be re-blasted and the primer reapplied to the specified DFT.
- E.** IOZR primer shall be cured in accordance with the manufacturer's recommendations and as follows prior to application of the intermediate coat and before bolting of connections
- Solvent based IOZR primer shall cure for a minimum of twenty-four (24) hours at 50° F or above and 50% relative humidity or above.
  - Water based IOZR primer shall cure for a minimum of twenty-four (24) hours at 50° F or above and 85% relative humidity or above.

All small cracks, cavities, and open seams around crimped stiffeners, connections, etc., shall be caulked with an approved caulking putty, and allowed to semi-dry before the prime coat is applied.

Surfaces not in contact but inaccessible after shop assembly shall be given an additional coat and shall be applied at a minimum dry film thickness of 1.5 mils.

With the exception of faced abutting joints, machine finished surfaces, including bearing rockers and pins, pin holes, sliding bearing contact areas, rocker-base plate contact areas, etc., shall be coated with Lubriplate 630AA, Drydene Multi-white, Rust Inhibitor, or approved equal as soon as practicable after cleaning.

Areas to be field welded shall be given 1 coat of rust- inhibitive petrolatum primer conforming to requirements of 811.02(I).

Erection marks and weight marks shall be reapplied after shop painting unless marker tags are attached.

Material shall not be loaded for shipment until it is thoroughly dry and in any case not less than twenty-four (24) hours after shop

paint has been applied. No degree of tackiness shall be present at the time of loading.

#### **707.09 FIELD PAINTING**

- A.** In the case where the Contractor does not exercise the option to apply both intermediate and finish coats in the fabrication shop and not more than two (2) weeks prior to application of the first field coat to the new steel, the exposed surfaces to be coated shall be cleaned by a high pressure water wash (800 psi. minimum), and dried, or allowed to dry, prior to application of the next coat of paint. The water shall meet the requirements of 822.01.
- B.** Additionally, in cases where a winter season has elapsed since application of the previous coat of paint to either new or existing steel, said surfaces shall be cleaned, as described in the previous paragraph, not more than two (2) weeks prior to the application of the next coat of paint.
- C.** Any areas exhibiting rusting in excess of Rust Grade 8, as determined using SSPC-Vis 2, or where this required cleaning results in failure of previously applied paint, shall be repaired as specified in 707.03(G).
- D.** Field primer shall be applied the same day the surface is blast cleaned. Surfaces that are not primed the same day they are blast cleaned shall be re-blasted to the specified degree of surface preparation and recoated with field primer.
- E.** Prior to application of the intermediate coat:
  - 1.** Dry overspray shall be removed by rubbing with a wire screen.
  - 2.** Primer which exhibits mud-cracking shall be removed. The area shall be reblasted to the specified degree of surface preparation and the primer reapplied.
  - 3.** Surfaces which exhibit rusting in excess of Rust Grade 8, as determined using SSPC-Vis 2, shall be re-blasted to the specified degree of surface preparation and the primer reapplied.
  - 4.** Zinc salts shall be removed by water blasting.
  - 5.** The dry film thickness (DFT) of the primer shall be measured. Areas exhibiting deficient or excessive DFT shall be re-blasted and the primer reapplied to the specified DFT.
- F.** The intermediate coat, if applied by spraying, shall be mist coated over the IOZR primer prior to application of the full wet film thickness, if necessary, in order to prevent bubbling.
- G.** The field primer and intermediate coat shall cure for the minimum drying period as stated by the manufacturer and shall not be recoated until verified by the Engineer. Additionally, the paint shall have
- H.** Prior to application of the finish coat
  - 1.** The cumulative DFT of the prime and intermediate coats shall be measured. The measured DFT shall be from 5 to 10 mils above the surface profile, except that the 80% tolerance specified in SSPC-PA 2 will not be allowed. Dry film thickness shall be determined in accordance with SSPC-PA 2, Measurement of Dry Film Thickness with Magnetic Gauges.
  - 2.** Surfaces which exhibit rust in excess of Rust Grade 8, as determined using SSPC- Vis 2, shall be re-blasted to the specified degree of surface preparation and the primer and intermediate coats reapplied.
- I.** After application of the finish coat, the cumulative dry film thickness shall be measured and shall be between 8 and 15 mils, except that the 80% tolerance specified in SSPC-PA 2 will not be allowed.
- J.** Areas exhibiting DFT's outside these limits shall be corrected as directed by the Engineer.

All paint shall be purchased in the tinted condition and under no circumstances shall tinting be accomplished on the Project except by adding lampblack. A color sample of the proposed paint shall be submitted to the Engineer for approval prior to use on the job.
- K. CONSTRUCTION METHODS** - Cleaning and painting shall proceed by sections usually consisting of a complete span, bay, portal, as approved by the Engineer. Field painting of new metalwork shall not start until the concrete deck slab has been placed and all removable formwork has been removed. If false work is not utilized for a painting scaffolding, suitable measures as approved by

the Engineer shall be provided to protect any traffic using roadways under structures from paint splatters, spray and cleaning operations.

All small cracks, cavities, and open seams around field splices and other field connections shall be caulked with an approved caulking putty, and allowed to semi-dry.

New open grid steel decking shall receive 2 top coats when erected; all bars shall be completely painted and dry before Structure is opened to traffic. Maintenance painting of open grid steel decking shall exclude surfaces of the grate bars exposed to vehicular traffic. However, grate bars in sidewalks, safety walks, and medians shall be completely painted.

- L. PAINTING GALVANIZED METAL** - New galvanized metal shall not be painted. When painting of existing galvanized metal is specified in the Contract Documents, surfaces first shall be cleaned in accordance with 707.06(A) and then primed with 1 complete coat of zinc dust-zinc oxide primer conforming to requirements of 811.02(H), and a top coat conforming to 811.04(A) at 1.0 mil each.
- M. PAINTING WOOD** - Wood items shall be given 1 coat of wood primer-sealer conforming to requirements of 811.02(J) prior to field painting or maintenance painting. Primer-sealer preferably shall be permitted to dry before paint is applied; otherwise primer-sealer shall dry to touch (heavy thumb pressure).

For new construction or when 2 coats of white paint are required, the first coat shall conform to requirements of 811.04(D)2, except that lampblack tinting shall be used. Final field coat shall conform to the requirements of 811.04(D)2.

For maintenance painting, the number of coats shall conform to requirements of the Contract Documents.

#### **707.10 MEASURE AND PAYMENT**

The unit of measure for painting will be the lump sum. No actual measurement will be made.

Painting will be paid for at the Contract lump sum price for the accepted items in the Schedule of Prices, which payment will include all cleaning and preparation of the surfaces, application and protection of drying paint coats, repair of damaged or unsatisfactory paint coats, application of paint to bridge deck drainage, protection of all portions of structure or structures against any disfigurement and against any physical damage, maintenance and protection of highway and pedestrian traffic, protection of and access to adjacent property, environmental protection, proper disposal of hazardous materials, and furnishing all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## 708 STONE MASONRY

### 708.01 GENERAL

**A. DESCRIPTION** - This item consists of stone masonry structures, stone masonry facing, and the stone masonry portions of structures, constructed in conformity with the lines, grades and dimensions shown in the Contract Documents. This item also includes, where applicable, furnishing and installing Structure identification emblems.

### B. DEFINITIONS

Bed – The top or bottom surface of a stone when in final position.

Depth – The dimension of the stone at right angles to the face of the masonry, measured from the pitch line (not including any rock face projection).

Rise (of a stone) – The dimension of a stone measured normal to the bed pitch line.

Rise (of a course) – The distance between the top bed of a course and the top of the next higher course.

Length – The dimension of a stone measured along the bed pitch line (including any rock face projection).

Face – The exposed surface of a stone.

### 708.02 MATERIALS

All stone shall be durable, sound, of uniform quality and texture, and shall be free from seams and defects which would impair its strength, durability or appearance.

- 815.01(A) or (B): Steel
- 811.06: Galvanizing
- 807.02(B): Caulking compound
- 806.05(B): PCC mortar mix

### 708.03 WORKING DRAWINGS AND SUPPLY

**A. WORKING DRAWINGS** - The Contractor shall prepare and submit to the Engineer, in accordance with 105.02, Working Drawings of all Class A (dimensioned) masonry; showing the individual stones in position, their face dimensions, designating marks, and such other detail drawings as are necessary to properly cut and set the Work. The drawing shall show all anchors, cramps and dowels.

**B. SUPPLY** - The Contractor shall submit to the Engineer for approval the names of the quarry or quarries from which the stone is to be obtained, together with evidence that sufficient stone to complete the Work is obtainable from the quarry, and that adequate manpower and equipment are available to produce and complete the required amount of stone work within the Contract Contract Time for completion of the Project.

### 708.04 SAMPLES AND SAMPLE WALL

**A. STONE SAMPLES** - Before proceeding with the Work, the Contractor shall submit for approval by the Engineer the name of the quarry and 2 samples of each kind of stone proposed for use in the Work; 1 sample shall show the lightest color and the other shall show the darkest color of each kind of stone to be furnished. All stone in the Work shall be within the color range defined by the approved samples and of the same type of stone. The samples shall have a face size of at least 6 by 6 inches.

**B. SAMPLE WALL** - The Contractor will be required to construct a sample wall of the designated class or classes of stone masonry, laid up in mortar and pointed, for approval of the Engineer. Each sample shall show examples of the specified stone finishes, quality of the workmanship in dressing the stone and placing them, and pointing of the beds and joints, and shall be sufficient area to illustrate the distribution of both the coloring and the stone size. The sample wall shall contain at least 1 edge dressed to show a representative corner. The top shall be dressed to show how the stone will abut the coping. Upon approval of such a sample by the Engineer, it shall become the standard for that class or classes of stone masonry in the entire Work. In general, the size of stone masonry sample wall shall not be less than 12 feet long and 6 feet high. However, for copings or other special types or shapes of dimensioned masonry, a short section showing examples of the proposed types of finish may suffice.

- C. PAYMENT** - At the option of the Contractor, this wall may be constructed in place as part of the stone masonry called for in the Contract Documents and if approved, the sample wall shall become part of the completed Work and will be paid for as specified herein for the designated class or classes of stone masonry.

### 708.05 CLASSES OF STONE MASONRY

The class of masonry used in each part of the Work shall be that shown in the Contract Documents. Masonry shall be classified as follows:

- Class A – Dimensioned ashlar stone masonry composed of stones each of which has 2 or more fixed dimensions shown on the Plans. It is intended for use particularly in arch rings, quoins, pilasters, copings, facing for concrete, parapets, etc.
- Class B – Ashlar stone masonry composed of stones shaped, dressed, and set in accordance with certain specified requirements given in the section which set forth the variations allowed in shaping, dressing, setting and coursing the Work. It is intended for use in walls, veneer facing, parapets, etc.
- Class C – Ashlar stone masonry same as for Class B stone masonry, but less exacting in the variations allowed in shaping, dressing, setting and coursing the Work.
- Class D – Rubble stone masonry composed of roughly dressed stones set in broken courses. It is intended for use in minor Culverts and other similar Structures.

### 708.06 SIZE OF STONE

- A. STONE SIZES** - Stones, not dimensioned on the Plans, shall be furnished in the sizes and face areas necessary to produce the general characteristics and appearance as indicated for the class of masonry specified. In general, stone sizes shall conform to the following limitations:
1. **Rise of any stone** – 4 inch minimum unless otherwise shown on the Plans.
  2. **Depth of any stone** – 6 inch minimum, except as shown on the Plans for stone veneer.
  3. **Length of any stone** – 1-1/2 times its rise, minimum; 5 times its rise, maximum; 3 times its rise, average.
- B. CLOSURE STONES** - Stone sizes shall not include closure stones. A minimum number of closures, not exceeding 5 percent of the exposed surface, may be used only when absolutely necessary. Closures shall be rectangular with their longest face laid horizontal.

### 708.07 FINISH FOR EXPOSED FACES

The kind of finish for the exposed faces of the masonry shall be as specified in the Contract Documents. Face stones shall be pitched to line along all beds and joints, with no depressions below the pitch line. Each stone shall be out of wind, i.e. the 4 corners are in the same plane. No drill or quarry marks shall show on the face of any stone. The specified finish shall be in accordance with the following definitions:

- A. EIGHT CUT** - Fine hammered. Interrupted parallel markings not over 3/32 inch apart. A corrugated finish. Smoother near arris lines and on small surfaces.
- B. SIX CUT** - Medium hammered. Interrupted parallel markings not over 1/8 inch apart. A corrugated finish. Smoother near arris lines and on small surfaces.
- C. FOUR CUT** - Coarse hammered. Interrupted parallel markings not over 7/32 inch apart. A corrugated finish. Smoother near arris lines and on small surfaces.
- D. SAWN** - Fairly plane surface. Varying texture ranging from close approximation to sand rubbed to scorings 3/32 inch in depth. When so specified, scorings shall be vertical or horizontal as produced by gang saws. All exposed surfaces thoroughly sand blasted to remove rust stains and iron particles.

- E. **SAWN AND SANDED** - Fairly smooth surface. Exposed surfaces cut with a wire saw and abrasive and further treated by sand blasting with new silica sand to blend saw marks into uniform texture.
- F. **SEAM FACE** - The surface shall present a smooth appearance, be free from tool marks, with no depressions below the pitch line and no projected plane exceeding 3/4 inch beyond the pitch line.
- G. **ROCK FACE** - The face shall be an irregular, convex with no concave surfaces below the pitch line, and with projections beyond the pitch line, when measured in inches, not exceeding the figure preceding the symbol as used on the Plans e.g., "1-1/2 inch Rock Face" means projections beyond the pitch line not exceeding 1-1/2 inches. Where a variable "rock face" is specified, stones of the same height of projection shall be well distributed.

**708.08 DRESSING STONE**

- A. **GENERAL** - Stones shall be dressed to remove any thin or weak portions. Face stones shall be dressed to provide bed and joint lines with a maximum variation from true pitch lines as follows:

**TABLE 708.08 (A) DRESSING STONE SIZES**

Class A (Dimensioned) masonry	True
Class B masonry	1/4 inch
Class C masonry	3/4 inch
Class D masonry	1-1/2 inch

All joints shall be vertical, except that splayed joints not greater than 45 degrees will be permitted in Class C and D masonry, with maximum of 10 percent of joints splayed in Class C. Beds shall be horizontal except under copings on a gradient.

Face stone adjoining the edges of exposed concrete work shall be accurately dressed along the edge paralleling the concrete work, allowing sufficient space for pointing.

- B. **BED SURFACE** - Bed surfaces of face stone shall be normal to the face of the stones for about 50 mm and from this point they may depart from a normal plane not to exceed 1 inch in 1 foot for Class A (dimensioned masonry) and 2 inches in 1 foot for all other classes of masonry.

The corners at the meeting of the bed and joint lines shall not be rounded in excess of the following radii:

**TABLE 708.08 (B) MAXIMUM ROUNDED RADII**

Class A (dimensioned) masonry	None
Class B masonry	None
Class C masonry	1 inch
Class D masonry	1-1/2 inch

- C. **JOINT SURFACES (EXCEPT RING STONES)** - For all classes of masonry, the joint surface of face stones shall be normal to the face of the stones for about 2 inches, and from this point they may depart from a normal plane not to exceed 2 inches in 12 inches.
- D. **RING STONE JOINT SURFACES** - Ring stone joint surfaces shall be radial and at right angles to the front face of the stones. They shall be dressed for a distance of at least 3 inches from the front face and the soffits, from which points they may depart from a plane normal to the face not to exceed 3/4 inch in 12 inches. The back surface in contact with the concrete of the arch barrel shall be parallel to the front face and shall be dressed for a distance of 4 inches from the intrados. The top shall be cut of 4 inches from the intrados. The top shall be dressed for a distance of at least 3 inches from the front.

**708.09 ANCHORS**

- A. GENERAL** - The Contractor shall furnish and set all anchors, cramps, dovetail slots, dowels, bolts and any other work to the concrete backing. All anchors, cramps, dowels, bolts, etc. shall be galvanized steel. Any bending shall be done before galvanizing.
- B. FOR CLASS A MASONRY** - Anchors shall be of 3/8 inch by 1-1/2 inch material and shall extend at least 9 inches into the concrete backing, except where limited by the thickness of the backing, with ends extending not less than 1-1/2 inches vertically into the stone and into the concrete. Cramps for tying stones together shall be of 3/8 inch by 1-1/2 inch material, turned down at least 1-1/2 inches at each end, and shall span at least 12 inches on the flat. In general, 2 anchors shall be used for each stone 1 meter or over in length, and 1 anchor for each smaller stone. Corner stones shall have 1 anchor and shall be cramped to adjoining stones. Special cramps, anchors and/or dowels shall be provided for cap stones, coping stones and other special stones. Each arch ring stone shall be tied to the concrete backing with side anchors, the type and location of which shall be shown in the Contract Documents.

Holes for anchors, cramps, bolts or dowels shall be at least 150 mm from any face of the stone, except that for stones less than 12 inches in depth, the holes shall be placed at the center of the depth.

Where necessary, stones shall be grooved for cramps and anchors so as to allow at least 1/8 inch for mortar between the cramps or anchors and the adjoining stone.

**C. FOR CLASS B, C AND D MASONRY**

- 1. Masonry constructed before placing concrete backing** - Anchors shall be of not less than 8 gage by 1-inch material embedded in the bed joints, spaced 2 feet on centers both horizontally and vertically and shall extend at least 9 inches into the concrete backing and to within 75 mm of the face of the stone. Each end of the anchors shall be of such approved shape and design as to mechanically engage the stone and the concrete backing. The anchor and the methods of anchorage shall be approved by the Engineer before any stone is erected.
- 2. Masonry constructed after placing concrete backing** - Anchors shall be of not less than 8 gage by 1-inch material, embedded in the bed joints and engaging 24 gage dovetail anchor slots in the previously placed concrete. Anchor spacing shall be 2 feet on center, both vertically and horizontally. The end of each anchor embedded in the masonry joint shall be of such approved shape in design as to mechanically engage the stone and shall extend to within 3 inches of the face of the stone. The dovetail anchor slots shall have a temporary filling of felt or other material to prevent the slots from being filled with concrete as the concrete is placed.

During the setting of the stone, the temporary filling shall be removed from the anchor slots and the voids in the anchor slots between the anchors shall be filled with setting mortar. No voids in any part of the wall will be permitted.

**708.10 CONSTRUCTION REQUIREMENTS**

- A. WEATHER LIMITATIONS** - Stone masonry shall not be placed when the temperature of the air or the stone is below 40 degrees Fahrenheit except by written permission from the Engineer, and then only by the use of such methods as he may prescribe for preparing the materials and protecting the Work after it has been laid. Such permission and the use of the methods prescribed shall not, however, release the Contractor from his obligation to build a satisfactory Structure. All Work damaged by cold weather shall be removed and replaced.

In hot or dry weather the masonry shall be satisfactorily protected from the sun, and shall be kept wet for a period of at least three (3) days after completion.

- B. LAYING STONE** - All masonry shall be constructed by experienced workmen. Face stones shall be set so as to produce the effect indicated herein for the class of masonry specified and to correspond with the sample wall section approved by the Engineer.
- 1. Beds and Joints** - Beds and joints for Class A masonry shall average 3/8 inch, plus or minus 1/8 inch. For Class B Masonry, the nominal size of beds and joints shall be 3/4 inch; for Class C masonry 3/4 to 1 inch; for Class D masonry 1 inch to 1-1/2 inches. All joints shall be vertical and shall not extend in an unbroken line through more than 2 stones, except that splayed joints not greater than 45 degrees will be permitted in Class C and D masonry, with maximum of 10 percent of joints splayed in Class C. Beds shall be horizontal except under copings on a gradient, and shall not extend in an unbroken line through more than 4 stones, unless otherwise shown in the Contract Documents. In no case shall the 4 corners of adjacent stones be contiguous.



2. **Bunching** - Care shall be taken to prevent the bunching of small stones or stones of the same size. When weathered or colored stones, or stones of varying texture, are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the Work. Large stones shall be used for the bottom courses. In general, the stones shall decrease in size from the bottom to the top of the Work.
  3. **Arch ring stone** - Arch ring stone shall be carefully thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread.
  4. **Bedding** - The stone shall be kept free from dirt, oil or any other injurious material which may prevent the proper adhesion of the mortar or detract from the appearance of the exposed surface. Stones shall be laid on their natural beds in full beds of mortar, and the other joints shall be flushed with mortar. The Engineer may direct the lifting and resetting of stones to assure proper bedding.
  5. **Placement** - The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set. The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by 2 men. The rolling or turning of stones on the walls will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar. All voids between back of stone veneer facing and face of concrete wall, including the voids of anchor slots after removal of the filler material, shall be filled solid with setting mortar. All shaping and dressing of stone shall be done before the stone is placed, and no dressing or heavy hammering will be permitted after it is placed.
  6. **Spalls** - No spalls shall be used in the face of the wall.
  7. **Cleaning** - Immediately after being laid, and while mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the Work is completed. Before final acceptance, if ordered by the Engineer, the surfaces of the masonry shall be cleaned using wire brushes and, if necessary, muriatic acid.
- C. **MIXING MORTAR** - Before adding water, materials, as described in 806.05(B) shall be mixed, either in a tight box or in an approved mortar mixing machine, until the dry mixture assumes a uniform color. Then the water shall be added as mixing continues. Sufficient water shall be added to produce a mortar of such consistency that it can be handled easily and spread with a trowel. Mortar that is not used within one (1) hour after water has been added shall be discarded. Re-tempering of mortar will not be permitted.
- D. **POINTING AND FINISHING**
1. **Pointing** - All beds and joints shall be raked out, before mortar is set, to a depth of not less than 3/4 inch deeper than the surface of the finished joint, then cleaned and pointed with pointing mortar as and when directed by the Engineer. The pointing mortar shall be well driven into the joints with hardwood ramming wedges or other approved method and finished with an approved pointing tool. The stone masonry shall be kept wet while pointing is being done, and in hot or dry weather, the pointed masonry shall be protected from the sun, and kept wet for twenty-four (24) hours.
  2. **Finishing** - The finishing of all points, beds and joints shall be as shown in the Contract Documents. For Class B masonry finished beds and joints shall be raked back 3/8 inch from pitch line. When raked beds and joints specified, the mortar shall be raked out squarely to the depth specified. Stone faces in the joint shall be cleaned free of mortar. When weather joints are called for, they shall be weather-struck.
- E. **BONDING** - Bonding for Class A (dimensioned) masonry shall be as shown on the Plans.
1. **Breaks** - All stone, except as shown on the Plans, shall be so placed as to break joints at least 4 inches and beds at least 3 inches in order to secure firm bond.
  2. **Bond with Concrete Surface** - Stone surface against which concrete is to be placed shall be thoroughly cleaned to remove all loose materials. Immediately before placing concrete against the masonry, the stone surfaces shall be blown free of dust by compressed air and then thoroughly wetted. The stone surface shall be kept wet at all times at points of spading concrete against them. Spading and vibrating the concrete along the stone surface shall be such as to flush the stone surface with mortar and to completely fill all interstices, securing a firm bond with the stone.
- F. **BRACING** - When in the opinion of the Engineer the placing of concrete against stone masonry might create pressure sufficient to cause deflection or displacement, the Contractor shall brace the stone masonry in a manner satisfactory to the Engineer.

- G. FALSEWORK** - Arch centering shall be designed, submitted for approval and constructed in accordance with 703.16, or as outlined in the Contract Documents.
- H. HEADERS** - When headers are required, they shall be distributed uniformly throughout the wall of Structures so as to form at least 1/5 of the faces. Headers shall extend not less than 12 inches into the core or backing, unless otherwise indicated. Headers in walls 2 feet or less in thickness shall extend entirely through the walls.
- I. BACKING** - The backing for gravity type walls shall be built primarily with large stones. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be completely filled with mortar or with spalls completely surrounded by mortar.
- J. PARAPETS** - Selected stone, squared and pitched to line and with heads dressed, shall be used in ends of walls and in all exposed angles and corners. Headers shall be well interlocked and as many as possible shall extend entirely through the wall. Both the headers and stretchers in the 2 faces of the wall shall be well interlocked in the heart and shall comprise practically the whole volume of the wall. All interstices in the wall shall be completely filled with mortar or spalls completely surrounded with mortar.
- K. WEEP HOLES** - All stone walls and abutments shall be provided with weep holes, unless otherwise shown or directed by the Engineer. The weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than 10 feet apart. The inlet end of weep holes shall be protected by placing a wire basket 1 foot by 1 foot by 1 foot, filled with coarse aggregate, size 7, 8, 57 or 68 immediately over or behind the holes as directed.
- L. EXPANSION OR CONTRACTION JOINTS** - Expansion or contraction joints shall be placed as shown in the Contract Documents. When caulking is required it shall be applied in accordance with the manufacturer's Specifications. The color shall be approved by the Engineer.
- Stone surfaces in contact with expansion or contractions joints shall be neatly squared back from the face of the wall for the full depth of the joints. Preformed joint material shall be anchored to joints by concrete nails at approximately 2 foot intervals.
- M. COPINGS, TOP WALLS, BRIDGE SEATS, BACK WALLS, ETC.** - Copings, top walls, bridge seats, back walls, etc. shall be constructed to the lines, grades, and cross sections, and of the material, indicated on the Contract Drawings or as directed by the Engineer.
1. **Concrete copings** - Concrete copings shall be constructed in sections from 5 to 10 feet long and shall be of such width and thickness as indicated on the Contract Drawings.
  2. **Stone copings** - Stone copings shall consist of carefully selected stones of the length, width, and thickness indicated on the Contract Drawings. They shall have a uniform surface and pitched to line along the top and bottom edge.
- N. FOUNDATION PREPARATION** - Structure excavation, foundation preparation, and backfill shall be performed and paid for in accordance with the provisions set out in Division 200. The foundation for this type of construction shall present a uniform bearing surface, and if a reinforced foundation is necessary, it shall be constructed and paid for in accordance with the Contract Drawings or as directed by the Engineer.

### 708.11 REJECTION OF STONE

Any stone not conforming to the approved sample or not in accordance with the Contract Documents shall be rejected and removed from the Site.

### 708.12 MEASURE AND PAYMENT

The unit of measure for the various classes of Stone Masonry will be the cubic foot. The number of cubic feet of Class A (dimensioned) masonry will be the actual volume of the individual stones determined from the dimensions shown on the approved Working Drawings. No measurement will be made of mortar backings or mortar joints between the Class A masonry. The number of cubic feet of Class B, C or D stone masonry will be determined from the actual measured length and height of the stone Structure and the average depth as indicated in the Contract Documents.

The volume of joints and beds between Class B, C or D stone masonry and either Class A stone masonry or PCC Structures shall be included in the measurement for Classes B, C or D stone masonry. No deductions will be made for openings of less than 2 square feet in area.

The number of cubic feet of Stone Masonry measured will be paid for at the Contract unit price per cubic foot for the various classes of Stone Masonry listed in the Schedule of Prices, which payment will include furnishing, cutting and setting of stone, mortar, anchoring devices, furnishing and setting of Structure identification emblems, cleaning and pointing, and all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## 709 RAILING

### 709.01 DESCRIPTION

Work shall consist of furnishing, fabricating, preparing, assembling, finishing, and erecting all railings, posts, connections, anchors, and all other Work incidental thereto as shown in the Contract Documents.

### 709.02 MATERIALS

Materials shall conform to the following requirements:

- 809.04 :Pipe railing –standard weight
- 815.01(A): Steel for railings
- 822.02(C): Neoprene Pads
- 811.06: Galvanizing
- 815.01(H): Steel Anchor Bolts, Nuts, Washers

### 709.03 FABRICATION

- A. STEEL RAILING** - Bridge railing shall be fabricated to the dimensions shown in the Contract Documents. Fabrication shall conform to the requirements of 706. Railing shall be galvanized unless otherwise specified in the Contract Documents.

Loading, transportation, unloading, and field storage of guide rail elements shall be conducted so as to avoid injury and deformation of the railing elements. Damaged pieces shall be repaired or replaced at the Contractor's expense.

Special care shall be exercised and protective shimming, wrapping, or other means shall be employed to protect galvanized surfaces from mechanical damage due to handling, storing, or erecting procedures.

- B. PIPE HANDRAIL** - Handrails shall be fabricated to the dimensions as shown in the Contract Documents. Handrails shall be fabricated by welding all joints. All welded joints shall be welded all around and ground flush with the pipe to present a smooth even finish. Immediately after fabrication the handrail shall be thoroughly cleaned in accordance with 707.06 and given 1 coat of shop paint meeting the requirements of 811.03(A).

### 709.04 ERECTION

#### A. GENERAL

1. **Anchor bolts** - Anchor bolts shall be accurately set with suitable rigid templates before placing concrete and shall be in accordance with approved location diagrams prepared by the railing fabricator. Bolts shall be securely fastened to prevent displacement during concreting operations. The anchor bolts shall protrude sufficiently from the surface of the concrete so that when the post is in place all threads of the nut are engaged.
2. **Base** - Railing posts and anchor bolts shall be set normal to grade. When post bases are to be set on concrete, the concrete surfaces shall be monolithically finished to correct Elevations and parallel to grade. Building up by grouting under the base shall not be done. Before erection, the areas of concrete upon which posts are to be set shall be dressed by grinding or rubbing to true plane surfaces as to the extent necessary for proper seating to the posts. If the areas of concrete upon which posts are to be set are low, full size shims of the same material as the post shall be used to bring the post to correct Elevation. When post bases are to be set on stone masonry, full size shims of the same material as the post shall be used to obtain proper alignment. Posts or shims shall be set on a 1/4 inch neoprene pad.
3. **Alignment** - Railing posts and rails shall be erected and carefully aligned before anchor nuts and rail bolts or set screws are tightened. In final adjustment, no post shall deviate more than 1/8 inch from true alignment and there shall be no abrupt breaks in alignment at any location.

**B. STEEL RAILING**

1. **Damaged pieces** - Prior to erection, and after erection, all parts shall be inspected for damage and for chipped or marred coatings. Pieces warped, deformed, or with substantial galvanized areas damaged to bare steel, as determined by the Engineer, will be rejected and the Contractor shall replace such damaged parts with parts meeting these Specifications at his sole expense. Marred or chipped areas in the galvanizing such as scratches extending nearly to bare steel, raw edges, spotting, etc., considered to be minor from an aesthetic or corrosion standpoint as determined by the Engineer, shall be properly cleaned and carefully touched up with a zinc rich paint containing not less than 93 percent zinc by weight. The color of the touchup paint shall be a silver-gray which will blend with galvanized surfaces. Yellow-green shades of zinc paint will not be permitted. Surface scratches will not require touchup.
2. **Alignment** - After the railing has been set in place, it shall be adjusted until the top rail is parallel to the curb line of the Roadway and has no irregularities apparent to the eye. If the clearance provided by the field holes is inadequate to permit proper adjustment, the field holes shall be reamed in the adjusted position. The adjustment of the railing shall assure that at every post, the top rail shall not depart more than 1/8 inch vertically or horizontally from the required line parallel to the center line of the Roadway or to the lines and grades shown in the Contract Documents. The cost of any necessary adjustment shall be included in the unit price for railing.

**C. PIPE HANDRAIL**

1. **Sleeve installation** - The pipe handrail shall be fastened to the concrete by making provisions at the time of pouring the concrete for steel pipe sleeves, capped at the bottom, of dimensions as shown in the Contract Documents. These sleeves shall be set vertical, shall be suitably plugged so that concrete and dirt cannot enter the sleeves and shall be checked for plumb position after concrete has been poured and finished.
2. **Handrail installation** - After the concrete has set, the upright posts of the handrail shall be inserted in the sleeves in a vertical position and braced so that there will be equal clearance all around between pipe and sleeves. Molten lead then shall be carefully poured into the void between pipe and sleeve and allowed to set for two (2) hours. After this time if the railing appears securely fastened at all points, bracing may be removed.
3. **Anchorage to Masonry** - Where handrails are to be fastened to a masonry wall, anchorage shall consist of a steel plate fastened to the wall with 4 expansion bolts as shown on the Plans.
4. **Painting** - After the handrail has been erected, it shall be painted in accordance with the requirements of 707. All painting will be included in the Contract unit price for the handrail.

**709.05 MEASURE AND PAYMENT**

The unit of measure for the various items of Railing listed in the Schedule of Prices will be the linear foot measured along the railing from out to out of end posts or end details excluding any openings exceeding 6 inches.

The actual number of linear feet furnished and erected, complete in place, will be paid for at the Contract unit price per linear foot, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work.

## 710 BRIDGE DECK DRAINAGE

### 710.01 DESCRIPTION

Work consists of furnishing, installing, and painting the scuppers, grates, drainpipe, collector pipe, fittings, hangers, supports and all other materials necessary for the bridge deck drainage system as shown in the Contract Documents.

### 710.02 MATERIALS

Materials shall meet the following requirements:

- 815.05: Scuppers
- 815.05: Grates
- 809.01(A): Pipe
- 809.01(B) (2): Pipe Fittings
- ASTM C 564: Gaskets

### 710.03 CONSTRUCTION REQUIREMENTS

- A. **SHOP DRAWINGS** - The Contractor shall prepare and submit to the Engineer construction drawings for any deck drainage system in accordance with Section 105.
- B. **ALIGNMENT** - Scupper surfaces shall conform to grades and lines of the completed Structure. Inserts shall be properly spaced for the collector pipe system and hangers adjusted so that the plan grades are secured. Straight pipe shall be in standard uniform lengths. Approved short pipe lengths shall be used where needed to meet line and grade as closure pieces.
- C. **CUTTING** - When pipe and fittings require cutting, the Contractor shall take field measurements for making, closing and connecting pieces of correct dimension. Cutting shall leave a smooth end.
- D. **JOINTS** - Joints shall be assembled to insure tight, flexible joints that safely permit movement caused by expansion and contraction. The inside of the socket and the outside of the spigot shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket. A thin film of approved gasket lubricant as supplied by the pipe manufacturer shall be applied to either the inside surface of the gasket or to spigot or both. The joint shall then be completed by forcing the spigot to the bottom of the socket with an approved forked tool, jack-type tool or other device. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that spigot is inserted to full depth. Field-cut pipe lengths shall be filed or ground to resemble the spigot end of pipe as manufactured.
- E. **CONNECTIONS TO EXISTING PIPES** - Prior to making connections to existing pipe the Contractor shall verify the actual size and location of existing pipe in service and provide pipe and fittings with suitable ends or adapters to connect to existing pipe. Limits of pipe and fittings for this purpose shall be as approved on drawings submitted by the Contractor.
- F. **PAINTING** - Scuppers and grates shall be shop painted in accordance with 707. After the collector pipe system has been completely installed, it shall be cleaned and painted in conformance with 707 for new metalwork. The color shall be as directed by the Engineer.

### 710.04 MEASURE AND PAYMENT

The unit of measure for Bridge Deck Drainage will be the lump sum. No actual measurements will be made.

Bridge Deck Drainage will be paid for at the Contract lump sum price, which payment will include painting, and all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## 711 WALL DRAINS AND CLEANOUTS

### 711.01 DESCRIPTION

Work for wall drains and cleanouts shall include furnishing complete in place: 8 inch diameter perforated PVC pipe carefully laid and sloped to drain to outlets, 6 inch cast iron or ductile iron pipe risers to cleanouts, 8 inch diameter cast iron or ductile iron sewer connect pipe, pipe fittings, cleanout boxes and covers, and the connection to the sewer system in the locations and as shown in the Contract Documents.

### 711.02 MATERIALS

Materials shall conform to the following requirements:

- 805.02: Pervious backfill
- 808.02(B): Perforated pipe
- 806.05(B)(4): Mortar
- 809.03: Cast iron pipe
- 809.01: Ductile iron pipe
- 809.01(B)(2): Pipe fittings

### 711.03 CONSTRUCTION REQUIREMENTS

- A. GENERAL** - Abutments and walls shall first be backfilled to a line approximately 6 inches below the bottom of the wall drainpipe. A minimum of 6 inches of pervious backfill shall be provided around the pipe. The pipe shall be carefully laid with perforations down.

Each section of the pipe shall have a firm bearing throughout its length and be true to the line and grade required. Wall drains shall be kept free from accumulations of silt, debris and other foreign matter during their construction and shall be free of such accumulations at the time of their final acceptance. Prior to final acceptance the Engineer may require that the drain system be checked by flushing water from a hose inserted into the cleanout, through the system. In the absence of a clear flow at the discharge end, the Engineer shall require replacement of that part of the system not functioning properly. All junctions, including connections with existing sewers, shall be made with regular wye connections and sharp turns shall be made with elbows.

The connection of the sewer connection pipe to the sewer structure shall be as directed by the Engineer.

#### **B. JOINTS**

1. **PVC pipe** - Adhesive formulated for joining PVC pipe shall be approved by the Engineer prior to use. Adhesive shall be applied so that the entire contact surfaces of adjoining pipes are coated. Adhesive shall be allowed four (4) hours to set before commencing backfill unless otherwise indicated by the manufacturer.
2. **Iron pipe** - Joints for iron pipe shall be as specified in 710.03.D.

### 711.04 MEASURE AND PAYMENT

The unit of measure of Wall Drains and Cleanouts will be the lump sum. Payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## 712 GLAZED CERAMIC TILE

### 712.01 DESCRIPTION

This Work shall consist of a mortar scratch coat applied directly to the concrete walls, ceilings and columns, a mortar float coat applied upon the mortar scratch coat and a facing of individual glazed ceramic tiles embedded in a freshly placed float coat.

### 712.02 MATERIALS

Materials shall conform to the following requirements:

- 806.04: Glazed Ceramic Tile
- 806.05(B)(3): Mortar Mixtures
- 807.07: Tile Joint Sealant

The Contractor shall provide approved equipment for checking tiles for warpage, wedging and size. The equipment shall mechanically measure compliance or non-compliance of the tiles with the specified limits of warpage and wedging and shall classify the tiles as to size group.

### 712.03 CONSTRUCTION REQUIREMENTS

- A. GENERAL** - No mortar or tiles shall be placed until all backfilling over tunnels, behind walls, etc., has been placed, compacted and approved by the Engineer. Placing of mortar or tiles shall not be permitted when the ambient temperature is less than 50 degrees Fahrenheit. If the ambient temperature is expected to fall below 50 degrees Fahrenheit following placement of any mortar or tiles, the Contractor shall furnish sufficient protection of the Work and necessary heating devices to maintain a minimum ambient temperature of 50 degrees Fahrenheit for a period of seven (7) days following placement of the mortar or tile.

During hot weather, the Contractor shall furnish necessary protection for all tile work against sun and wind, such as wind breaks, polyethylene cover or waterproof paper. Moistening by fog spraying or sponging may also be required.

The tile shall be delivered to the Project in the original sealed containers, each container to be clearly marked as to color, finish, size, shape and quantity. Tile shall be stored on pallets.

The Contractor shall determine the actual sizes and locations of all air port openings, door openings, niches, expansion joints and similar features. These features may not be of the same size or locations shown on the Plans and may be out of plumb or out of square. The Contractor shall neatly cut and fit tile bull noses of such features. No additional payment will be made because of these features varying from the Plans or because they may be out of plumb or out of square.

#### **B. MORTAR**

- 1. Mixing mortar** - Mortar may be either machine mixed or mixed by hand. The Portland cement and sand shall be thoroughly mixed dry after which sufficient water and lime shall be added to produce a stiff mix. Mortar shall be freshly mixed for prompt use and no mortar shall be used that has been mixed beyond the time limit as directed by the Engineer.

Re-tempering of mortar shall not be permitted under any circumstances. The use of chemicals in the mortar to prevent freezing shall not be permitted.

The mixing machine, size of batch and mixing time will be approved by the Engineer. When hand mixing is used, the mixing shall be accomplished in a clean, leak-proof mortar box constructed specifically for that purpose.

- 2. Applying mortar** - The concrete surfaces on which the mortar scratch coat is to be placed shall be thoroughly cleaned by water at 200 psi minimum pressure or by other methods satisfactory to the Engineer. After cleaning, the surfaces shall be dampened, but not saturated, with water and a neat Portland cement wash applied immediately before placing the mortar scratch coat. The Portland cement wash shall consist of 7 gallons of water per bag of cement and shall be used within six (6) hours after mixing.



The scratch coat shall be trowelled to an even surface, parallel to and not more than 3/8 inch from the back surface of the body of the tile, exclusive of the lugs and keys. Where, due to irregularities in the concrete surfaces, the scratch coat requires a thickness of more than 1/2 inch, the scratch coat shall be built up in 2 or more coats; the initial coat shall have a maximum thickness of 1/2 inch and each subsequent coat shall have a maximum thickness of 3/8 inch. Wherever more than 1 scratch coat is necessary, the surface of each coat shall be scored before hardening and dampened immediately before application of the next coat. The surface irregularities of the final scratch coat shall not exceed 1/4 inch in a length of 10 feet. The final scratch coat, while still plastic, shall be deeply scored or scratched horizontally and diagonally with marks about 1/2 inch apart.

After the scratch coat has been completed and cured at least twenty-four (24) hours, the float coat shall be applied within a period of seventy-two (72) hours after curing of the scratch coat. Before the float coat is applied, the scratch coat shall be cleaned where necessary, and thoroughly moistened, but not saturated with water. Screeds or temporary guide strips shall be mortared to the scratch coat to indicate accurately the surface planes of the float coat. The thickness of the float coat shall not exceed 3/8 inch. The float coat shall be well rodded and floated to a true surface parallel to the finished surface of the wall and shall be applied only in such quantities as can be covered with tile before the initial set of the mortar as directed.

3. **Setting tile** - All tile shall be thoroughly sprayed with or immersed in clean water prior to setting. Immediately after placing the float coat, a skim coat of neat cement, not exceeding 1/8 inch thickness, shall be applied uniformly to the back of each tile so as to completely fill all spaces between lugs or keys and present an even plane surface. Each tile shall be tapped firmly into place and brought flush with adjacent units. Lines shall be kept straight and all finished surfaces shall be true. Broken, cracked, marred, or other defective tiles shall be replaced before the mortar has set.

Wherever there is a change in direction of the tile facing, all corners, coves, angles, combinations, or other trimmer tile shall be furnished and installed as required.

The tile shall fit neatly around all wall niches, openings, and horizontal and vertical expansion joints. The Contractor shall do all field cutting and drilling required for the installation of the tile. So far as practicable, all cutting shall be done by power saws, and the cut edges shall be smooth and straight and free from chipping. Hand-cut tile shall be filed or ground smooth on the cut edges.

Each graded size or lot of tile shall be set in separate segregated groups or areas extending for the full height of the walls or columns, and for the full width of the ceilings. The size of tile in adjoining groups shall not vary by more than 1/32 inch.

Joints in the tile facing of the walls, ceiling and columns shall be constructed as specified herein and as shown on the Plans, using approved spacing gauges or devices. Expansion joints shall be constructed directly over all expansion joints in the concrete masonry and where the tile abuts another material. If the joints in the concrete masonry are spaced greater than 16 feet, either vertically or horizontally, small relieving joints equal to a normal tile joint width (approximately 1/8 inch) shall be provided at intervals of 12 to 16 feet but not to exceed 16 feet, and shall be sealed with materials conforming to the requirements of 807.07. Joints shall be carried through all mortar coats and the tile surface, at the same width as the width of the joint in the concrete masonry.

After the mortar has hardened sufficiently to hold the tile firmly in place, loose mortar shall be raked out and the faces of the surface shall be thoroughly washed clean with water, and while still moist, the joints between the tile shall be grouted with white Portland cement combined with sufficient water to obtain a consistency of thick cream. The grout shall be forced into the joints by trowelling or other approved method, and finished straight and true. Special care shall be taken to prevent the scratching of the glaze on the face of the tile. Prior to hardening, any excess grouting shall be washed off with a sponge and water leaving all joints full, smooth, and flush with the cushion edge of the tile, and the face of the tile clean. Remixing or use of grout that has partially hardened will not be permitted.

As the Work of setting tile progresses, the Contractor shall remove all unused material and debris and shall give the tile Work a thorough cleaning with water and cloths. All traces of cement or dust accumulation shall be completely removed. No acid solution will be allowed, under any conditions, for cleaning tile surfaces. The Contractor shall take such precautions as may be necessary to prevent the soiling or injury of the tile Work during the remainder of the Project, and shall clean or replace any tile that may become soiled or injured. Before final payment is made, all imperfect, loose, or misplaced tile shall be removed by the Contractor at his own cost and expense, and replaced with approved units.

The Contractor shall clean and remove all stains, oil, dust, grease, and marks from the walls and repair any defective joints or fixtures prior to final acceptance of the wall tile.

**712.04 MEASURE AND PAYMENT**

- A. MORTAR SCRATCH COAT FOR TILE** - The measure for Mortar Scratch Coat For Tile will be the square foot. The quantity to be paid for will be the number of square feet of mortar scratch coat actually placed and accepted by the Engineer, measured on the exposed surface of the mortar with no deduction for areas 1 square foot or less for outlets for mechanical or other fixtures.

Payment will be made at the Contract unit price per square foot bid in the Schedule of Prices, which payment shall constitute full compensation for the furnishing of all materials, labor, tools, equipment, neat coat of cement, scaffolding, and incidentals necessary to complete this item of Work.

- B. GLAZED CERAMIC TILE** - The measure for Glazed Ceramic Tile for Walls and Glazed Ceramic Tile for Ceilings will be the square foot. The quantity to be paid for will be the number of square feet, as indicated on the Plans, actually placed, and accepted by the Engineer, measured on the exposed surface of the tile with no deduction for areas 1 square foot or less for outlets for mechanical or other fixtures.

Payment will be made at the Contract unit price per square foot, which payment shall constitute full compensation for the furnishing of all materials, labor, tools, equipment, mortar float coat, neat cement skim coat, grout, elastic joint sealing materials, scaffolding, cleaning and incidentals necessary to complete this item of Work.

## 713 STEEL SIGN STRUCTURES

### 713.01 DESCRIPTION

Work consists of furnishing, fabricating, galvanizing and erecting sign structures including horizontal trusses, maintenance catwalks, upright supports, base plates, and anchor bolts, as required in the contracts document and/or as directed.

Work also includes replacement of damaged pieces.

### 713.02 MATERIALS

Materials shall conform to the following requirements:

- 824.03: Materials for Steel Sign Structures
- Self-Anchoring Bolts per FSS-FF-S-325 for Group I, Type 2, Styles 1 and 2; Group II, Type 4, Class 1 and 2; or Group III, Types 1 and 2. Bolts shall be galvanized per 811.06 and be capable of withstanding a proof test load 4 times greater than design working load.
- 822.08(B) and 806.05(C): Epoxy Adhesive and Mortar

### 713.03 MILL AND SHOP PROCEDURES

Requirements of AASHTO M 160 shall be met at all times.

The Contractor shall verify all horizontal dimensions of the overhead truss sign structure span length before fabrication. Span lengths shown on Plans are approximate only. All horizontal trusses shall be cambered to compensate for dead load deflections and to overcome the illusion of sag. Each truss shall be checked in the shop for alignment, sound welds and general workmanship.

The Contractor shall take the necessary steps to insure that errors, defects, omissions, unauthorized corrections made by flame cutting or grinding, defectively driven rivets, etc., are caught and corrected by acceptable methods at the earliest stage practicable.

The Contractor also shall make provisions to furnish and maintain at both the steel mill and fabrication shop, adequate space with drawing table, light and a telephone for the exclusive use of personnel performing mill and shop inspection for the District.

For rejected Work and material under mill, shop and job Site inspection, 1 reinspection for each instance of corrective action will be allowed at no cost to the Contractor. All costs associated with further re-inspection will be paid by the Contractor.

### 713.04 WELDING

Welding procedures will conform to 706.18, and/or as specified herein.

When evidence of record is accepted in lieu of required tests, the Contractor shall furnish the manufacturer's certification that the filler metal and shielding being used on the Project were manufactured with the same material and process requirements as the filler metal and shielding used for the evidence of record procedure.

After welding has been completed and prior to galvanizing the assembly, mating surfaces of arm flange plates must meet the flatness requirements of AASHTO M 160.

### 713.05 TRANSPORTATION AND FIELD STORAGE

Loading, transportation, unloading and field storage of fabricated and rolled material shall be conducted so as to avoid injury and deformation of the metal. Damaged material shall be repaired or replaced by the Contractor at his expense, as determined by the Engineer.

Special care shall be exercised and protective shimming, wrapping or other means employed to protect galvanized surfaces from mechanical damage due to handling, storage or erection procedures.

Marred or chipped areas in the galvanizing such as scratches, extending nearly to bare steel, raw edges, spotting, etc., considered to be minor from aesthetic or corrosion standpoint as determined by the shall be properly cleaned and carefully touched-up with a zinc rich paint, the delivered paint containing not less than 93 percent zinc by weight. Color of touch-up paint shall be a silver gray which will blend with galvanized surfaces. Yellow-green shades of zinc paint will not be permitted. Fineline scratches, however, will not require touch-up.

### 713.06 ERECTION METHODS

Sign structures shall not be erected until the support footings have cured and are properly backfilled. Before erection, bottom surfaces of base plates shall be given a pretreatment wash of either cold phosphate pretreatment or basic zinc-chromate- vinyl butyral wash coat and 2 field coats of primer per FSS TT-P-641, Type II.

Field drilling of holes in any part of sign structures is prohibited.

Upright sign structure members shall be erected truly vertical with the tops of each installation at the same elevation. Upright members shall be plumbed and brought to final grade by means of leveling nuts on the anchor bolts.

Horizontal cross members shall be erected so that beam clamps on each upright are at the same elevation; members shall be cambered to insure that after placement of signs, cross members will not appear to deflect below the horizontal. Horizontal cross members shall be erected at the proper height to insure that after placement of the sign, required minimum clearance between bottom of sign panel, sign light support or catwalk support, and highest point of roadway is provided.

After each overhead structure has been properly erected, grout meeting the requirements of 806.05(E) shall be placed to completely fill the space under support base plates. Grout shall be neatly finished with beveled surfaces.

Grout shall contain no more water than needed to produce a workable, plastic mix.

### 713.07 ERECTION ON EXISTING STRUCTURES

Where it is necessary to attach a sign or sign support to an existing bridge or retaining wall, care shall be taken to prevent damage to the existing structure. All areas damaged as a result of Contractor operations shall be acceptably restored to their original condition by the Contractor at Contractor expense.

Bolt installation may be made at a temperature not lower than 35 degrees Fahrenheit and only when temperature during cure period will not drop below 25 degrees Fahrenheit.

#### A. DRILLED ANCHOR HOLES - Anchor bolts shall be set in drilled holes.

Drilled anchor bolts holes shall be at least 1 inch larger in diameter than the bolts used. Holes shall be drilled in PCC and/or stone masonry to depth needed for proper anchorage.

Work includes cutting through reinforcing steel, if any, and use of diamond bits or other procedure to properly drill holes, plus repair of damage to anchorage area. Drilling templates shall be used to insure aligned holes. Holes shall be washed out to remove all residue, dried out, and bolts promptly mortared in the holes. Holes shall be protected from frost action.

#### B. GROUTED ANCHORED BOLTS - Bolts shall be clean and degreased with toluene.

Bolts may be installed by either: (1) pouring grout to a predetermined level in the hole, then inserting bolt and working it up and down plus tapping lightly to insure embedment; or (2) inserting bolt and pouring grout into the entire annular space between bolt and hole.

With either method, templates shall be used to secure bolts in proper position until the grout cures.

#### C. SELF-ANCHORING BOLTS - Self-anchoring bolt installations shall be made in holes drilled to proper dimensions to accommodate the type of self-anchoring bolt being used.

Self-anchoring bolts shall be inserted according to the manufacturer's recommendations.

### 713.08 MEASURE AND PAYMENT

The unit of measure for Steel Sign Structures will be lump sum.

Payment for Steel Sign Structures will be made at the Contract lump sum price for each sign structure, which payment will include furnishing anchorage units complete, drilled anchorages complete, grouting, galvanizing, base plate painting and all labor, tools, material, equipment and incidentals needed to complete specified Work.

The Contractor also shall have bid a unit price per pound for Steel Sign Structures, which price will become the Contract unit price for "adds" and "deducts" required and approved by the Engineer due to field conditions, changes, etc.

## 714 BRIDGE DECK CONCRETE OVERLAYS

### 714.01 DESCRIPTION

This Work shall consist of placing various concrete overlays as a wearing surface on bridge decks, to the prescribed depth and to the lines and grades shown on the Contract Plans and as specified herein.

### 714.02 LOW SLUMP CONCRETE OVERLAY

**A. GENERAL** – This Work shall consist of placing a low slump concrete wearing surface on bridge decks, to the prescribed depth and to the lines and grades shown on the Plans and as specified herein. Also included shall be removal and disposal of existing asphalt overlay and waterproofing membrane, if present, and between a 1/4 inch to 1/2 inch thickness of concrete from the top of existing deck slabs.

### B. MATERIALS

Materials shall conform to the following requirements:

- 817, Class I: Portland Cement Concrete – High early strength cement shall not be permitted
- 803.01: Fine Aggregate
- 803.02: Coarse Aggregate – Coarse aggregate shall be a crushed trap stone, except that the grading shall be Size No. 78 as specified in AASHTO M 43.
- 822.01: Water
- Bonding Agent – Grout for bonding the low slump concrete to previously placed concrete shall consist of equal parts by weight of Portland cement and sand mixed with sufficient water to form stiff slurry that will not run or puddle in low spots. For sealing vertical joints between adjacent lanes and at curbs, this grout shall be thinned to paint consistency.

### C. EQUIPMENT

1. **General** – Equipment used shall be subject to the approval of the Engineer and in conformance to the requirements of Division 900, where applicable, except concrete spreading and finishing machines. The finishing machine shall be inspected and approved by the Engineer before Work is started. A mechanical strike-off shall be required to provide a uniform thickness of concrete in front of the oscillating screed.
2. **Screed machine** – At least 1 oscillating screed shall be designed to consolidate the concrete to 100 percent of the unit weight, determined in accordance with ASTM C 138-71T, by vibration. A sufficient number of identical vibrators shall be effectively installed such that at least 1 vibrator is provided for each 5 feet of screed length. The bottom face of this screed shall be at least 5 inches wide with a turned up or rounded leading edge to minimize tearing of the surface of the plastic concrete. Each screed shall have an effective weight of at least 75 pounds for each square foot of bottom face area. Each screed shall be provided with positive control of the vertical position, the angle of tilt, and the shape of the crown. Design of the finishing machine together with appurtenant equipment shall be such that positive machine screeding of the plastic concrete will be obtained within 1 inch of the face of existing curbs. The length of the screed shall be sufficient to extend at least 6 inches beyond the line where a saw cut is intended to form the edge of a subsequent placement section, and shall overlap the sawn edge of a previously placed course at least 6 inches. Provision shall be made for raising the screeds to clear the screeded surface for traveling in reverse.
3. **Rails** – Supporting rails upon which the finishing machine travels will be required on all surfacing projects. The support for these rails shall be fully adjustable (not shimmed) to obtain the correct profile. When placing concrete in a lane abutting a previously completed lane, that side of finishing machine adjacent to the completed lane shall be equipped to travel on the completed lane.

**D. CONSTRUCTION REQUIREMENTS**

1. **Surface preparation** – Work on the surface shall not commence until the lower course meets the compressive strength of 4,500 psi on field test cylinders made in the field and cured in the Laboratory but not less than seven (7) days after placement. The entire surface of the newly placed concrete floor shall be sandblasted to remove all dirt, oil and other foreign material as well as any laitance followed by oil- free, dry air cleaning. Curbs, sidewalks, concrete and/or metal barrier railings, hand railing, etc., shall be protected from the sandblasting. Grout shall be applied on this cleaned, dry surface by brushing on a thin and even coat, then immediately followed by placing and finishing a low slump concrete. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete.
2. **Placement** – The placement of the concrete shall be a continuous operation. The new concrete shall be manipulated and mechanically struck off slightly above final grade. It shall then be mechanically consolidated to 100 percent of the rodded unit weight with minus 2 percent tolerance. The rodded unit weight will be determined in accordance with ASTM C 138-71T. The elapsed time between depositing the concrete on the floor and final screeding shall not exceed ten (10) minutes.
3. **Joints** – At transverse and longitudinal joints, the surface course previously placed shall be sawn to a straight and vertical edge before the adjacent surface course is placed. No edges shall be chipped. Concrete shall not be placed adjacent to a surface course less than thirty-six (36) hours old except to a continuation of placement of a lane or strip beyond a joint in the same lane or strip. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout.
4. **Texture** – When a tight, uniform surface has been achieved the surface shall be textured with metal tines as described in 905.09(F).
5. **Curing** – The surface shall then be immediately covered with wet burlap meeting the requirements specified in 814.01. Curing shall be done in the manner described in 703.19, except that the burlap shall be kept constantly wet for seventy-two (72) continuous hours instead of seven (7) days.
6. **Temperature** – The PCC Surface mixture shall not be placed at temperatures lower than 45 degrees Fahrenheit. It may be placed at 45 degrees Fahrenheit when rising temperatures are predicted and then only if and until the prediction indicates eight (8) hours over 45 degrees Fahrenheit for the curing period. At temperatures above 85 degrees Fahrenheit, the Engineer may require placements to be made at night or early morning hours, if in his opinion a satisfactory surface finish is not being achieved.

**714.03 LATEX-MODIFIED CONCRETE OVERLAY**

- A. **GENERAL** – This Work shall consist of placing a 1 course, latex modified concrete overlay on bridge decks, to the prescribed depth and to the lines and grades shown on the Plans and as specified herein. Also included shall be removal and disposal of existing asphalt overlay and waterproofing membrane, if present, and between a 1/4 inch to 1/2 inch thickness of concrete from the top of existing deck slabs.
- B. **MATERIALS** – Materials and their use shall conform to the following requirements:
  - 817, Class J: Portland Cement Concrete - High early strength cement shall not be permitted.
  - 803.01: Fine Aggregate
  - 803.02: Coarse Aggregate shall be a crushed trap stone except that the grading shall be Size No. 7 as specified in AASHTO M 43.
  - 822.01: Water
  - Latex Admixture – The formulated latex admixture shall be Dow SM-100 Modifier A, Tylac 97-314 (Thermoflex 8002), Polysar 1186 or Deco-Rez 4776. A manufacturer's certification shall accompany these products stating that the latex being supplied is of identical formulation to that supplied to the FHWA Turner-Fairbanks Highway Research Station for initial approval.
  - Other Styrene-Butadiene latex admixtures may be used provided they have been tested in accordance with and meet the acceptable criteria of the testing program outlined in Report No. FHWA-RD-78-35 of the Federal Highway Administration.

- Each shipment of latex admixture shall be accompanied by a report of tests performed in accordance with the Certification Program found in Section VII of Report No. FHWA-RD-78-35. In addition to the actual test results, the report shall include the date of manufacture, batch or lot number(s), quantity represented, manufacturer's name, place of manufacture, a statement that all test results are satisfactory and the date on which the one (1) year certification will expire.
- The latex admixture shall be packaged and stored in containers and storage facilities which will protect the material from freezing and from temperatures above 85 degrees Fahrenheit. Additionally, the material shall not be stored in direct sunlight and shall be shaded when stored outside buildings during moderate temperatures. Any latex admixture which has been exposed to freezing temperatures shall not be used.
- Latex Modified Concrete Mix Design – Latex concrete shall meet the following requirements:

**TABLE 714.03 (A) LATEX CONCRETE REQUIREMENTS**

Material or Property	Modified Concrete
Cement Content, bags/C.Y.	7.0
Latex Emulsion Admixture Modifier, gal./bag	3.5
Air Content, % of plastic mix	7.5 or less
Water/Cement ratio including water in latex emulsion, max	0.40
<sup>a</sup> Slump, inches	4-6
Percent Fine Aggregates as percent of total aggregate by weight	50-60
<sup>b</sup> Strength, psi	4000 in 28 days

- a The slump shall be measured four (4) to five (5) minutes after discharge from the mixer. During this waiting period, it shall be deposited on the deck on a suitable container and not be disturbed. Care shall be exercised to ensure that traffic vibrations do not affect the measurement.
- b 6 inch x 12 inch cylinders shall be wet cured for twenty-four (24) hours, stripped and air cured before testing.

C. **EQUIPMENT** – All equipment for the deck preparation, mixing, placing and finishing of latex modified concrete shall be approved by the Engineer prior to the start of any Work. A standby mobile mixer shall be on the Site during the entire mixing operation.

1. **Proportioning and Mixing Equipment** – Proportioning and mixing equipment shall be a self-contained, mobile, continuous mixer subject to the following requirements:
  - a. *Mixing unit* – The mixing unit shall have a metal plate or plates permanently attached in a prominent place on which are plainly marked the gross volume of the unit in terms of mixed concrete, operating speed, auger mixing angle and the weight-calibrated cement constant of the machine in terms of a revolution counter or other output indicator, all as rated by the manufacturer.
  - b. *Compartments* – Separate compartments shall be provided to carry the necessary ingredients needed for the manufacture of latex modified concrete. Aggregate bins shall be covered at all times. The cement bins shall be free of moisture and contamination at all times. Suitable means as approved by the Engineer shall be provided to carry water and additives on the truck and to incorporate the additives with the mixing water in the mix.
  - c. *Feed systems* – The unit shall have a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Each bin shall have an accurately controlled, individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The cement bin feeding mechanism shall be set to discharge continuously at a uniform rate, a given volumetric weight equivalent of cement during the mixing operation. The fine aggregate feeding mechanisms shall be coordinated with the cement feeding mechanisms to deliver the required proportions.

- d. *Mixer unit* – The mixer unit shall be an auger type mixer incorporated into the truck’s discharge chute or other suitable mixing mechanism approved by the Engineer and shall produce concrete of uniform consistency and discharge the mix without segregation.
- e. *Dials and Measuring Devices* – The unit shall be equipped with an accurate revolution counter indicator permitting the reading of the volumetric weight equivalent of cement discharge during the concrete mixing operation. The counter shall be equipped with a ticket printout to record this quantity. A fine aggregate dial shall permit the setting of required openings for volumetric proportioning of aggregates.

The unit shall be equipped with a water flow meter or gauge to indicate the discharge rate of water by volume entering the mix. The water and additive measuring devices shall be coordinated with the cement and aggregate feeding mechanisms. The flow meters shall be equipped with scales commensurate with the type and amount of material being added.

A tachometer to indicate the drive shaft speed shall be mounted on the unit. All indicating devices that bear on the accuracy of proportioning and mixing of concrete shall be in full view and near enough to be accurately read or readjusted by the operator while concrete is being produced. The operator shall have convenient access to all controls.

- f. *Calibration* – The unit shall be constructed to permit convenient calibration of the gate openings and meters. The calibration shall be conducted at least once a year by the manufacturer of the concrete in the presence of the Department representatives. The manufacturer of the concrete shall make satisfactory arrangements with the Engineer at least one (1) week in advance of calibration.

Recalibration shall be conducted in the event of a change in the source of fine aggregate. Additional calibrations shall be conducted when deemed necessary by the Engineer. Each unit approved by the Engineer shall carry a copy of the calibration certification.

Certification of the calibration by an approved testing authority will be accepted as evidence of this accuracy if the yield is shown to be true with a tolerance of 1.0 percent according to the following test:

With the cement meter set on zero and all controls set for the desired mix, activate the mixer, discharging mixed material into a 1/4 cubic yard container, 36 inches x 36 inches x 9 inches. When the container is level struck full, making provisions for settling the material into all corners, the cement meter must show a discharge of 2 bags of cement for modified mortar (8 bags/c.y. mix).

- g. *Mixing and Delivery Control* – Cement and aggregate shall be proportioned, measured and batched by the volumetric equivalent method. In the operation, the entire measuring and batching mechanism must produce the specific proportions of each ingredient. Tolerances in proportioning the various ingredients shall be as follows:

**TABLE 714.03 (B) TOLERANCES**

Cement, weight percent	0 to +4
Fine Aggregate, weight percent	± 2
Water, weight or volume percent	± 1
Latex, weight or volume percent	± 2

The tolerances are based on a volume/weight relationship established during the calibration of the measuring devices. During mixing, the driveshaft speed as indicated by the tachometer shall be maintained at the operating speed ±50 RPM. The auger mixing angle shall be set in the range determined by the manufacturer. The interval between the continuous placing of succeeding batches shall not exceed thirty (30) minutes. The mixer shall be equipped to spray water over the entire placement width as it moves ahead to ensure that the surface to be overlaid is wetted prior to receiving the modified material.

- 2. **Placing and Finishing Equipment** – An approved finishing machine, meeting the requirements of 905.06(B), shall be used for finishing all large areas of Work. The finishing machine shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse.



The machine may also be of the vibrating screed type designed to consolidate the modified composition by vibration. The vibration frequency shall be variable with positive control between 3000 and 11,000 vpm. The bottom face of the screeds shall be not less than 4 inches wide and shall be metal covered. The screeds shall be provided with positive control of the vertical position. Screed rails shall be constructed of 1/2 inch bar stock not less than 2 inches wide, drilled and countersunk for attachment to the prepared surface. A suitable portable lightweight or wheeled work bridge shall be required and used behind the finishing operation.

Placing and finishing equipment shall include hand tools, meeting the requirements of 905.09, for placement and brushing in freshly mixed modified concrete and for distributing it to approximately the correct level for striking off with the screed. Approved hand-operated vibrators and screeds shall be used to place and finish small areas of Work.

#### D. CONSTRUCTION REQUIREMENTS

- 1. Surface preparation** – Not more than twenty-four (24) hours prior to placement of the latex modified concrete overlay, the entire surface of the deck shall be sandblasted to remove all laitance, dirt, oil and other foreign material followed by an air blast cleaning using compressed air with a high velocity nozzle. The edges of previously placed lanes of overlayment shall be sandblasted to remove the trowel cut surfacing and promote bond. If necessary, detergent cleaning, followed by sandblasting and air blast cleaning shall be required. Immediately prior to placement of latex modified concrete, the clean surface shall be thoroughly wetted for a period of not less than one (1) hour. Any standing water in depressions or holes in the areas of concrete removal shall be blown out with compressed air.

To ensure bonding, paste from the Latex Modified Concrete shall be broomed into the surface of the substrate concrete. The excess aggregate left after brooming shall not be mixed back into the LMC and shall be discarded. The brooming, placement, and screeding operations shall be continuous and completed within ten (10) to fifteen (15) minutes.

- 2. Placing and Finishing** – Anchorages for supporting rails shall provide horizontal and vertical stability. Screed rails shall not be treated with parting compound to facilitate their removal.

The admixture shall be placed and struck off to approximately 1/4 inch above final grade. It shall then be consolidated and finished at final grade with the vibrating devices. Spud vibration shall be used at the edges and adjacent to joint bulkheads. Hand finishing with a float may be required along the edge of the placement or on small areas of repair. Edge tooling shall be required at joints, except next to metal expansion dams, curbs and previously placed lanes.

Screed rails and/or construction bulkheads shall be separated from the newly placed material by passing a pointing trowel along their inside face. Metal expansion dams shall not be separated from the overlayment. Care shall be exercised to ensure that this trowel cut is made for the entire depth and length of rails after the mixture has stiffened sufficiently.

The surface shall be promptly covered with a single layer of clean wet burlap as soon as the surface will support it without deformation. Within one (1) hour of covering with wet burlap, a layer of 4 mil polyethylene film shall be placed on the wet burlap and the surface cured for twenty-four (24) hours. The curing material shall then be removed for an additional seventy-two (72) hour air cure. Wet burlap-polyethylene sheets may be substituted for the polyethylene film with the approval of the Engineer, but shall not replace the initial wet burlap application.

When the latex modified overlay has been cured, it shall be textured in accordance with the requirements of 703.22(C).

- 3. Limitation of Operations** – No vehicular traffic shall be permitted on the latex concrete surface until one hundred and twenty (120) hours after placement. At temperatures below 55 degrees Fahrenheit, the Engineer may require a longer curing period.

The latex modified mixture shall not be placed at temperatures below 45 degrees Fahrenheit. It may be placed at 45 degrees Fahrenheit when rising temperatures are predicted and then only if and until the prediction indicates a temperature of over 45 degrees Fahrenheit during the initial eight (8) hours of the curing period. At temperatures above 85 degrees Fahrenheit, the Engineer may require placements to be made at night or early morning hours if in his opinion a satisfactory surface finish is not being achieved.

A construction dam or bulkhead shall be installed in case of a major delay in the placement operation resulting in the formation of the plastic film. During minor delays, the placement shall be protected from drying with several layers of wet burlap.

Adequate precautions shall be taken to protect freshly placed modified concrete from sudden or unexpected rain. All placing operations shall stop when rain begins. The Engineer may order removal of any material damaged by rainfall.

4. **Application of Live Loads** – Truck mixers and other heavy equipment shall not be permitted on the latex modified concrete overlay, nor shall the traveling public, until authorized by the Engineer. Such authorization may only be given after the prescribed curing period has taken place, after the last concrete has been placed, and providing that the concrete placed on the deck has attained a minimum strength of 3500 psi. Specimens shall be cured in the same manner the deck is cured.

#### 714.04 MICROSILICA CONCRETE OVERLAY

- A. **GENERAL** – This Work shall consist of placing a 1 course, microsilica concrete overlay on bridge decks, to the prescribed depth and to the lines and grades shown on the Plans and as specified herein. Also included shall be removal and disposal of existing asphalt overlay and waterproofing membrane, if present, and between a 1/4 inch to 1/2 inch thickness of concrete from the top of existing deck slabs.

#### B. MATERIALS

1. **Concrete** – The concrete for PCC overlay including filling depressions created by removal of concrete, shall conform to 703 except for the following modifications:

**TABLE 714.04 (A) CONCRETE**

Portland Cement	635 lb/cy
Water (Cement + Silica Fume) Ratio	0.40 (max.)
Slump	6 + 2 in
Air Content	7 + 2 percent
Silica Fume	8 to 10% (Solids) by weight of cement added as admixture in slurry form
Synthetic Fiber	1 lb
Compressive Strength	4500 psi at 28 days

2. **Silica Fume** – Silica Fume shall conform to the following chemical and physical requirements:

**TABLE 714.04 (B) SILICA FUME**

Silicon Dioxide (SiO <sub>2</sub> ),min %	85.0
Sulphur Trioxide (SO <sub>3</sub> ),max %	3.0
Moisture Content, max %	3.0
Loss on ignition, max %	6.0
Avail. Alkaline as Na <sub>2</sub> O,max %	1.5
Percent Retained on 45-micrometer (No. 325) Sieve, max %	5.0
Specific Surface(Nitrogen adsorption) min m /g	18
Specific Surface(Nitrogen adsorption) max m /g	28

Silica fume shall not be used in dry form.

#### C. REMOVAL OF CONCRETE AND SURFACE PREPARATION

1. Removal of concrete shall consist of the following steps
- Scarification to remove 1/4 inch to 1/2 inch thickness for the entire area of the deck.
  - Removing deteriorated concrete up to top layer of the existing reinforcement, at designated locations as shown on the Plans or as directed by the Engineer.

- c. Removing concrete to depths below the top layer of reinforcement if additional loose or deteriorated concrete is detected. Such additional removal shall be done only upon approval by the Engineer.
  2. All bridge deck areas to be overlaid shall be protected from intrusion from construction operations and by adhering to the following conditions
    - a. Barricades shall be placed between all Work areas and adjacent public areas.
    - b. Plywood shall be placed over any surface that concrete or oil-leaking equipment will pass over.
    - c. Water run-off shall be controlled to prevent staining of non-construction areas or automobiles.

**3. Surface preparation**

- a. The existing concrete surface upon which concrete is to be placed shall be pre-saturated with water and kept continuously wet at least twelve (12) hours before placing concrete.
    - b. Immediately, prior to concrete overlay placement, the existing, roughened concrete surface shall be SSD (Saturated, Surface-Dry), clean, free of all dust, dirt, grease, oil, wax, debris or other foreign matter. The concrete surface pore structure shall be open.
    - c. The existing concrete surface temperature shall not be less than 40 degrees Fahrenheit or greater than 85 degrees Fahrenheit at the time of concrete placement.

**D. EQUIPMENT** – As per 714.02(C), except that all scarification removal of concrete shall be done by hydro-jetting.

**E. CONSTRUCTION METHODS**

1. The Contractor shall have a technical representative of the Silica Fume manufacturer available at the job Site at all times during placement of overlay at no additional cost to the District. After the surface has been cleaned and immediately before placing concrete, a thick coating of bonding grout shall be scrubbed into the wet, prepared surface. This bonding grout shall consist of 2 parts of fine sand and 1 part Portland cement plus micro silica (in the same proportion as the mix design) mixed with water to give a thick paint or creamy consistency. Care shall be exercised to insure that all parts receive a thorough, even coating and that no excess grout is permitted to collect in pockets. The rate of progress in applying grout shall be limited so that grout does not become dry before it is covered with new concrete.
2. Discharge of concrete from the delivery trucks shall be completed within sixty (60) minutes after introduction of mixing water to the cement and aggregates.
3. The new concrete shall be manipulated and mechanically struck off slightly above final grade. It shall then be mechanically consolidated and screeded to final grade with slope to the drains.
4. Fresh concrete, 3 inches or more in thickness, shall be vibrated internally in addition to the surface screed vibration.
5. Immediately after leveling to final grade, start finishing with bull float to produce a tight, uniform surface. Use a light fog-spray of water to keep the concrete surface moist between the finishing operations.
6. After the broom finish, continue light fogging only as necessary to keep the concrete surface wet before start of curing.
7. When a tight uniform surface has been achieved, the surface shall be textured in accordance with 703.22(C).

**F. CURING**

1. At the time when fresh concrete can support a worker's weight without damaging the finish, cover the surface with a single layer of wet burlap. Cover burlap with layer of clear 4 mil thick polyethylene sheeting.
2. Provide a wet burlap cure for at least seven (7) days. The burlap shall meet the requirements specified in 814.01.A. The burlap shall be kept continuously wet. Do not cover the wet burlap.
3. For fourteen (14) days after casting, the concrete shall be protected from damage due to mechanical disturbances such as shock and vibration due to adjacent construction activity. Protect finished concrete surfaces from damage.

**G. TOLERANCES** – Horizontal surfaces shall be true planes within 1/4 inch in 10 feet as determined by a 10 foot straightedge placed anywhere on the surface in any direction (Class B per ACI 301-84).

**H. CONTRACTOR QUALITY CONTROL** – As a minimum, the Contractor shall conduct a program of field quality control as outlined in the following paragraphs:

1. For each placement before concrete is placed, the following shall be inspected and approved:
  - a. Existing slab surface cleanliness, temperature and water saturation.
  - b. Concrete batch ticket.
  - c. Elapsed time since batching and number of mixing truck drum revolutions.
  - d. Concrete temperature.
  - e. Hot weather concreting conditions.
  - f. Slump in accordance with ASTM C 143-78 for each truck load.
  - g. Air content per ASTM C 231-82 for each truck load.
  - h. Water addition at the Site.
2. The slump shall be measured at the job Site before addition of the high-range water reducer, if it is added at the job Site. The slump shall also be measured at the point of final placement.
3. The air content shall be measured at the point of final placement.
4. Concrete test specimens shall be made in accordance with ASTM C 31-88. 1 set of samples shall be taken not less than once per day nor less than once for each 4,000 square feet of surface area cast in one (1) day. Each set shall consist of six cylinders. The specimens shall be tested for compressive strength in accordance with ASTM C 39-85. 2 specimens shall be tested at seven (7) days and 3 specimens at twenty-eight (28) days. The sixth specimen shall be held in reserve. The samples for strength test shall be removed from concrete at the point of final placement.

**I. LIMITATIONS OF OPERATIONS**

1. A bulkhead shall be installed in case of major delay in the placement operation. During minor delays of one (1) hour or less, the end of the placement may be protected from drying with several layers of wet burlap.
2. The elapsed time between depositing the concrete on the floor and final screeding shall not exceed ten (10) minutes.  
At transverse and longitudinal joints, the surface course previously placed shall be sawn to a straight and vertical edge before the adjacent surface course is placed. No edges shall be chipped. Concrete shall not be placed adjacent to a surface course less than thirty-six (36) hours old except to a continuation of placement in a lane or strip beyond a joint in the same lane or strip. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout.
3. Screenshot rails or trips may be removed at any time after the concrete overlay has taken initial set. Adequate precaution shall be taken during screed removal to protect the edge of the new surface from damage.
4. Preparation of any area may be started in a lane or strip adjacent to newly placed overlay twenty-four (24) hours following its placement. During the next seven (7) days following the placement of the overlay, the Work shall be restricted as follows:
  - a. No operations shall be undertaken which will interfere with the curing process.
  - b. No power-driven tools, including chipping and jack hammers shall be used.
  - c. No vehicles or construction equipment shall be permitted on a finished overlay until water curing is complete. At temperatures below 50 degrees Fahrenheit, a longer waiting time will be required.

**J. CLEANUP** – Debris shall not be allowed to accumulate at any time. Clean-up and debris removal shall be done daily.

**K. PROTECTION** – The Contractor shall be responsible for protecting the Work from damage such as impact, overloading, marring of surfaces or other damage until Final Acceptance.

- L. **ACCEPTANCE** – Should an approval not be obtained for any Work requiring approval, such Work and all subsequent Work will be rejected. Appearance of plastic shrinkage cracks due to inadequate finishing and curing shall be cause for rejecting the Work so affected. Surface concrete in the rejected area shall be removed and replaced at no additional cost to the Department.

#### **714.05 MEASURE AND PAYMENT**

- A. **MEASURE** – The unit of measure for the various types of Bridge Deck Concrete Overlay will be the square yard, complete in place. The number of square yards will be the actual surface area computed from measurements taken in the field.
- B. **PAYMENT** – Payment for the specified type of Bridge Deck Concrete Overlay will be made at the Contract unit price per square yard, which payment will include removal and disposal of existing asphalt surface and membrane waterproofing, scarifying if specified, sandblasting, air cleaning, grouting, and proportioning, mixing, placing, finishing, and curing concrete. Payment will also include the cost of furnishing all materials, tools, equipment, incidentals and labor necessary to complete the item as shown on the Plans and specified herein.
- C. **PAYMENT FOR DECK REPAIR** – Payment for removal and disposal of deteriorated concrete beyond the prescribed thickness will be paid for at the Contract unit price per cubic yard for Structure Hard Surface Excavation.

## 715 CONCRETE BRIDGE DECK REPAIR

### 715.01 DESCRIPTION

This Work shall consist of removing a specified amount of the existing bridge deck mechanically or through hydro-jetting, removal of additional areas of deteriorated concrete, cleaning all surface areas to be repaired, replacing deteriorated reinforcing steel, and placing repair concrete.

### 715.02 MATERIALS

- A. **PORTLAND CEMENT CONCRETE** – Concrete shall conform to Class A or Class B unless otherwise specified or shown on drawings, but shall contain aggregates no greater than 1/2 inch nominal size.
- B. **EPOXY RESIN ADHESIVE (BONDING AGENT)** – Epoxy adhesive shall conform to AASHTO M235 Type III, 2 part mix equal parts (1:1), thixotropic, and in accordance with 822.08(B) (1).
- C. **ALTERNATE CONCRETE BONDING AGENT** – Bonding agent compound for bonding uncured concrete to existing concrete shall be Thorobond, Weld-Crete, Link, or approved equal with a polyvinyl acetate homopolymer base for surface bonding application.

### 715.03 EQUIPMENT

#### A. REMOVAL EQUIPMENT

- 1. **Existing wearing surface** – This equipment shall only be required when the existing bridge contains an asphalt wearing surface. It shall be capable of removing the wearing surface without damaging armored joints that are to remain or the existing concrete surfaces beyond the specified minimum removal depth. When pavement breakers are proposed, broad face chisel blades shall be used and operated at a slight angle with the horizontal to peel off the wearing surface.
- 2. **Concrete surface** – Power operated mechanical type or high pressure water jet type equipment shall be capable of uniformly removing the specified minimum depth from the existing concrete surface.
  - a. *Mechanical type* – This equipment shall be limited to depths not closer than 1/2 inch from the top of the existing reinforcement. When additional removal is required, it shall be performed by high pressure water jet, power driven hand tools or hand tools.
  - b. *High Pressure Water Jet (Hydro-jetting)* – This equipment may be used to any depth above and below the reinforcing steel. The runoff water shall be satisfactorily controlled to prevent it from reaching any traveled roadway, waterways, or any other areas designated in the Plans or by the Engineer.
  - c. *Power driven hand tools* – This equipment shall be used for removal of unsound concrete or to achieve the required depth when deeper than 1/2 inch above the top of existing reinforcing steel. Pneumatic hammers heavier than a nominal 45 pound class shall not be used, and chipping hammers heavier than a nominal 15 pound class shall not be used to remove concrete from beneath any reinforcing steel.
  - d. *Hand tools* – Hand tools such as hammers and chisels shall be provided for removal of remaining particles of unsound concrete from beneath existing reinforcing steel or to achieve the required depth of removal.
  - e. *Cleaning* – This equipment shall be capable of removing rust scale and old concrete from reinforcing steel and small chips of concrete partially loosened by the removal. Abrasive blasting shall not be used when epoxy coated reinforcing steel is present in the concrete.

- B. **PLACEMENT EQUIPMENT** – Equipment shall conform to 905.

**715.04 REMOVAL**

- A. ASPHALT WEARING SURFACE REMOVAL** – The asphalt wearing surface, if present, shall be removed to the limits shown in the Plans.
- B. INSPECTION** – The Engineer shall inspect the entire exposed portion of the deck and designate the extent and depth of concrete removal.
- C. CONCRETE REMOVAL** – The previously designated areas to be repaired shall be outlined with saw cuts to a depth of at least 1 inch. The areas of deteriorated concrete shall be removed down to sound concrete by means of the appropriate equipment. At a minimum, concrete must be removed 3/4 inch below the top mat of reinforcing steel in the deck. The proposed removal method is subject to the approval of the Engineer. Where it is anticipated that the depth of removal will be half of the original concrete deck thickness and deeper removal is possible, the Contractor shall furnish and erect temporary protective shields in accordance with 626.
- D. REINFORCING STEEL** – Exposed reinforcing steel shall be cleaned. Epoxy coated reinforcing steel shall not be cleaned by abrasive blasting. Damaged epoxy coating shall be repaired in accordance with 704.09(D). Reinforcing steel that is damaged or deemed unsuitable by the Engineer shall be lapped 30 bar diameters on each side of the damaged portion with new bars of the same size if sufficient length of the existing bar is exposed. Otherwise the new bar shall be welded or mechanically connected in accordance with 704.

**715.05 CONCRETE DECK REPAIR****A. SURFACE PREPARATION**

- 1. Cleaning** – After the completion of removal of deteriorated concrete, remove all dirt, oil or other foreign material followed by an airblast cleaning using compressed air with a high velocity nozzle.
- 2. Bonding agent** – An epoxy resin adhesive shall be applied to the prepared surface. Adhesive shall be applied when the ambient air temperature is in excess of 60 degrees Fahrenheit unless otherwise recommended by the manufacturer. The adhesive shall be in “Tacky” condition immediately prior to placing repair material.

**B. REPAIR TYPES** – The top surface of all deck repairs shall be flush with the top of the adjacent concrete deck, and the concrete will be cured in accordance with 703.

- 1. Partial depth deck repair** – This repair shall include all areas where the depth of deck removal is less than the full depth of the original concrete deck. The Contractor shall fill the void with Class A Concrete.
- 2. Full depth deck repair** – This repair shall include all areas where the depth of deck removal is the full depth of the original concrete deck. The Contractor shall fill the void with the concrete class specified on the Plans. For areas greater than 4 square feet, forms shall be supported by blocking erected from the existing girders. Otherwise forms may be suspended from existing reinforcing steel by wire ties. All forms shall be removed upon completion of the concrete curing process.

**715.06 MEASURE AND PAYMENT**

- A. MEASURE** – The unit of measure for the various types of Concrete Bridge Deck Repair will be the square foot, complete in place. The number of square feet will be the actual surface area computed from measurements taken in the field.
- B. PAYMENT** – Payment for the specified type of Concrete Bridge Deck Repair will be made at the Contract unit price per square foot, which payment will include removal and disposal of existing asphalt surface and membrane waterproofing, abrasive blasting, air cleaning, grouting, and proportioning, mixing, placing, finishing, and curing concrete. Payment will also include the cost of furnishing all materials, tools, equipment, incidentals and labor necessary to complete the item as shown on the Plans and specified herein.

## 716 REPAIR-REPLACE PCC STRUCTURE

### 716.01 GENERAL

The materials and methods specified below apply to the particular types of structural repairs as shown on the Plans and specified herein.

Due to the time interval between the field survey and Notice to Proceed, further deterioration may have occurred which would not be reflected in the quantities for the particular Bid Item; the Engineer will be the sole judge of the extent and total quantity of repairs that are to be made.

### 716.02 MATERIALS

- A. **PORTLAND CEMENT CONCRETE** – Concrete shall conform to Class B Concrete or as otherwise specified or shown on drawings, but shall contain aggregates no greater than 1/2 inch nominal size.
- B. **NON-SHRINK GROUT** – A propriety formulation with a minimum bond strength of 2000 psi per ASTM C 882, compressive strength of 5000 psi minimum after twenty-four (24) hours per ASTM C 579.
- C. **NON-SHRINK MORTAR** – Mortar shall be cement base non-shrink type meeting the requirements of ASTM C 109 for 3000 psi, twenty-eight (28) day strength. It shall be non-sag, stiff consistency for vertical surfaces, and capable of adhering to damp concrete surfaces.
- D. **EPOXY RESIN ADHESIVE (BONDING AGENT)** – Epoxy adhesive shall conform to AASHTO M 235 Type III, 2 part mix equal parts (1:1), thixotropic.
- E. **LOW VISCOSITY EPOXY GROUT FOR PRESSURE INJECTION GROUTING** – High-modulus, moisture insensitive, low-viscosity, for application at not less than 40° F, fast setting, rigid, for grouting both damp and dry cracks. ASTM C 881 Types IV, Grade 1, Class B and C. If recommended by epoxy manufacturer, provide a compatible surface sealer. Pressure injection shall be carried out in strict accordance with manufacturer's instruction.
- F. **SURFACE SEALANT** – Epoxy resin used to seal cracks and ports before injection. ASTM C 881, Type IV, Grade 3, Class B and C.
- G. **CAULKING COMPOUND** – A 1 component, non-sag (gun grade) urethane sealant, color gray, meeting Federal Specification TT-S-00230C Type II for vertical use and ASTM C 920.
- H. **WELDED WIRE FABRIC REINFORCEMENT** – AASHTO M 55 non-deformed wire fabric.
- I. **NON-SHRINK EPOXY GROUT** – A proprietary formulation, rapid set, flowable epoxy grout, for tight clearances meeting applicable AASHTO Specifications for epoxy and cement components, non-shrink per ASTM C 827 and tensile strength of 2000 psi minimum per ASTM C 190.
- J. **EPOXY MORTAR** – Epoxy-cement, proprietary formulation, non-metallic, non-flowable, stiff consistency and in accordance with 806.05(C).
- K. **MASTIC LUBRICANT** – Non-flowable material, wash resistant to moisture, compatible with elastomeric material, molybdenum disulfide base.
- L. **ALTERNATE CONCRETE BONDING AGENT** – Bonding agent compound for bonding uncured concrete to existing concrete shall be Thorobond, Weld-Crete, Link, or approved equal with a polyvinyl acetate homopolymer base for surface bonding application.
- M. **ANCHOR BOLTS** – Self-anchoring bolts shall be per 822.06(B).



**716.03 SUBMITTAL**

- A. MATERIALS CERTIFICATION** – Submit certification for all materials in accordance with 822.08(D).
- B. CONSTRUCTION DRAWINGS** – Submit construction drawings and calculations showing temporary shoring and support systems (if applicable).
- C. DRAWING CERTIFICATION** – Shop drawings and construction drawings shall be certified by a Professional Engineer registered in the District.
- D. AS-BUILT DRAWINGS** – As-Built drawings shall indicate the type, location and extent of the repairs and the products and methods actually used.

**716.04 CONSTRUCTION METHOD CONCRETE REPAIR OR PATCH**

- A. LIMITS OF DETERIORATION** – The extent for removal of deficient concrete shall be as indicated by sounding with a hand held steel hammer. A hollow sound indicates deficiency. All sounding shall be performed by the Engineer. Where sounding indicates a deficient area has increased beyond that indicated on the Contract Drawings, obtain the Engineer's approval before commencing Work.
- B. CONCRETE REMOVAL** – The limits of the repair areas previously designated shall be saw cut along neat lines to a depth of at least 1 inch so as to obtain a rectangular area. The saw cut lines shall encompass the area of deterioration by maintaining a minimum of 2 inches offset from the designated area of deterioration. Special care shall be taken to protect any parts of the Structure that are not specifically to be removed. Pneumatic hammers may be used to remove unsound concrete. The maximum hammer size is 60 pound class. All devices proposed for concrete removal shall be approved by the Engineer.
- C. DEPTH OF CONCRETE REMOVAL** – Concrete shall be removed in the previously designated areas to depth at which sound concrete is found. The depth at which sound concrete is found will determine the type of repair to be utilized as follows:
  - 1. Depth Greater Than 4 Inches – Repair Type 1, Concrete Repair
  - 2. Depth 4 Inches or Less – Repair Type 2, Concrete Patch

After concrete removal to a depth of 2 inches has taken place, the Engineer shall have the option to remove additional concrete depth and designate which repair type will be used. Payment shall be made under the repair type designated.
- D. EXISTING REINFORCING STEEL** – Extreme care shall be taken when removing concrete so as not to damage the existing reinforcing steel. If the reinforcing steel is damaged or deemed unsuitable by the Engineer, it shall be replaced by dowel bars that are the same diameter as the damaged reinforcing steel. The minimum size of a replacement dowel shall be a #5 bar. The replacement dowel bars shall be provided at the Contractor's expense.
- E. UNDER CUT** – The perimeter of the repair area shall be under cut or bevel cut to key in the proposed repair.
- F. SURFACE PREPARATION** – The repair areas shall be structurally sound and free from all dust, dirt, grease, paint and other foreign material. Exposed reinforcing steel shall be sandblasted to a bright metal. The concrete surfaces that are to be repaired shall then be blown clean with oil-free and clean air.

**716.05 REPAIR TYPE 1, CONCRETE REPAIR**

- A. WELDED WIRE FABRIC WITH ANCHORS** – Place 3/8 inch diameter concrete anchors at a maximum spacing of 18 inch on centers in each direction and attach welded wire fabric to anchors. A minimum of 1 anchor is required per repair area. The welded wire fabric shall be of an appropriate size to fill the repair area.
- B. FORMS** – Set forms maintaining all chamfers and flush with adjacent concrete surface.

Provide adequate ports in forms for applying the bonding agent and placing repair concrete. The forms shall be removable. Provide a minimum of 1 inch cover by bending existing reinforcement back behind finished surface if required.

- C. BONDING AGENT** – An epoxy resin adhesive shall be applied to the prepared surface.

Adhesive shall be applied when the ambient air temperature is in excess of 60 degrees Fahrenheit unless otherwise recommended by the manufacturer. The adhesive shall be in tacky condition immediately prior to placing repair concrete.

- D. REPAIR** – Fill cavity with repair concrete, finish and cure concrete in accordance with 703.

#### 716.06 REPAIR TYPE 2, CONCRETE PATCH

- A. FORMS** – Set forms maintaining all chamfers and flush with adjacent concrete surface. Provide adequate ports in forms for applying the bonding agent and placing repair concrete. The forms shall be removable. Provide a minimum of 1 inch cover by bending existing reinforcement back behind finished surface if required.

- B. BONDING AGENT** – An epoxy resin adhesive shall be applied to the prepared surface. Adhesive shall be applied when the ambient air temperature is in excess of 60 degrees Fahrenheit unless otherwise recommended by the manufacturer. The adhesive shall be in a tacky condition immediately prior to placing repair material.

- C. REPAIR** – The material used to effect this repair type shall conform to either of the following:

1. **Epoxy mortar** – Finish and cure in accordance with the manufacturer's Specifications and 703.
2. **Non-shrink grout** – Finish and cure in accordance with the manufacturer's Specifications and 703.

#### 716.07 REPAIR TYPE 3, CRACK REPAIR

- A. GENERAL** – The Work covered by this item includes surface repair of concrete cracks by pressure injection of epoxy as shown on the Contract Documents. The method of application shall be approved by the Engineer prior to beginning Work.

- B. LOCATIONS** – Prior to the beginning of Work, the Engineer will mark the exact crack locations to receive epoxy injection.

- C. DAMAGE** – Extreme caution shall be taken when selecting a pressure necessary to complete crack repair so as not to damage the Structure by causing additional cracking. If additional damage occurs, the Contractor shall bear full responsibility.

#### **D. SURFACE PREPARATION**

1. **Cleaning** – Concrete surfaces shall be clean and sound. Clean all cracks of loose matter such as dirt, laitance, oil, grease, salt or any other contaminants by sandblasting compressed air.
2. **Surface seal** – If necessary, apply surface seal material to the crack and establish entry ports in the surface seal at 6 to 18 inches apart. Substrate temperatures shall not be less than 40 degrees Fahrenheit or as recommended by the epoxy manufacturer. Allow surface seal to set before beginning injection procedure.

- E. INJECTION** – Inject low viscosity epoxy adhesive at the lowest port. Continue injection until epoxy begins to flow out of the port at the next higher level. Plug the first port and start injection at the second port. Repeat until all of the ports are filled. Allow epoxy to cure as per the manufacturer's Specifications.

- F. FINISH** – After the epoxy injection is complete, all entry ports shall be removed and all excess surface seal and epoxy shall be removed flush with adjacent concrete surfaces.

#### **G. TESTING**

1. **First test** – After the completion of the first crack repair, the Engineer shall designate a random location within the finished crack repair to be cored. Extreme care shall be taken in the selection of the core locations to avoid primary reinforcing steel. The core shall be 1 inch in diameter, and shall extend to the depth of crack being investigated. This core will be examined by the Engineer to verify the full sealing of the crack. If the crack is not sealed to the satisfaction of the Engineer, the procedure used for crack injection will be modified.

2. **Additional tests** – The Engineer shall designate 1 location for every 25 linear feet of crack repair and no less than 1 additional random location where the cracks have been epoxy injected for the Contractor to core. These cores will be examined by the Engineer to verify full sealing of the cracks.
3. **Core holes** – The core holes shall be filled with a non-shrink grout and finished to the satisfaction of the Engineer.

## 716.08 MEASURE AND PAYMENT

### A. REPAIR TYPE 1 – CONCRETE REPAIR

1. **Unit of measure** – The unit of measure will be the square foot.
2. **Payment** – Payment will be made at the Contract unit price per square foot, for which payment will include furnishing all materials, labor, tools and equipment to accomplish the Work specified.

### B. REPAIR TYPE 2 – CONCRETE PATCH

1. **Unit of measure** – The unit of measure will be the square foot.
2. **Payment** – Payment will be made at the Contract unit price per square foot, for which payment will include furnishing all materials, labor, tools and equipment to accomplish the Work specified.

### C. REPAIR TYPE 3 – CRACK REPAIR

1. **Unit of measure** – The unit of measure will be the linear foot of crack repaired.
2. **Payment** – Payment will be made at the Contract unit price per linear foot, for which payment will include furnishing all materials, labor, tools and equipment to accomplish the Work specified and shown.

## 716.09 PNEUMATICALLY APPLIED CONCRETE

- A. **GENERAL** - This Work shall consist of the furnishing and placing of pneumatically applied concrete for repairing spalls and delaminations on concrete structures. The texture and color of the applied concrete shall match the surrounding surfaces. This method shall be used only at the direction of the Engineer.

Pneumatically applied concrete shall consist of either dry-mixed fine aggregate and Portland cement pneumatically applied by a suitable mechanism, to which mixture with water is added immediately previous to its expulsion from the nozzle, or concrete premixed by mechanical methods and pneumatically applied through a nozzle onto the prepared surface.

No Work shall be performed on historic bridges until successful completion and approval of field trials as specified in (G) below.

- B. **MATERIALS** - Aggregate shall be fine aggregate, except that up to 30 percent coarse aggregate, conforming to AASHTO M 43 for size 3/8 inch to No. 16, may be substituted for fine aggregate. Recovered rebound which is clean and free of foreign material may be reused as fine aggregate in quantities not to exceed 20 percent of the total fine aggregate requirements. The mix shall have the following strength requirements:

Compressive Strength (ASTM C 39)

One (1) Day - 1,500 psi minimum

Twenty-eight (28) Days - 5,000 psi minimum

The materials used shall conform to the following:

- 801.01: Type I/II Portland Cement
- 801.04: Ground Granulated Blast Furnace Slag
- 803.01: Fine Aggregate
- 803.02: Coarse Aggregate
- 822.01: Water

- 814.03: Air Entraining Admixtures
- 814.04: Chemical Admixtures
- 814.05: Color Admixture
- 812.01: Welded Wire Fabric
- 812.03: Reinforcement Bars
- Black Annealed Tie Wire - 14 gauge

Anchor studs used to support reinforcing bars as shown on the Contract Plans shall have sufficient embedment in sound concrete to resist a pullout force of 300 lb. The Contractor shall perform this test in the presence of the Engineer.

The Contractor shall submit the proposed mix design to the Engineer for approval prior to start of any field trial unless otherwise specified. The mix design shall provide a cement-to-aggregate ratio, based on dry loose volumes, of not less than 1:3.5 for the repair of concrete. The water content shall be as low as practical and shall be adjusted so that the mix is sufficiently wet to adhere properly and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces.

Mixing shall be done either by the dry mix or wet mix process. Before being charged into the placing equipment, the material shall be thoroughly and uniformly mixed using a mixer designed for use with pneumatic application. The mixer may be either paddle type or drum type. Transit mix equipment and methods may be used for the wet process.

- C. QUALIFICATION OF CONTRACTOR** -The Contractor or Subcontractor performing the exterior concrete repair work shall submit proof of their qualifications for approval prior to the start of Work. Qualifications shall include a minimum five (5) years of consecutive experience in rehabilitation of concrete structures including rehabilitation of tooled surface-textured concrete structures. Only experienced foremen, gunmen, nozzlemen, and rodmen shall be employed and satisfactory evidence of such experience shall be furnished to the Engineer.

The Contractor shall employ skilled foremen who have successfully performed and completed similar type of concrete repair work for rehabilitation of concrete bridges over the last five (5) years on at least 3 similar projects.

The Contractor shall employ qualified nozzlemen who have had previous experience in application of pneumatically applied concrete on at least 2 projects of comparable nature. Work shall be performed under the immediate supervision of foreman with experience specified above. Each nozzleman shall demonstrate for approval by the Engineer, acceptable proficiency in uniformity of application of shotcrete to vertical and overhead test panels before beginning production work.

The Contractor shall submit the following for approval to demonstrate that they have satisfied the above requirements for his and their previous experiences:

- Project resume with color photos of each restoration project
- Resumes of all technicians who will perform the Work
- Test panels for strength testing at Site locations

- D. METHODS** - Submit Shop Drawings as specified in CONCRETE REPAIR. Follow the procedure specified on the Contract Plans. Field trials, if required, shall be performed for approval by the Engineer to ensure that the color and texture match the surrounding surface. The Contractor shall not commence the repair work until obtaining the Engineer's approval of both the mix design and the field trial.

If the reinforcement steel is exposed, abrasive blast all exposed existing reinforcing steel that will be incorporated in the new work to a near white finish to remove all rust, dirt, scale and loose concrete. Cut out the reinforcing bars that have lost 15 percent or more of their original dimension. Weld new reinforcing steel to existing steel as specified.

Maintain the temperature of the concrete mixture just before placement of between 50 and 85 degrees Fahrenheit. The ambient temperature and surface temperature at the time of application shall be 50 degrees Fahrenheit, and rising.

1. **Wet Process** - Shotcrete subject of freezing and thawing shall have an air content of 7.5 percent plus or minus 1.5 percent as delivered to the Project Site shall be mixed in accordance with Section 703.

2. **Dry Process** - Solid ingredients for dry mix shotcrete shall be pre-dampened as needed and mixed in a batch type or continuous mixer. Most of the mixing water shall be added at the nozzle. Dry mix shotcrete shall be applied within forty-five (45) minutes after batching or pre-dampening. The fine aggregate shall contain not less than 3 percent nor more than 6 percent moisture by weight.

The minimum cementitious materials shall be 658 lbs per a cubic yard.

The method of application shall be approved by the Engineer prior to beginning Work. After the last lift of pneumatically applied concrete is placed, it shall be allowed to set up thirty (30) minutes or as recommended by the manufacturer before protection is removed and the patch is troweled off flush with the surrounding surface. If texturing is required to match the surrounding concrete surface, the pneumatically applied concrete shall be allowed to set up for an additional sixty (60) minutes before texturing begins. At this point, the consistency of the material shall be soft enough to carve in the texture, yet hard enough so that no damage to the cohesive bond could occur from texturing techniques. After concrete has been cured for twenty-eight (28) days, additional texturing may be performed by lightly chiseling at the repair areas to create a rougher surface. Then the area shall be lightly sandblasted to create a weathered look.

When concrete is to be placed against concrete, all deteriorated or loose material shall be removed by chipping with pneumatic or hand tools. The surface shall be sandblasted as necessary to produce a clean-texture surface on the concrete. The surface against which concrete is to be placed shall be kept wet for at least one (1) hour and then allowed to dry to a surface dry condition just prior to application of the concrete.

Anchor studs shall be spaced no more than 12 inches, center to center, on overhead surfaces; 18 inches center to center, on vertical surfaces; and 36 inches, center to center, on top horizontal surfaces. At least 3 anchors shall be used in each individual patch area.

Unless otherwise shown or specified, for repair work, all areas where the thickness concrete exceeds 1.5 inches shall be reinforced with a single layer of 3x3-W0.9xW0.9 welded wire fabric.

All steel items, including anchors, reinforcing bars and wire fabric, shall be no closer than 1-1/2 inch to the finished surface of the concrete.

The Contractor shall provide protection around both horizontal, vertical overhead patches to protect the adjacent areas from shotcrete overspray. Protection shall consist of 6 mil poly attached to the surrounding patch area using wooden strips anchored to the face with small anchor bolts.

The concrete shall be applied by pneumatic equipment that sprays the mix onto the prepared surface at high velocity as needed to produce a compacted dense homogeneous mass. The air compressor and delivery hose lines shall be of adequate capacity and size to provide a minimum pressure 35 psi at the nozzle for 1-inch nozzles and proportionally greater for larger nozzles. The velocity of the material as it leaves the nozzle must be maintained uniform at rate determined for the given job conditions to produce minimum rebound.

Water that is added at the nozzle shall be supplied at a uniform pressure of not less than 15 psi greater than the air pressure at the nozzle.

The concrete shall be applied as dry as practicable to prevent shrinkage cracking. Shooting strips shall be employed to ensure square corners, straight lines, and a plane surface of concrete, except as otherwise permitted by the Plans or approved by the Engineer.

When applying concrete to surfaces, the stream of flowing material from the nozzle shall be directed as nearly as possible at right angles to the surface being covered, and the nozzle shall be held from 2 to 4 feet from the working surface.

A sufficient number of concrete coats shall be applied to obtain the required thickness. On vertical and overhead surfaces, the thickness of each coat shall be not greater than 1-1/2 inch, except as approved by the Engineer.

Rebound or accumulated loose sand shall be removed from the surface to be covered prior to placing of the original or succeeding layers of concrete and shall not be embedded in the Work.

Material that has been mixed for more than forty-five (45) minutes and has not been incorporated in the Work shall not be used, unless otherwise permitted by the Engineer.

When texturing is required, the repaired area shall be roughened by tools such as a stone cutter knife, chisel point, wooden mallet, geologist's pick hammer, brick hammer and sandblast to match the surrounding surface.

Pneumatically placed concrete shall be water cured in conformance with the requirements of item 703.19, CURING CONCRETE STRUCTURES. The minimum water curing duration shall be ninety-six (96) hours. The concrete shall be protected from freezing during the curing period. Materials for the pneumatically applied concrete at the underside of concrete structures shall have manufacturer's recommended curing characteristics that allow for placement and curing procedures to be performed within the time period permitted for closure of traffic. If approved by the engineer curing compound meeting the requirements of ASTM C 309 Type 2 Class A on surfaces not exposed to view in the complete work. Use Type 1 D with a fugitive dye curing compound on other surfaces. The rate of application shall not be less than 1 gallon of curing compound per 100 square feet of surface.

- E. PRECONSTRUCTION TESTING** - Shall conform to item G. and with at least 4 of the test panels containing steel reinforcement representative of that which will be used on the Project.
- F. TEST PANELS** - Compressive strength tests, 1 test panel shall be prepared for each day's production or for each 200 square feet of shotcreting. The panels shall be 36 inches square and 6 inch deep with a smooth bottom. Core each test panel as directed by the Engineer and deliver the cores to the Department Laboratory for testing. Cores shall have a diameter of at least 4 inches and be at least 6 inches long. 3 cores will be tested at seven (7) and twenty-eight (28) days. Core strength will be corrected in accordance with AASHTO T 24.
- G. FIELD TRIALS FOR HISTORIC STRUCTURES** – Field trials may be required when repairing the exterior surfaces of historic structures. Prior to application of pneumatically applied concrete on the repair areas of the Bridge, the Contractor shall apply the approved mix to at least 3 horizontally overhead and 3 vertical test panels to simulate repair of the different colors and textures encountered on the Structure. The test panels shall not be less than 36 inches square by 6 inches thick. The mix and colors for this Work shall be approved by the Engineer prior to the field trial. The Contractor shall submit field trial procedures for the Engineer to review before constructing the test panels. The field trial work shall be performed in the presence of the Engineer by the workers who will be performing the actual repairs. Texturing shall be performed on the test panel by applicable tools. Concrete cylinders shall be taken for each mix for strength testing.

Upon completion of the field trial, the panels shall be cured and submitted for approval of colors and textures. If the color, texture or strength of the panels is not to the satisfaction of the Engineer, another field trial shall be performed. The application of pneumatically applied concrete shall not proceed until the Engineer approves the cured panels produced in the field trial. The method of actual application on the Bridge shall be the same as the methods used for the approved field trial. Failure to provide field trial panels acceptable to the Engineer may be grounds for disqualification of the exterior concrete repair Contractor. After approval of the test panels, the Contractor shall retain them at the Project Site in a secure location for comparison with work on the Structure.

- H. MEASURE AND PAYMENT** - The unit of measure will be the square foot. Payment for PNEUMATICALLY APPLIED CONCRETE REPAIR will be made at the Contract unit price per square foot, which payment will include furnishing all materials, labor, tools, equipment and incidentals needed to accomplish the Work specified.

**717 ARMORED JOINT WITH NEOPRENE STRIP SEAL****717.01 DESCRIPTION**

Work consists of furnishing and erecting at various locations an armored joint with neoprene strip seal, including neoprene extrusions, steel angles, plates, extrusions, anchor studs, and fasteners as shown on the Plans, as specified herein, and in accordance with the recommendations of the manufacturer.

**717.02 MATERIALS**

Materials shall conform to the following requirements:

- AASHTO M 270, Grade 36 (ASTM A 709): Steel Shapes, Plates
- AASHTO M 270, Grade 36 (ASTM A 709): Steel Extrusions
- AASHTO M 225 (ASTM A 496): Deformed Bar Anchor
- Anchor Studs - ASTM A 108
- 815.01(D): High Strength Bolts
- Adhesive See Below
- Neoprene Strip Seal – The strip seal gland shall be preformed and manufactured from a vulcanized elastomeric compound using polychloroprene as the only base polymer, meet the requirements of ASTM D 2628 and have physical properties described in Table 717.02.
- Adhesive – The adhesive lubricant used to install the strip seal gland into the steel extrusion shall be a 1 part moisture curing polyurethane compound meeting the requirements of ASTM D 4070.

**TABLE 717.02 PROPERTY AND REQUIREMENTS**

<b>PROPERTY</b>	<b>ASTM TEST</b>	<b>REQUIREMENTS</b>
Tensile strength	D 412	2,000 psi min
Elongation at break	D 412	250 % min
Hardness, Type A durometer	D 2240 (modified)	60 +/- 5
Compression set, 70 hr. at 212°F, maximum	D 395 Method B (as modified)	40 %
Tensile strength loss; After oven aging (70 hr at 212°F) per ASTM D 573	D 412	20 % max.
Elongation, loss; Oven aging, After oven aging (70 hr at 212°F) per ASTM D 573	D 412	20 % max.
Hardness, type A durometer points change; After oven aging (70 hr at 212°F) per ASTM D 573	D 2240 (modified)	0 to + 10
Oil swell, ASTM oil No. 3; 70 hrs at 212° F weight change	D 471	45% max
Ozone resistance 20 percent strain, 300 pphm, in air at 104°F (wiped with toluene to remove contamination)	D 1149 (modified)	No cracks
Low temperature stiffening; 7 days at 14° F (-10° C) hardness, type A Durometer points change	D 2240 (modified)	0 to +15

**717.03 SHOP DRAWINGS**

The Contractor shall verify all dimensions to insure the accuracy of the joint prior to fabrication. Required Shop Drawings shall show the entire joint layout, with field splices of the extrusion and be submitted for approval prior to fabrication. Included shall be the type, location and details of the mechanical devices required to compress the joint to its required width based on the ambient temperature at the time of erection.

**717.04 FABRICATION**

The armored joint with neoprene strip seal shall be shop assembled and delivered to the job Site ready for installation. The neoprene extrusion shall run continuously through the full width of the joint, including concrete barriers and s. No splices will be permitted in the neoprene seal. Splices of steel extrusions shall develop the full strength of the extrusion. Structural steel shall be fabricated per 706. All metal portions of the expansion joints not in direct contact with the neoprene strip seal shall be shop painted per 707.

**717.05 CONSTRUCTION REQUIREMENTS**

Immediately prior to installation, the neoprene strip seal shall be examined to insure that the seal is fully inserted in the recess. After the armored joint has been set to its proper line and grade and securely attached, all the temporary mechanical devices shall be removed and become the property of the Contractor. During stage construction, installed portions of the steel extrusion shall be protected from traffic and construction activity to the satisfaction of the Engineer. Splices of the extrusions shall develop the full strength of the member.

After the armored joint has been erected and after all adjacent concrete has been placed, the joint shall be cleaned and painted in conformance with 707 for new metalwork.

**717.06 MEASURE AND PAYMENT**

The unit of measure for Armored Joint with Neoprene Strip Seal will be the linear foot along the center line of the joint, complete and in place.

Armored Joint with Neoprene Strip Seal will be paid at the Contract unit price per linear foot, which payment will include painting and all labor, materials, tools, equipment and incidentals including steel angles, high-strength bolts, anchor studs, necessary to complete the Work as specified herein.



## 718 NEOPRENE COMPRESSION SEAL

### 718.01 DESCRIPTION

Work consists of furnishing and installing neoprene compression seals to be used on joints where shown in the Contract Documents.

### 718.02 MATERIALS

The neoprene compression seal shape shall be the angled, webbed design as shown on Plans and shall have the physical properties as per Section 807.06.

Adhesive – The lubricant-adhesive used when installing the preformed joint seals shall be as recommended by the seal manufacturer, and shall be a compound consisting of the same base polymer as the seals, blended with suitable volatile solvents. It shall have suitable consistency at the temperature at which the seals are to be installed, shall be compatible with the seals and the concrete, and shall be relatively unaffected by the normal moisture in the concrete.

The lubricant-adhesive shall be delivered in containers plainly marked with the manufacturer's name or trademark, lot number and date of manufacture.

### 718.03 CONSTRUCTION REQUIREMENTS

The temperature at the time of joint construction determines the width of the working joint. The Contractor shall form the joint allowing for temperature variations found on the drawing or as directed by the Engineer.

The seal size for all joints shall be approved by the Engineer and shall be suitable for the joint movement caused by thermal expansion and contraction.

Joint preparation shall be as shown on the Contract Drawings and shall otherwise conform to the manufacturer's recommendations. All surfaces to receive the compression seal shall be free from dirt, water, oil, rust, frost and any other loose foreign debris which may be detrimental to effective joint sealing. All joints to receive the compression seal shall be free from defects such as spalls, cracks or loose materials. The joint sides shall be constructed straight and parallel to each other to the proper width and depth as shown on the Plans.

For ease of installation, the air temperature should be below 85 degrees Fahrenheit. A continuous coat of adhesive shall be applied to both joint interfaces immediately prior to seal installation. The adhesive shall not be applied below 40 degrees Fahrenheit. Unless otherwise specified, the seal shall be recessed 1/8 inch to 1/4 inch below the surface depending on seal size application and as directed by the Engineer.

### 718.04 MEASURE AND PAYMENT

The unit of measure for Neoprene Compression Seal will be the linear foot, complete and in place.

Neoprene Compression Seal will be paid at the Contract unit price per linear foot, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## 719 FINGER PLATE EXPANSION DEVICE

### 719.01 DESCRIPTION

Furnishing and installing finger plate expansion devices as designed and shown in the Contract Documents.

### 719.02 MATERIALS

Provide fabric troughs for finger plate expansion devices that comply with Section 820.

### 719.03 CONSTRUCTION REQUIREMENTS

- A. GENERAL** - The Contractor shall prepare and submit Shop Drawings and coordinate the fabrication of the joint assemblies.

Submit Shop Drawings, for each location, type and model of expansion device used, according to the Shop Drawings.

Do not perform any fabrication until the Shop Drawings are approved and the Engineer has authorized the fabrication.

Any purchase of materials before fabrication and authorization is at the Contractor's risk. Changes to approved Shop Drawings are subject to the approval of the Engineer. Hot-dip galvanized steel components of finger plate expansion devices, except support angles and finger plates, which shall be shop painted.

Galvanize according to ASTM A 123.

Prepare steel surfaces and apply inorganic zinc according to Section 707, except provide a nominal dry film thickness of 3 mils.

The Contractor is responsible for coordinating the fabricator of the expansion device with the fabricator of the structural steel members for the Bridge superstructure.

- B.** Place alignment marks on the anchor plates and finger plates on each side of the expansion gap to facilitate accurate installation.

Align the finger joint assemblies in position and check the expansion opening. The expansion opening must be adjusted for temperature prior to bolting, welding or placing concrete on each side of the joint. To adjust for the effects of sunlight on the girders, place reference marks on the Bridge prior to sunrise. Use these reference marks to set the expansion opening using the Plans and the average ambient temperature over the previous twenty-four (24) hours.

Test fit the finger plates with all the armoring and anchorages in place. Install the finger joint centered over the expansion gap, in line and slope as per the plan, and make sure the fingers do not rub during the full range of temperature movements.

The Engineer will confirm the procedure, opening and alignment prior to concrete placement. After confirmation, remove the finger plates before concreting. Place concrete around the joint and vibrate so the concrete paste comes up through the air vents and no voids exist under the anchor unit. Start concrete placement at the low end of the joint and work toward the high end. If the Bridge has a normal crown, start at the edge and work toward the center from both sides.

Three (3) days after concrete placement, the Engineer will check for voids and loose bolts by sounding anchor plate. Fill any voids by drilling through the anchor plate and pumping in an approved epoxy mortar at a minimum pressure of 75 psi. This Work will be subsidiary to the Bid Item "Finger Plate Expansion Device".

Install the fabric trough and the finger plates according to the Contract Documents.

Thoroughly clean the top of the anchor plates to remove dried concrete paste before final assembly. Lubricate anchor bolts with bee's wax or equivalent and torque the nut according to Table 719.03.

**TABLE 719.03 FINGER PLATE TORQUES (FT-LBS.)**

Size (inches)	7/8	15/16	1	1 1/8
Type I	176	218	264	387
Type II	277	342	415	608

After installation of the finger plates, the Engineer will inspect the plates for alignment. Any finger joints that the Engineer determines are misaligned shall be ground as directed by the Engineer. This Work will be subsidiary to the Bid Item "Finger Plate Expansion Device".

Install fabric troughs below the finger plate; clean the trough of all foreign material after the completion of all bridge superstructure Work.

**719.04 MEASURE AND PAYMENT**

The unit of measure for Finger Plate Expansion Device will be the linear foot, along the centerline of the expansion joint complete and in place. Finger Plate Expansion Device will be paid at the Contract unit price per linear foot, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the Work as specified herein.

## **720 PROTECTION SHIELD**

### **720.01 DESCRIPTION**

Work shall consist of designing, furnishing, installing, relocating, maintaining, removing and disposing of a temporary protection shield along the length of the Bridge. The shield shall be sized and designed to provide a floor sufficiently sturdy and tight to prevent equipment and materials of demolition and construction from falling through the shield and upon any portion of the area under the Structure and the immediate vicinity. Care must be taken to ensure the safety of motorists, pedestrians, bicyclists and others who may be in the area under or adjacent to a structure. Required minimum horizontal and vertical clearances, as indicated in the Contract Documents, must be maintained.

The design, construction and maintenance of protection shields shall meet the requirements of 703.16, Falsework and Centering.

### **720.02 SHOP DRAWINGS**

The shield shall be designed by a registered Professional Engineer and drawings shall bear his/her registration seal. Approval of said drawings shall be obtained from the District prior to commencing construction of the shield. Plans (including Shop Drawings and calculations) for the protection shield shall be submitted to the Engineer for approval prior to start of demolition. This approval does not relieve the Contractor from the responsibility for the structural adequacy of the installation. Demolition shall not begin until the protection shield is completely erected and approved by the Engineer.

Care shall be taken to ensure the safety of the traveling public using any Roadways, railroads, pedestrian/bicyclist/horse trails that may pass beneath the Structure.

### **720.03 CONSTRUCTION REQUIREMENTS**

The protection shield shall be installed prior to start of any demolition and/or construction operations. The limits of the protection shield shall be equal to the full length of the superstructure, that is from back wall to back wall of abutments and shall cover all spans simultaneously, unless specifically exempted by the Contract Documents. The shield shall extend transversely at least 5 feet beyond the limits of construction for each particular phase, shall have barricades extending from the underside of the shield to an elevation of 6 feet above the floor of the shield and shall provide a minimum vertical clearance of 12 feet-6 inches, or as indicated in the Contract Documents.

The floor of the protection shield shall be constructed to support a uniform live load of 85 pounds per square foot, or equivalent to the weight of the existing deck slab if that is larger. The side barriers shall be designed to resist a wind force of 50 pounds per square foot.

The protection shield may be installed and used in stages, if approved by the Engineer. However, any portion of the Structure where demolition and/or construction operations are taking place shall have a protection shield installed prior to the start of any Work.

### **720.04 MAINTENANCE**

The protection shield shall be inspected daily and shall be cleaned at the end of each working day. Regular maintenance shall be performed to ensure the structural adequacy of the installation and the ability of the flooring to retain construction debris.

### **720.05 MEASURE AND PAYMENT**

The unit of measure for Protection Shield will be lump sum. No direct measure will be made. Payment will be made at the Contract lump sum price which payment will include the cost of design, Shop Drawings, fabrication, erection, staging, maintenance, dismantling, disposal and all labor tools, materials, equipment and incidentals needed to complete the Work as specified.

## **DIVISION 800 MATERIALS**

<b>801</b>	<b>HYDRAULIC CEMENT/CEMENTIOUS MATERIALS</b>	<b>599</b>
801.01	PORTLAND CEMENT	599
801.02	MASONRY CEMENT	599
801.03	BLENDED HYDRAULIC CEMENT	599
801.04	GRANULATED IRON BLAST FURNACE SLAG	599
801.05	FLY ASH USED IN PORTLAND CEMENT CONCRETE	599
<b>802</b>	<b>BITUMINOUS MATERIALS</b>	<b>600</b>
802.01	GENERAL	600
802.02	PERFORMANCE GRADED ASPHALT	600
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**801 HYDRAULIC CEMENT/CEMENTIOUS MATERIALS****801.01 PORTLAND CEMENT**

- A. GENERAL** - Unless specified otherwise, Portland Cement shall be as specified in 801.01(B), except that for sewer and water work, Portland Cement shall be as specified in 801.01(C). The cement may be accepted on the basis of a manufacturer's certification furnished in accordance with the requirements of 106.13.

The temperature of the cement at time of delivery to the mixer shall not exceed 160°F. Different brands of cement, the same brand of cement from different sources, or cements for which the chemical analysis indicates them to be of different types shall not be mixed for use on a project. Different brands of cement or the same brand of cement from different sources may be used alternately on a project only in case of an emergency and with the specific approval of the Engineer.

For Portland Cement used in concrete with aggregates that are deleteriously reactive, the alkaline content of the Portland Cement shall not exceed 0.60 percent as described in optional requirements of AASHTO M 85.

- B. STANDARD PORTLAND CEMENT** - Standard Portland Cement shall meet the requirements of AASHTO M 85, Type I.
- C. MODERATE HEAT OF HYDRATION PORTLAND CEMENT** - Moderate heat of hydration Portland Cement for sewer and water work shall meet the requirements of AASHTO M 85, Type II.
- D. HIGH EARLY STRENGTH PORTLAND CEMENT** - High early strength Portland Cement shall meet the requirements of AASHTO M 85, Type III.
- E. WHITE PORTLAND CEMENT** - Portland Cement for white Portland Cement Concrete shall meet the requirements of AASHTO M 85, Type I, except that the cement shall contain no more than ½ percent of Ferric Oxide (Fe<sub>2</sub>O<sub>3</sub>) by weight.

**801.02 MASONRY CEMENT**

Masonry cement shall meet the requirements of ASTM C 91, Type M unless otherwise specified.

Masonry cement may be accepted on the basis of a manufacturer's certification furnished in accordance with the requirements of Masonry Cement Mill Certification available from the Engineer of Materials and Research. Different brands of cement or the same brand of cement from different sources may be used alternately on a project in the case of emergency and with the approval of the Engineer.

**801.03 BLENDED HYDRAULIC CEMENT**

Blended hydraulic cement shall conform to AASHTO M 240 for Type IS or IP. A manufacturer's certification shall be furnished indicating the source, amount, and composition of the blended cement, and indicate that the material was tested during production or transfer in accordance with this specification, and a report of the test results shall be furnished at the time of shipment.

**801.04 GRANULATED IRON BLAST FURNACE SLAG**

Granulated slag, when used as a substitute for Portland Cement, shall conform to the requirements of ASTM C 989, Grade 120 or Grade 100. When blended with Portland Cement, the blend shall meet the requirements of 801.03, AASHTO M 240, Type 1S. Certification requirements of ASTM C 989 apply.

**801.05 FLY ASH USED IN PORTLAND CEMENT CONCRETE**

Fly ash used in Portland Cement Concrete shall meet the requirements of AASHTO M 295, Class C or Class F, except that the maximum loss in ignition for Class C and Class F shall be 4.0 percent. The supplemental requirements of Table 2A shall apply when required by the Engineer. When blended with Portland Cement, the blend shall meet the requirements of 801.03, and AASHTO M 240, Type 1P.

Written certification is required that all pozzolan meets these Specifications for physical and chemical requirements.

## 802 BITUMINOUS MATERIALS

### 802.01 GENERAL

In accordance with the quality control plan of the manufacturer and as approved by the Department QA/QC Division, each delivery of bituminous material shall be accompanied by a copy of recently (not more than four (4) weeks) certified results of test on the material being delivered and a statement as to the type and amount of material contained in each carrier and the identification of the storage tanks from which the material is being delivered. This statement shall be presented to the Engineer or his representative upon delivery.

### 802.02 PERFORMANCE GRADED ASPHALT

**A. PERFORMANCE GRADED ASPHALT BINDER** - Mixes containing all virgin materials shall conform to AASHTO M 320, Table 1. The asphalt binder recovered from the final Plant mixed material will be considered Rolling Thin Film Oven (RTFO) material and shall conform to AASHTO M 320 for the specified performance grade.

The PG binder shall be pre-approved by the Department.

The Contractor shall submit a certificate of analysis showing conformance with the PG Binder Specification AASHTO M 320.

The PG binder for HMA mixes shall be achieved by the use of neat asphalt with elastomer polymer modifications when needed.

**TABLE 802.02 ASPHALT BINDERS**

Functional Classification of Streets	Asphalt Binder
Interstate	P.G. 70-22
Other Freeways and Expressways	P.G. 70-22
Principal Arterials	P.G. 70-22
Minor Arterials	P.G. 64-22
Collectors	P.G. 64-22
Local Streets	P.G. 64-22

**B. CERTIFICATION** - The manufacturer and hauler shall furnish as specified.

The manufacturer shall also certify:

1. Date and time of loading
2. Tank or blending system
3. Identification of hauling unit
4. Binder grade, temperature and quantity of materials
5. Complete certified analysis
6. Lot number, if applicable
7. Mixing and compaction temperatures when the binder is polymer modified.

The hauler shall also certify:

1. Identification of hauling unit
2. Binder grade and source of last delivery
3. The date of last delivery using this hauling tank and volume of material remaining in the tank at the time of current loading.

**C. PERFORMANCE GRADED ASPHALT MATERIAL FOR PARTIAL RE- CYCLING** - As specified by the Engineer.

**802.03 CUT-BACK ASPHALT**

Unless otherwise specified, cut-back asphalt shall meet the requirements of AASHTO M 82 for the Type and Grade specified.

**802.04 EMULSIFIED ASPHALT**

Emulsified asphalt for securing mulch shall meet the requirements of AASHTO M 140, SS-1 or AASHTO M 208 for the Type and Grade specified.

Emulsified asphalt to be used as tack coat shall meet the requirements of AASHTO M 140, Grades SS-1, SS-1h, or as specified.

**802.05 BITUMINOUS MATERIALS FOR WATERPROOFING**

- A. ASPHALT PRIMER FOR WATERPROOFING** - Asphalt primer for waterproofing shall meet the requirements of ASTM D 41.
- B. ASPHALT SEAL FOR WATERPROOFING** - Asphalt seal for waterproofing shall meet the requirements of ASTM D 449.
- C. TAR PRIMER FOR WATERPROOFING AND COAL TAR PITCH SEAL FOR WATERPROOFING** - Tar products are not approved for use in public space.
- D. WATERPROOFING MEMBRANE** - Waterproofing membrane for Bridge decks shall conform to ASTM D 6153.

**802.06 SOFTENING AGENT**

Softening agents used to reconstitute the bitumen of recycled asphaltic concrete shall be asphalt cement or a modifying agent and shall conform to these specification requirements.

**802.07 LIQUID ANTI STRIP ADDITIVE**

The Engineer shall determine the compatibility of the asphalt, aggregates, and liquid anti strip additive proposed for use in accordance with 818.02 and AASHTO R 15. Liquid anti strip additives shall be introduced at the refinery or at the Plant by line blending, metering or other measuring to assure accurate proportioning and thorough mixing.

**802.08 EMULSIFIED ASPHALT FOR CONCRETE VAULTS**

Emulsified asphalt used as a protective coating and moisture barrier for cast-in-place and precast concrete vaults, shall meet the requirements of AASHTO M 140.

**802.09 ASPHALT FOR PERMEABLE BASE**

Asphalt for Permeable Base shall conform to AASHTO M 320 for PG Binder 76-22.

## 803 AGGREGATES

### 803.01 FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

Fine aggregates for Portland Cement Concrete (other than lightweight aggregate) shall meet the size and quality requirements of AASHTO M 6 as modified herein. The weighted loss shall not exceed 15 percent by weight when the fine aggregate is subjected to 5 cycles of the magnesium sulfate soundness test, as per AASHTO T 104.

To determine the degree of uniformity of the fine aggregate, fineness modulus (FM) determinations shall be made on representative samples from each source. Thereafter, if the fineness modulus varies by more than 0.20 from the value established on representative samples, the fine aggregate shall be rejected until suitable adjustments are made in the concrete proportions to compensate for the difference in grading.

Alkaline reactivity of fine aggregate shall be tested in accordance with AASHTO M 6. Fine aggregate capable of producing a deleterious reaction when combined with Portland Cement shall not be used in Portland Cement Concrete.

The amount of deleterious substances shall meet the requirements of AASHTO M 6, Class A. Chert, metaquartzite, or a combination of both shall not exceed 8 percent by weight per ASTM C 295.

Organic impurities shall produce a color not darker than Organic Plate No. 2 per AASHTO T 21 or ASTM C 40.

Fine aggregate for Portland Cement Concrete shall be well graded from coarse to fine and shall conform to the requirements of AASHTO M 6.

### 803.02 COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

Coarse aggregate for Portland Cement Concrete, (other than light-weight aggregates) shall consist of gravel, crushed gravel, crushed stone, crushed air-cooled blast furnace slag, crushed trap rock, or other approved inert materials of similar characteristics, or a combination thereof as specified, and shall meet the quality requirements of AASHTO M 80, and shall meet the size requirements of AASHTO T 96.

The percentage of wear as determined by the Los Angeles Abrasion Test shall not exceed 40, as per AASHTO T 96. The weighted percentage of loss shall not exceed 15 percent by weight when the coarse aggregate is subjected to 5 cycles of the magnesium sulfate soundness test per AASHTO T 104.

The amount of deleterious substance shall meet the requirements of AASHTO M 6, Class A.

Chert, metaquartzite or a combination of both shall not exceed 3 percent by weight per ASTM C 295.

For alkali-carbonate reactive constituents, test specimen shall not exceed 0.08 percent expansion after sixteen (16) days in accordance with ASTM C 1260 and ASTM C 1567.

Organic impurities shall produce a color not darker than Organic Plate No. 1 per AASHTO T 21 or ASTM C 40.

After first dry sieving on the No. 200 sieve in accordance with AASHTO T 27, the adherent coating on coarse aggregate as tested in accordance with AASHTO T 11, with a wetting agent added to the wash water, shall not exceed 1 percent by weight.

### 803.03 FINE AGGREGATE FOR BITUMINOUS CONCRETE

**A. FOR HOT ASPHALTIC CONCRETE PAVEMENT** - Fine aggregate for hot asphaltic concrete pavement shall meet the general requirements of AASHTO M 29. The gradation of the fine aggregate or a combination of fine aggregates shall be such that, when combined with the other mix ingredients, it will produce the specified bituminous paving mixture. Each of the fine aggregates, when subjected to 5 cycles of the magnesium sulfate soundness test, shall have a weighted loss of not more than 20 percent.

Each individual ingredient or source of material combined to be fine aggregate, and the fine aggregate as a whole shall contain no clay lumps and shall be non plastic.

**B. STONE-FILLED SHEET ASPHALT FOR JOINT REPAIR** - Fine aggregates for stone-filled sheet asphalt surface shall meet the quality requirements of 803.03(A). The gradation of the fine aggregates or combination of fine aggregates shall be such that it will produce the specified bituminous mixture properties when combined with other mixed ingredients. The combined fine aggregates shall consist of not less than 40 percent by weight of crushed stones Grade No. 10 from an approved source containing

from 8 to 15 percent fines passing the No. 200 sieve. The fine siliceous natural sand shall meet the gradation requirements for mortar sand per 803.06(A) except that the quantity passing the No. 200 sieve shall not exceed 6 percent.

**803.04 COARSE AGGREGATE FOR BITUMINOUS CONCRETE**

Crushed stone or graded aggregate supplied from a quarry producing aggregates of asbestos bearing content or having asbestos present at the quarry are prohibited. Should such aggregates be utilized, both the Contractor and the stone supplier will be directed to remove all asbestos bearing aggregates and replace them with non asbestos bearing aggregates. The Contractor and supplier shall further be liable for any and all consequential damages which may result as a violation of this requirement.

- A. **GENERAL** - Coarse aggregate for use in bituminous mixtures shall be crushed stone. Coarse aggregate for surface course shall be non-polishing rock. The portion of the total aggregate passing the No. 4 sieve shall have a sand equivalent value of not less than 35 when tested in accordance with AASHTO T 176. The portion of aggregate retained on the 9.5 mm (3/8 inch) sieve shall not contain more than 15 percent of particles by weight so flat or elongated, or both, that the ratio between the maximum and the minimum dimensions of a circumscribing rectangular prism exceeds 5:1. Coarse aggregate for bituminous concrete shall conform to the following:

**TABLE 803.04 COARSE AGGREGATE SPECIFICATIONS**

Abrasion by Use of Los Angeles Machine Percentage of Wear, maximum	40
Soundness, Weighted Average, Percent Loss, Maximum, 5 cycles, Magnesium Sulfate	15
Total Material finer than No. 200 sieve (AASHTO T 11), maximum percent by weight	
Material which contains clay or shale	1.0
Material free of clay or shale	1.5

After first dry sieving on the No. 200 sieve in accordance with AASHTO T 27, the adherent coating on coarse aggregate as tested in accordance with AASHTO T 11 shall not exceed 1 percent.

- B. **COARSE AGGREGATE FOR BITUMINOUS SURFACE COURSES** - Coarse aggregate for bituminous Surface Courses shall conform to the quality requirements of 803.04(A) and aggregates containing a substantial portion of serpentine or talc minerals or carbonate aggregates containing less than 25 percent by weight insoluble residue, as determined by in sizes No. 200 to No. 10, shall not be used in surface course mixes. Shale and other material susceptible of polish shall not be used.
- C. **COARSE AGGREGATE FOR BITUMINOUS BASE AND BINDER COURSES** - Coarse aggregate for bituminous base and binder courses shall conform to the quality requirements of 803.04(A).

**803.05 MINERAL FILLER FOR BITUMINOUS CONCRETE**

Mineral filler shall be limestone dust, hydrated lime or Portland Cement meeting the requirements of ASTM D 242.

Fly ash shall not be used as mineral filler unless approved by the Engineer. The mineral filler shall be uniformly graded, non plastic, free from lumps or balls or any foreign materials and shall have a moisture content of not more than 0.5 percent when incorporated into the bituminous mixture.

Mineral filler shall be graded within the following limits:

**TABLE 803.05 MINERAL FILTER GRADES**

Sieve Designation	Percent Passing By Weight
No. 16	100
No. 30	97-100
No. 50	95-100
No. 200	70-100

**803.06 FINE AGGREGATE FOR MASONRY MORTAR**

- A. Fine aggregate shall meet the requirements of AASHTO M 45.
- B. Fine aggregate for mortar bond test behind ceramic wall tile shall be standard Ottawa sand passing the No. 20 sieve and retained on the No. 30 sieve.
- C. **SAND** - Sand for use in ceramic tile mortar for scratch and float coat shall be clean washed sand and shall be composed of hard, strong, durable, clean grains, free from soft or flaky particles, shale, foam, alkali, organic matter, and other deleterious substances. It shall contain not more than 3 percent of silt by weight as determined by decantation. Sand subjected to the colorimetric test for organic impurities and producing a color darker than the standard (Organic Plate No. 3) sand shall be rejected. Sand shall be uniformly graded from coarse to fine within the following limits and in addition shall have a fineness modulus of not less than 1.90 nor more than 2.50:

**TABLE 803.06 FINE AGGREGATE SIEVE DESIGNATIONS**

Sieve Designation	Percent Passing By Weight
No. 4	100
No. 8	95-100
No. 16	65-90
No. 30	45-75
No. 50	10-35
No. 200	0-10

**803.07 LIGHTWEIGHT AGGREGATE FOR STRUCTURAL CONCRETE**

Lightweight aggregate for structural concrete shall meet the quality requirements of AASHTO M 195.

Lightweight fine aggregate shall meet the grading requirements of AASHTO M 195, Grading No. 4 to 0.

Lightweight coarse aggregate shall meet the grading requirements of AASHTO M 195, Grading No. 3/4 inch to No. 4.

The absorption value of coarse aggregate shall not exceed 10 percent in twenty-four (24) hours.

**803.08 AGGREGATE FOR SLURRY SEAL**

Aggregate for slurry seal shall meet the quality requirements of 803.03(A). When combined with mineral filler, the mineral aggregate mix shall meet the following gradation:

**TABLE 803.08 AGGREGATE FOR SLURRY SEAL SIEVE DESIGNATIONS**

Sieve Designation	Percent Passing By Weight
3/8 inch	100
No. 4	85-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15



**803.09 AGGREGATE FOR RIPRAP**

Aggregate for riprap shall be field or quarry stone of approved quality and may be certified from a source previously approved. Maximum dimension shall not exceed 4 times the minimum dimension. Stone or grade aggregate from a quarry producing aggregate of asbestos content or having asbestos present at the quarry are prohibited.

Stone for riprap shall be uniformly graded from the smallest to the largest pieces as specified on the Contract Drawings. The stone will be accepted upon visual inspection at the point of usage, and shall conform to the following;

**TABLE 803.09 (A) RIPRAP SIZE AND PERCENTAGE**

<b>Class of RIPRAP</b>	<b>Size</b>	<b>Percent of Total (by weight)</b>
0	Heavier than 33 lbs	0
	Heavier than 10 lbs	50
	Less than 1 lbs	10 max
I	Heavier than 150 lbs	0
	Heavier than 40 lbs	50
	Less than 2 lbs	10 max
II	Heavier than 700 lbs	0
	Heavier than 200 lbs	50
	Less than 20 lbs	10 max
III	Heavier than 2000 lbs	0
	Heavier than 600 lbs	50
	Less than 40 lbs	10 max

Note: Optimum grading is 50 percent of stone being above and 50 percent below the midsize. Reasonable Visual Tolerances will apply.

## 804 AGGREGATES FOR SOILS AND BASE COURSE CONSTRUCTION

### 804.01 GENERAL

Samples of excavated trench and embankment material, borrow fill material for trenches and embankments, and subgrade gravel shall be submitted by the Contractor to the Engineer with test results. Soils shall be free from snow, ice, frozen materials, trash, brick, clay lumps, broken concrete, tree roots, sod, ashes, cinder, glass, plaster, vegetable matter and any other foreign matter.

The Engineer will approve or disapprove the material based on the test results submitted or have analyses made on excavated material prior to use of excavated material as backfill. For excavated trench material, a minimum of 1 analysis will be made for each 500 feet of trench.

Sampling will be performed in accordance with AASHTO T 2; the sample shall be prepared in accordance with AASHTO T 27 and AASHTO T 88; the percentage of wear shall be determined in accordance with AASHTO T 96. The liquid limit shall be determined in accordance with AASHTO T 89; and the plasticity index shall be determined in accordance with AASHTO T 90.

### 804.02 EMBANKMENT BACKFILL

Material used in embankments shall meet the following Specifications and may be rejected on visual inspection pending the testing of representative samples. No gravel or stone shall be larger than 3 inches in any dimension. The material shall have at least 10 percent, but not more than 35 percent, by weight, passing the No. 200 sieve. The soil shall have a liquid limit of not greater than 40 and a plasticity index of 6 to 15 inclusive. In confined embankment areas, the minimum plasticity index need not apply. Compaction of materials for embankment fill shall meet the density requirements per 203.03.

### 804.03 BLANKET SOIL

Blanket material shall consist largely of clays or mixtures of silts and clays that when compacted will present a relatively impervious surface to prevent the entrance of water. In no case shall it be principally composed of sands or coarser material. Liquid limit shall be a minimum of 50 and plasticity index shall be a minimum of 20. Permeability shall be a minimum of  $10^{-6}$  cm/sec.

### 804.04 BASE COURSE AND/OR STRUCTURAL BACKFILL

Material approved for use as a base course shall have a minimum CBR of 75 (AASHTO T 193) when prepared in accordance with AASHTO T 180 Method D.

- A. CRUSHED STONE BASE** - Crushed aggregate shall consist of crushed stone having hard, strong, durable particles, and conforming to the applicable requirements of AASHTO M 147 for Bases.

Additional fine aggregate shall consist of material of the same type and quality as specified above for the coarse aggregate. The use of soil fines or natural sands will not be permitted.

The coarse aggregate and additional fine aggregate shall be so proportioned as to produce a final mixture meeting the following gradation requirements, including the tolerances:

**TABLE 804.04 (A) GRADATION REQUIREMENTS FOR COARSE AGGREGATE**

Sieve Designation	Percent Passing by Weight	Job Mix Tolerances (Percent Passing by Weight)
2 inch	100	-2
1-1/2 inch	95-100	± 5
3/4 inch	70-92	± 8
3/8 inch	50-70	± 8
No. 4	35-55	± 8
No. 30	12-25	± 5
No. 200	0-8	± 3

- B. RECYCLED CRUSHED CONCRETE FOR BASE** - Recycled crushed concrete may be used as a base course for sidewalks, trench backfill, multi-use trails, roadway embankments, and Portland Cement Concrete (PCC) pavement. When used under PCC pavements as a base material it must be used at least 2 feet above saturated soil or ground water condition and at least 3 feet from

geotextiles. Recycled crushed concrete shall not be used as a base under pervious concrete or porous concrete surface, flexible pavements; and as backfill behind Mechanically Stabilized Earth (MSE) Systems and reinforced earth slopes.

All recycled crushed concrete for use as a base material may require testing and certification to ensure compliance with all applicable local and EPA regulations. Therefore, in order to use it as a base material, recycled crushed concrete must be sampled, tested, and maintained. A captive stockpile must be created for storing recycled crushed concrete prior to use. Acceptance samples for the captive stockpile must be sampled and tested for approval whenever the source of the crushed concrete changes. The required testing may include, but not be limited to the EPA Toxicity Characteristic Leaching Procedure (TCLP) or its successor. At a minimum the producer is required to test pH at the Plant per AASHTO T 289 every 1000 tons shipped. pH shall be less than 12.4 for all applications.

Testing and certification for all recycled materials must be provided at no additional cost to DDOT. These requirements do not preclude the normal materials acceptance process, thus recycled crushed concrete shall meet all applicable Specifications. EPA regulations governing the use of the material, certified test results, and material safety data sheets shall accompany the source of supply letter and sample submitted for approval.

Materials of this type for use in base course shall meet the following specification requirements.

The combined aggregate for this use shall consist of crushed concrete or mortar, crushed stone, and crushed or uncrushed sand and gravel. Materials that break up under alternate freezing and thawing or wetting and drying shall not be used.

Coarse aggregate retained on the No. 10 sieve shall have a percentage of wear of not more than 50 in accordance with AASHTO T 96 and should have a minimum California Bearing Ratio of 25.

The fraction passing the No. 200 sieve shall not be greater than 2/3 of the fraction passing the No. 40 sieve. The fraction passing the No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6.

The composite material shall be free from organic matter, asphalt, bricks, lumps or balls of clay and other non-concrete material, and shall conform to the following grading requirements, including the tolerances:

**TABLE 804.04 (B) GRADATION REQUIREMENTS FOR RECYCLED CRUSHED CONCRETE**

Sieve Designation	Percent Passing By Weight	Job Mix Tolerances (Percent Passing by Weight)
2-1/2 inch (63mm)	100	-2
2 inch (50mm)	90-100	± 5
3/4 inch (19mm)	60-90	± 8
No. 4 (4.75mm)	30-60	± 8
No. 10 (2.00mm)	20-45	± 6
No. 40 (0.425mm)	10-30	± 5
No. 200 (0.075mm)	4-12	± 3

**C. SLAG FOR BASE COURSE** - The quality and grading requirements for slag used as a base course shall conform to 804.04(A).

**804.05 TRENCH BACKFILL**

Material used in trench backfill shall be a well graded soil-aggregate mixture with 10 percent, but no more than 35 percent, by weight, passing the No. 200 sieve. The soil shall have a liquid limit not greater than 40 and a maximum plasticity index of 10. Recycled crushed concrete may be used in lieu of trench backfill if approved by the Engineer.

Within 1 foot of the pipe, no gravel or stone shall be larger than 1-1/2 inches in any dimension.

For remainder of trench, no gravel or stone shall be larger than 4 inches in any dimension, and not larger than 1 inch within 2 feet of finish grade.

Backfill shall be free from snow, ice, frozen materials, trash, brick, clay lumps, broken concrete, tree roots, sod, ashes, cinders, glass,

plaster, organic matter, and any other foreign matter.

Backfill shall have a minimum dry weight density of 100 pounds per cubic foot.

Backfill shall have a uniform moisture content suitable for compaction to the specified density. The Contractor shall moisten or dry soils materials to obtain a suitable, uniform moisture content. If the materials are of such nature that heaving, pumping, rutting, or shearing occurs in the compacted backfill under the action of construction equipment, even though soil meets density requirements, affected material shall be replaced to limits as directed.

#### **804.06 TRENCH SUBGRADE GRAVEL**

Gravel to backfill trench undercut areas shall be per AASHTO M 43, Grading Size No. 57.

#### **804.07 FLOWABLE BACKFILL**

**A. DESCRIPTION** - This Work shall consist of placing flowable backfill in lieu of compacted soil or aggregate backfill in underground utility lines.

**B. MATERIALS** - Materials used in flowable backfill shall conform to the requirements of the following Specifications and standards:

- 801.01: Hydraulic Cement
- AASHTO M 295, Class F: Fly Ash
- 822.01: Water
- 803.01: Aggregates
- 814.04 and 814.05: Admixtures
- Do not use calcium accelerators with fly ash.

**C. MIX DESIGN** - The mix design for flowable backfill shall be provided by the Contractor.

Flowable backfill shall have a design compressive strength of 50 to 150 psi. at twenty-eight (28) days when tested in accordance with AASHTO T 23. The Contractor shall be responsible for providing a flowable mixture using these guidelines and adjusting the mixture design as called for by circumstances or as may be directed by the Engineer. The Contractor shall submit a mix design for approval supported by laboratory test data for one (1), three (3), and twenty-eight (28) day compressive strengths. The mix design shall be approved by the Engineer prior to beginning Work.

**D. CONSTRUCTION** - Mixing and transporting shall be in accordance with 501 or by other methods approved by the Engineer.

When used as backfill for pipe and floatation or misalignment occurs, correct alignment shall be assured by means of straps, soil anchors, or other approved means of restraint.

**805 AGGREGATES FOR DRAINAGE****805.01 GENERAL**

Aggregates shall be free from snow, ice, frozen materials, trash, brick, clay lumps, broken concrete, tree roots, sod, ashes, cinder, glass, plaster, organic matter, and any other foreign matter.

**805.02 FINE AGGREGATE FOR PERVIOUS FILL**

Material for use in underdrains and pervious backfill shall consist of a well graded mixture of crushed or natural fine gravels and coarse sands conforming to AASHTO M 6 grading requirements.

Foundry sand, crushed stone, or other material which may be cementitious or are not suitable for water percolation shall not be used.

**805.03 COARSE AGGREGATE FOR UNDERDRAIN**

Coarse aggregate for bedding and encasement of pipe shall be grading No. 57 or No. 67 Crushed Stone/Gravel complying with AASHTO M43, be an inert material.

**805.04 BLANKET SOIL FOR UNDERDRAIN**

See 804.03

## 806 MASONRY UNITS

### 806.01 CLAY OR SHALE BRICK

Color shall be as specified in the Contract Documents.

- A. **SEWER BRICK** - Sewer brick shall meet the physical requirements of AASHTO M 91, Grade MS for manholes and Grade SS for invert surfaces, and shall be 2-1/4 x 3-3/4 x 8 inches in size.
- B. **SIDEWALK BRICK** - Sidewalk brick shall meet the requirements of ASTM C 902, Class SX, Type 1.
- C. **BUILDING BRICK** - Building brick shall meet the requirements of AASHTO M 114, Grade SW.
- D. **GUTTER BRICK** - Gutter brick shall meet the physical requirements of AASHTO M 91, Grade SS, and shall be size 7-1/2" x 3-1/2" x 3-1/2" with a maximum water absorption by five (5) hour boiling test less than 8 percent. The exposed face of the brick shall be smooth.
- E. **ALLEY AND ALLEY DRIVEWAY BRICKS** - Alley bricks shall meet the requirements of ASTM C 1272, Grade PX and shall meet the requirements of Table One physical requirements. Bricks shall be 8 inch x 4 inch x 2.75 inch minimum depth and shall be tested for efflorescence.

### 806.02 PRESSED CONCRETE BLOCK PAVERS

Pressed Concrete Block Pavers shall have a non-slip or stipple finish. Large, rough, exposed aggregate surfaces are not acceptable. All top edges of pavers shall have a 3/16 inch bevel. The color shall be natural limestone gray or as approved by the Engineer. The pavers shall also meet the following requirements.

- A. **SIZE** - Sidewalk pavers shall be 24 x 36 x 2 inches (nominal) or metric equivalent.  
 Driveway pavers shall be 8 x 4 x 3 inches or metric equivalent. Pavers shall have a tolerance of  $\pm 1/16$  inch in length and width and  $\pm 1/8$  inch in thickness.
- B. **COMPRESSIVE STRENGTH** - Average compressive strength of four 2 x 2 x 2 inch cubes or 2 inch diameter cylindrical cores obtained from 2 pavers per lot shall be 5000 psi minimum as tested by AASHTO T 32.
- C. **WATER ABSORPTION** - Maximum twenty-four (24) hour cold water absorption shall be less than 5 percent tested in accordance with AASHTO T 32, Section 8, except that 4 specimens will be tested.
- D. **FREEZING-THAWING RESISTANCE** - After 50 cycles of freezing and thawing, in accordance with AASHTO T 32, or, after a three (3) day submersion in 3 percent sodium chloride solution, 1/2 inch deep over the top of the test specimen, weight loss shall be less than 3 percent with no visual signs of deterioration.

### 806.03 CONCRETE BRICK

Concrete brick shall conform to the composition and physical requirements for the weight, type and grade specified.

### 806.04 GLAZED CERAMIC TILE

- A. **GENERAL** - All tile shall be glazed ceramic wall tile of the sizes and shapes specified herein and as shown in the Contract Documents. The quality of the tile shall be standard and grade as defined in A1371.1 ANSI Standard Specification for Ceramic Tile.
- B. **PHYSICAL PROPERTIES** - Tiles (other than trimmer tiles, angles, etc.) shall have a nominal size of 4-1/4 inches by 4-1/4 inches. The size of the tile shall not vary from the nominal 4-1/4 inch dimension by more than 3/64 inch. All tile shall be of a uniform thickness of not more than 1/2 inch nor less than 3/8 inch, including the projecting lugs or keys as specified in this section, and not less than 5/16 inch thick exclusive of said lugs or keys. They shall be graded for size into groups by the manufacturer for the

Contractor, and each group shall be composed of 1 size tile varying not more than 1/32 inch. Each group of sizes shall be segregated and shipments shall be made in substantial quantities of 1 size.

The tiles shall have an approved cushion edge and the backs shall be free from glaze, glaze sheen or film. The edges shall be reasonably free from a glaze coating and shall not have drops or globules exceeding 1/64 inch in thickness. The body shall be free from concave warpage exceeding 0.2 percent of the diagonal of the square and shall be free from convex warpage exceeding 0.3 percent of the diagonal. They shall be free from wedging or crooked edges exceeding 0.5 percent of the edge length and from other imperfections such as pressing cracks, dents, swelling, and chipping.

The Contractor shall provide approved equipment for checking tile for warpage, wedging, and size. The equipment shall mechanically measure compliance or non-compliance of the tile with the specified limits of warping and wedging and shall classify the tile as to size group.

Tiles shall be manufactured with projecting lugs or keys on the backs and with rough back surfaces so as to furnish a satisfactory mechanical bond with supporting mortar. The width of the back face of the lugs or keys shall be appreciably greater than the width at the base of the said lugs or keys. The lugs or keys shall project not less than 3/32 inch beyond the back face of the body of the tile and shall be of such pattern as to avoid closed pockets by which air might be entrapped within the mortar backing. If the tile is manufactured with projecting edge rims or borders on 2 or more adjacent sides, there shall be provided at least 2 slots on each side of the tile where said rims or borders occur so as to avoid entrapment of air within the mortar backing. These slots shall be not less than 5/16 inch in width and shall extend across the full width of the edge rims or borders and for the full depth of the edge rims or borders to the body of the tile. The pattern of the lugs or keys shall be subject to the approval of the Engineer.

The face of the tile shall be a glazed finish with a semi-matte texture having a specular gloss factor of 21 to 70 units when determined as specified herein. The glazed surface shall be smooth, easily cleaned and free from all imperfections or injurious defects such as waviness, pinholes, specks, spots, blisters, feathering, crawling, crazing, chipping, scumming, discoloration, or sanding to an extent which would affect the appearance of the tile. The daylight luminous directional reflectance when measured as specified herein shall be a minimum of 70 percent. The light reflectance requirements do not apply to the darker tile as used for trim.

The color of the tile shall be as specified in the Contract Documents and samples of tile having the required finish, texture and color shall be submitted to the Engineer for approval. These samples shall have the following identification: "Samples of Glazed Ceramic Wall Tile Illustrating Finish, Texture and Color Only."

- C. **SAMPLING** - During progress of the Work, the Contractor shall furnish at his own expense as many sample lots of tile as may be required for testing. A sample lot shall consist of 30 tiles. Samples of the tile for test purposes will be selected by the Engineer from tile delivered to the Project and shall be identified as a lot. On each project, a sample lot of tile shall be obtained and tested prior to start of tile construction irrespective of the quantity of tile facing involved. On projects involving less than 25,000 square feet of tile, additional samples and testing shall be at the option of the Engineer.

In case the sample from any one lot of tile fails to meet the requirements of these Specifications, an additional sample from the same lot will be selected and subjected to the prescribed tests. Should the additional sample also fail to meet specification requirements, the entire lot so represented will be rejected. Rejected tile shall be promptly removed from the job Site and disposed of and shall not be used or submitted again for inspection or test.

- D. **TESTING** - The Contractor shall secure certified results of tests from the manufacturer indicating that the tile being furnished on the Project conforms in all respects to the requirements specified. Sampling of tile delivered to the Project will be performed as provided herein. Sample lots tested shall meet the requirements of the tests listed below. The tests specified for dimensions, warpage and light reflectance are non-destructive and tiles used for these tests shall also be used for the remainder of the tests.
1. **Dimensions** - 5 tiles shall be selected at random from the sample lot consisting of 30 tiles and tested for conformance to the requirements specified for dimensions. When so tested, the dimensions for the 5 specimens shall be within the tolerances specified.
  2. **Warpage** - 5 tiles shall be selected at random from the sample lot and tested for conformance to the warpage requirements. When so tested, the warpage of the 5 specimens shall be within the tolerances specified.

3. **Specular Gloss and Light Reflectance** - 5 tiles shall also be selected at random for the specular gloss and light reflectance tests. The specular gloss shall be determined in accordance with ASTM D 523, 60 degree Geometry Method. The daylight luminous directional reflectance shall be measured by a Gardner (Hunter design) Color and Color Difference Meter, operated in accordance with manufacturer's instructions. When so tested, the specular gloss and light reflectance of the 5 tiles shall conform to the requirements.

4. **Absorption** - A sample consisting of 5 tiles shall be dried in an oven for two (2) hours at 110°C, cooled to room temperature and weighed separately on a scale sensitive to 0.5 gram. The dry tiles shall then be placed in water at a temperature of 15 to 30°C. The water shall be boiled for two (2) hours and permitted to cool gradually to within 15°C to 27°C. The tiles shall be removed from the water twenty-four (24) hours after the initial immersion, their surfaces wiped dry with a clean damp cloth and quickly weighed separately. The percent absorption of each specimen shall be calculated on the basis of its weight.

The average water absorption of the 5 specimens tested shall not exceed 2 percent. The water absorption of any individual specimen shall not exceed 2-3/4 percent.

5. **Crazing** - An autoclave with sufficient capacity to contain not less than 5 tiles shall be used. The apparatus shall be equipped with a safety valve, blow-off valve, pressure gauge whose accuracy is within 2 percent of the scale range, and a burner of sufficient capacity to insure a constant steam pressure. A sufficient amount of water shall be placed in the autoclave so that after a one (1) hour test at 200 pounds steam pressure, a slight excess of water will remain. The sample consisting of 5 or more tiles shall be loosely placed on edge in a suitable wire container above the water line within the autoclave at room temperature. The autoclave head shall then be securely fastened in place.

The water in the bottom of the autoclave shall be heated from an external source. The blow-off valve shall be kept open until steam begins to escape, thereby expelling most of the air. After closing the blow-off valve, the water shall be kept boiling and the steam pressure increased at a uniform rate until 200 psi is reached within a period not exceeding one (1) hour. Sufficient heat shall be applied to maintain a constant steam pressure of 200 pounds per square inch for an additional hour. The burner shall then be shut off and the steam pressure immediately released by opening the blow-off valve. The autoclave head shall be loosened but not removed until the specimens have cooled slowly to room temperature and a washable black ink rubbed upon their surfaces to aid in the detection and examination of failure.

After being subjected to 5 consecutive cycles of the foregoing crazing test, the 5 tiles tested shall show no crazing, chipping, spalling or cracking of either the body or glaze. The glazed surface of the tile shall show no permanent clouding, dulling or pitting. Slight dull streaks will be permitted provided they do not comprise more than 20 percent of the glazed surface area.

6. **Thermal Shock** - A sample consisting of 3 tiles shall be placed in an oven at room temperature. The temperature within the oven shall then be uniformly raised to 110°C in a period of one (1) hour, and maintained at the temperature for an additional hour after which each specimen shall be removed from the oven and immediately plunged into a mixture of ice and water having a temperature of not more than 2°C. At the end of ten (10) minutes, each specimen shall be removed from the water mixture and a washable black ink applied upon the glazed surfaces and bodies to aid in the detection and examination of failures.

After being subjected to 5 consecutive cycles of the foregoing thermal shock test, the 5 tiles shall show no crazing, chipping, spalling or cracking of either the body or glaze.

7. **Weathering** - A sample consisting of 5 tiles shall be placed in water at room temperature. The water shall then be boiled for a period of two (2) hours and permitted to cool gradually to room temperature. The specimens shall then be removed from the water and their surfaces wiped dry with a clean damp cloth. Immediately thereafter they shall be placed in a freezing chamber (not immersed in water) for a period of four (4) hours. The freezing chamber shall be maintained at a temperature below minus 12°C. The specimens shall then be removed from the freezing chamber and immediately immersed in water at room temperature. After the specimens have completely thawed in the water, they shall be removed, their surfaces wiped dry with a clean damp cloth, and a washable black ink rubbed upon their surfaces to aid in the detection and examination of failures. After being examined, the 5 tiles shall again be immersed in water until such time as is convenient to again place them in the freezing chamber for the additional cycles of the weather test.

After being subjected to 5 consecutive cycles of the foregoing weather test, the 5 tiles tested shall show no crazing, chipping, spalling, or cracking of either the body or glaze.



- 8. Glaze Hardness** - A sample consisting of 5 tiles shall be used in the glazed hardness test utilizing the Moh Scale of minerals. A piece of mineral having a hardness of 4 as measured by the Moh Scale shall be slowly drawn across the glazed surface of each specimen with a steady, uniform pressure of approximately 25 pounds. When subjected to the above test, the glazed surface of the 5 tiles shall not show a scratch.
- 9. Bond** - Before the design of the back of the tiles is approved, the tile shall meet the following requirements: This test will be performed only on the sample of tile obtained prior to start of tile construction.

A layer of mortar shall be placed in the bottom of 5 molds of a thickness of 1 inch. The mortar shall contain the following, by weight of mix:

- 801.01(D): Portland Cement - 1 part
- 803.06(B): Sand - 2-1/2 parts
- 822.03 (E): Hydrated Lime - 16-1/2 parts by weight of cement

The inside dimension of the molds shall be 4-3/8 inches square and 1-1/8 inches in depth. The tiles shall be thoroughly wetted following which a skim coat of neat Portland Cement shall then be spread evenly on the back of each tile, filling all spaces between lugs or keys, to a thickness not exceeding 1/8 inch prior to setting the tile on the mortar. The tile shall be firmly pressed or tapped into place and the bond test specimen consisting of mold, mortar and tile shall be stored in a normal atmosphere at room temperature for seven (7) days until tested for strength of bond in shear in a suitable compression machine at a rate of load of 2400 pounds per minute. The average strength of bond in shear of the specimen shall not be less than 225 pounds per square inch.

### 806.05 MORTAR MIXTURES

**A. GENERAL** - Materials used in mortar mixtures shall conform to the following:

- 801.02: Masonry Cement
- 801.01: Portland Cement
- 822.03(D): Hydrated Lime
- 803.06: Fine Aggregates
- 803.06(C): Sand
- 822.01: Water
- 822.08: Epoxy

**B. PORTLAND CEMENT MORTAR MIX**

1. Mortar for stone masonry (setting) shall be composed of 1 part Portland Cement, 3 parts fine aggregate by volume and hydrated lime in an amount equal to 10 percent of the cement by weight.
2. Mortar for stone masonry (pointing) shall be composed of 1 part dark Portland Cement and 2 parts fine aggregate to which sufficient hydrated lime may be added to make as stiff a mixture as can be properly worked with a caulking tool.
3. Mortar used for scratch and float coat in ceramic tile construction shall be composed of 1 part Portland Cement and 2-1/2 parts sand meeting 803.06(C) and 1/5 part hydrated lime (slaked twenty-four (24) hours minimum before use).
4. Joint mortar for sewer pipe and valve casings shall consist of 1 part Type II Portland Cement and 2-1/4 parts fine aggregate by volume thoroughly mixed dry, and sufficient water to make a stiff mix.
5. Joint and parging mortar for manhole brickwork shall consist of 1 part Type II Portland Cement and 2-1/4 parts fine aggregate per 803.06(A) by volume and sufficient water to make a stiff mix. Lime in mortar is prohibited.

**C. EPOXY MORTAR** - Epoxy mortar shall be composed of sand conforming to 803.06(A) and epoxy conforming to 822.08 and proportioned by volume as follows:

**TABLE 806.05 (A) EPOXY MORTAR**

Parts Sand-Dry (by volume)	Parts Epoxy (by volume)
1	3 to 4 with Grade 1 Epoxy
	2 to 3 with Grade 2 Epoxy
	1 to 1-1/2 with Grade 3 Epoxy

Type and class of epoxy and proportions of sand to epoxy shall be per 822.08(C).

- D. MASONRY CEMENT MORTAR MIX** - Masonry mortar shall be composed of 1 part masonry cement and 2 parts fine aggregate by weight.
- E. NONSHRINK GROUT** - Nonshrink grout shall be premixed, nonmetallic, non corrosive, nonstaining product containing silica sands, Portland Cement, shrinkage compensating agents, and plasticizing and water-reducing agents. The hardened grout shall obtain 6000 psi minimum compressive strength at twenty-eight (28) days when tested in accordance with. The shrinkage shall not exceed 0.00 inches in plastic state or in hardened state when tested in accordance with ASTM C 1107.
- F. NONSHRINK GROUT FOR SEWER-WATER WORK** - Nonshrink grout for sewer-water work shall be premixed, non-metallic, non-corrosive, non-staining product containing silica sands, Portland Cement, shrinkage compensating agents, and plasticizing and water-reducing agents.

The Contractor shall furnish recent independent laboratory tests signed and sealed by a Professional Engineer and showing compliance with specified requirements. Certification or affidavits will not be acceptable.

The Contractor shall furnish manufacturer's literature describing product and instructions for use.

Grout shall be delivered in moisture proof bags with the manufacturer's name, product name, and general instructions for placement printed on the bag.

The product shall be stored on pallets and protected from moisture and damage.

All grout shall be non-metallic, non-shrink, non-gas forming, pre-blended and ready-for-use requiring only the addition of water.

1. Grout shall contain no metals nor rust or corrosion promoting agents, or gypsums.
2. The addition of set control agents or water reducers shall not be allowed.
3. Grout shall conform to the following properties:

**TABLE 806.05 (B) GROUT SPECIFICATIONS**

Property	Test Methods	Requirements
Shrinkage below Placement Volume		0
Drying Shrinkage	ASTM C 596	0
Expansion	ASTM C 596	0.10 max.
Compressive Strength <sup>a</sup>	24 hours	3,000 psi min.
	7 day	6,000 psi min.
Initial Set Time	#5 bar grouted	Min. 45 minutes
Pull-Out Strength	6" deep in a 7/8" dia. hole in saturated surface dried concrete	10,000 lbs

a Flowable mix

Water shall be clean and free from injurious chemicals and deleterious materials.

## 807 JOINT MATERIALS

### 807.01 PREFORMED EXPANSION JOINT FILLER

- A. FOR USE IN PAVEMENT CONSTRUCTION** - Preformed expansion joint for use in PCC pavement, base, sidewalk, curb and gutter construction and sewer-water structures shall meet the requirements of AASHTO M 153, Type II (Cork).

Preformed joint material shall be new material for all Work and furnished in longest lengths practicable for intended use as determined by the Engineer, and in no case shall joint material be furnished in lengths less than 10 feet. Pieces for curb and gutter and as directed shall be cut in exact size from larger furnished sections. All splices in joint material shall be carefully made to insure against penetration of PCC between adjacent strips of joint material. Joint material shall neither be furnished nor stored in rolls.

When dowel bars or other approved load transfer devices are specified, the preformed filler shall have holes of the proper diameter or size drilled through it at the specified intervals to receive the bars and to insure a tight fit.

- B. FOR USE IN STRUCTURES** - Preformed expansion joint filler for use in Structures shall meet the requirements of AASHTO M 153, Type II or III (Cork or Self-expanding Cork). Pre-molded joint fillers shall be of suitable length to minimize splices and of proper width to eliminate field cutting longitudinally.

### 807.02 JOINT SEALING MATERIALS

**A. HOT-POURED TYPE**

- 1. Joint and Crack Sealant for Portland Concrete and Asphalt Pavements** - Hot applied type sealant for use in sealing joints and cracks in PCC and asphaltic concrete pavements shall meet the requirements of ASTM D 6690 , Type 11.
- 2. Elastomeric Joint Sealants** - Hot-poured elastomeric-type of 1-component, hot-applied, concrete joint sealant for joints in slabs and walls shall meet the requirements of AASHTO M 282. Bond breaker shall be suitable polyethylene tape of correct width to suit conditions. The sealant manufacturer shall submit written certification that the sealant is resistant to acid (to pH of 3.5) and alkali (to pH of 8.5).
- 3. Fuel-Resistant Joint Sealant** - Hot-poured sealant for use in sealing joints and cracks in PCC pavements subject to exposure to fuels shall meet the requirements of ASTM D 7116.

- B. CAULKING COMPOUND** - Caulking compound for Structures shall meet the requirements of the ASTM C 920.

### 807.03 LOAD TRANSFER ASSEMBLIES

- A. GENERAL** - The load transfer assembly for all transverse expansion and contraction joints shall be of a material and design approved prior to use. The assembly shall provide means for transfer of load across the joint by use of dowels or other approved methods. Only the dowels shall cross the joint.

Load transfer assemblies shall be one of the types shown on the Standard Drawings or Contract Plans.

Dowels for expansion joints shall be provided with a sleeve meeting the requirements of 807.03(C).

The assembly shall be a single unit and of a length equal to the width of the slab being constructed. It shall be sufficiently rigid to hold each dowel in correct position and alignment with 1/8 inch in 12 inches and to support the weight of a man such that when the weight is removed, the dowels will be within the specified position and alignment. Assemblies fabricated for use with preformed expansion joint filler shall be constructed such that the filler will be firmly held in a vertical position and in a straight line during placement of concrete.

- B. DOWEL BARS** - When dowel bars are used, they shall be plain rounded bars of the diameters and lengths as shown on the Standard Drawings or Contract Plans.

All dowels shall meet the requirements of AASHTO M 31, Grade 60. They shall be painted with paint conforming to the requirements of 811.03(E). When the paint has dried and immediately before the dowels are placed in position, the free end shall be thoroughly coated with an approved lubricant.

- C. DOWEL SLEEVES** - Dowel sleeves shall be of the dimensions as shown in the Contract Documents and shall fit the dowel bar snugly. The dowel sleeves shall be capable of sliding over  $2 \pm 1/4$  inches of the dowel. One end of the sleeve shall be closed so that concrete cannot enter. The sleeve shall be indented or have suitable flange at least 1 inch from the closed end to provide a limiting stop for the sleeve when being placed on the dowel bar and to insure subsequent free movement of the dowel in the sleeve. The sleeve shall be of such rigid design that the closed end will not collapse during construction.
- D. METAL PLATES FOR TRANSVERSE CONTRACTION JOINTS** - Metal plates for use in curb and/or gutter sections shall be 14 gauge metal sheets, or other approved materials.

#### 807.04 TIE ROD ASSEMBLIES AND TIE RODS

- A. TIE ROD ASSEMBLY** - Tie rod assemblies shall be of the dimensions as shown in the Contract Documents.

The adapter shall be threaded internally such that the bars may be inserted therein, and shall be of such strength and design that it will conform to the strength requirements specified herein.

Tie rod assemblies shall conform to the requirements of AASHTO M 227, Minimum Grade 60. When tested in assembled condition in accordance with AASHTO T 244, the tie rod assembly shall conform to the tensile requirements of AASHTO M 227, Minimum Grade 60, based on the measured cross-sectional areas of the unthreaded portion of the bars.

- B. DEFORMED STEEL TIE RODS** - Tie rods shall be deformed bars, conforming to the requirements of AASHTO M 31, Grade 40.

#### 807.05 WATERSTOPS

- A. NEOPRENE WATERSTOP**

- Description** - Neoprene water stops shall be manufactured from a vulcanized elastomeric compound containing neoprene as the sole elastomer. Manufacturer's shop splices shall be fully vulcanized.
- Requirements** - The material for neoprene water stops shall be tested as per 807.05(A)(3) and conform to the following:

**TABLE 807.05 WATERSTOP REQUIREMENTS**

Physical Tests	Requirements
Tensile Strength, psi	2,000 minimum
After aging, not less than	85 % of original
Elongation at Break, %	300 minimum
Ozone Resistance	No Crack

- Method Of Testing** - Tensile Strength and elongation testing shall be in accordance with ASTM D 412. The accelerated aging shall be in accordance with the requirements of ASTM D 573 for seventy (70) hours at 212° F. Ozone Resistance testing shall be in accordance with ASTM D 1149 using 20 percent strain for one hundred (100) hours at 100° F  $\pm$  2 degrees.

- B. POLYVINYL CHLORIDE (PVC) WATERSTOP**

- Description** - Polyvinyl chloride water stops shall be manufactured from polyvinyl chloride conforming to the Corps of Engineers Specification Number CRD-C 572 and shall conform to the ozone resistance as required for neoprene water stops. A certificate shall be furnished with the test sample supplied stating that all of the performance requirements specified under paragraph 6 of the said Specifications have been satisfied. Use of reclaimed PVC is prohibited.

Water stop for water-sewer structures shall be 9 inch dumbbell type for construction joints and dumbbell with center bulb for expansion joints.

All other water stop shall be the size, shape, dimensions and tolerances as specified in the Contract Documents.

2. **SAMPLES** - A sample consisting of not less than 2 square feet shall be obtained from each type of finished water stop proposed for use.
3. **SPLICES** - Field splices for polyvinyl chloride water stops shall be performed by heat sealing the adjacent surfaces in accordance with manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not char the plastic. Water stops when being installed shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

#### 807.06 COMPRESSION SEALS

- A. **PREFORMED EXTRUDED COMPRESSION SEALS** - Preformed extruded compression seals shall be the shape (angled and webbed) as specified in the Contract Documents and shall be composed per ASTM D 2628. Adhesive for use with this seal shall be 1 part moisture curing polyurethane and aromatic hydrocarbon solvent mixture with the following physical properties:

**TABLE 807.06 ADHESIVE PROPERTIES FOR COMPRESSION SEALS**

Average weight per gallon	8.00 lbs ±10
Solids content	72-74 % by weight
Adhesive shall remain fluid	5°F to 120°F
Film Strength (ASTM D 412)	1200 psi
Elongation (ASTM D 412)	350%
Low Temperature Strength (ASTM D 746) -60°C, tensile	1200 psi

Each lot of adhesive shall be delivered in containers plainly marked with the manufacturer's name or trade mark and date of manufacture and shall be accompanied by an affidavit attesting conformance with this article.

- B. **O-RING SEALS** - O-ring compression seals for precast sewer manhole rings shall be per ASTM C 361 or ASTM C 443.

#### 807.07 TILE JOINT SEALANT

Joint sealant for ceramic wall tile shall be as per manufacturer's recommendation.

## 808 NON METALLIC PIPE

### 808.01 PCC PIPE

- A. NONREINFORCED PCC PIPE** - Non-reinforced PCC pipe shall meet the requirements of AASHTO M 86 for the Class of pipe as specified in the Contract Documents.

- B. REINFORCED PCC PIPE** - Reinforced PCC pipe shall be of Class B PCC, Class III minimum, Wall B minimum for the diameter(s) specified in the Contract Documents and per ASTM C 76 and AASHTO M 170 modified as follows:

PCC mix proportions shall be determined per 817.01(B) prior to production. PCC shall contain a minimum of 564 lbs. cement per cubic yard.

PCC pipe shall be furnished with rubber gasket joints per 808.03.A and ASTM C 443.

PCC pipe and joints for sanitary and combined sewers shall pass a 13 psi hydrostatic test performed by the pipe manufacturer per AASHTO M 315, Section 10, and ASTM C 497.

PCC pipe for building sewer connections and cleanouts shall be furnished with bell and spigot, rubber gasket joints as per AASHTO M 315. Joints shall pass a 13 psi hydrostatic test.

The bevel or drop on bevel pipe shall not exceed the pipe wall thickness.

Except for closure sections and as otherwise specified, PCC pipe shall be furnished in minimum 8 foot lengths in sizes 12-inch through 72-inch diameter and minimum 6 foot lengths in sizes larger than 72-inch diameter.

Branches and specials shall have standard reinforcement deflected to facilitate opening for the branch or special and shall be formed at time of pipe manufacture. Additional reinforcement shall be welded to longitudinal and circumferential steel where deflection or opening results in bar spacing in excess of 1 ½ times the wall thickness. The design and fabrication plan for branches and specials shall be submitted for approval prior to manufacture.

Pipe 12-inch through 72-inch diameter will be accepted from a manufacturer's existing stock provided crushing strength tests meet AASHTO M 170 requirements and, for sanitary and combined sewer, the pipe meets hydrostatic test requirements. Crushing tests shall be performed under the supervision of a District Inspector on the manufacturer's testing machine.

Pipe 78-inch diameter and larger will be accepted based on tests of quality of the PCC as placed in the pipe and by examination of the quality, amount, and accuracy of placement of the steel reinforcement per AASHTO M 170 requirements and, for sanitary and combined sewer, the pipe meets hydrostatic test requirements.

### 808.02 POLYVINYL CHLORIDE (PVC) PIPE

- A. PVC PIPE** - Polyvinyl chloride (PVC) pipe and fittings for Pipe Sewer shall be per ASTM D 3034 SDR 35 for pipe up to 15-inches diameter, and ASTM F 679 and wall thickness T-1 for pipe 18 thru 27-inches diameter. Unless otherwise approved, lengths of pipe sections shall not exceed 13 feet and lengths of Y-branches shall not exceed 3 feet. Saddle Y-branches shall not be used.

Joints for both the pipe and fittings shall be of the integral bell type with integral wall section per ASTM D 3212. PVC pipe shall be furnished with elastomeric gasket seals per 808.04.

All pipe and fittings furnished shall be accompanied by a certification, per ASTM D 3034, which will be the basis of acceptance of the material. Pipe and fittings will be inspected upon delivery. Rejected pipe and fittings shall be removed by the Contractor.

- B. PVC PERFORATED PIPE** - Perforated PVC pipe and fittings shall meet the requirements of ASTM D 2729 with a dimension ratio (DR) of 35. Unless otherwise approved, lengths of pipe sections shall not exceed 13 feet and lengths of Y-branches shall not exceed 3 feet. Saddle Y-branches shall not be used.

- C. PVC BUILDING CONNECTION PIPE** - Polyvinyl Chloride (PVC) pipe shall meet the requirements of ASTM D 3034. Unless otherwise approved, 20 foot lengths of pipe shall be used wherever practicable and lengths of wye-branches shall not exceed 3 feet. Saddle wye-branches shall not be used. Pipe and fittings will be inspected upon delivery. Rejected pipe and fittings shall be removed by the Contractor.

Pipe fittings and joints shall meet the requirements of ASTM D 3311. Joints shall be solvent welded with solvent cement meeting the requirements of ASTM D 2564.

- D. HIGH DENSITY POLYETHYLENE PIPE (HDPE)** - All HDPE pipe shall conform to ASSHTO M 252 and M 294. All HDPE pipe shall contain a minimum content of 2 percent carbon black as required by ASTM D 3350. Pipe shall be Type S and have a full circular cross section, with an outer corrugated pipe wall and a smooth inner wall.
- E. HDPE PERFORATED PIPE** - Perforated High Density Polyethylene pipe shall meet the requirements of AASHTO M 252 and M294. Pipe shall be Type SP with Class 1 perforation.
- F. JOINT MORTAR** - Joint mortar for sewer pipe shall be per 806.05(B) (4).
- G. PIPE BEDDING** - Pipe bedding for sewer pipe shall be per AASHTO M 43, Size No. 57.

### 808.03 GASKETS

- A. GASKET, REINFORCED PCC PIPE** - Rubber gaskets for PCC pipe joints shall be per AASHTO M 315. Joints shall pass 13 psi hydrostatic test performed by pipe manufacturer. The bevel or drop on bevel pipe shall not exceed the pipe wall thickness.
- B. GASKET, POLYVINYL CHLORIDE TYPE** - Solid cross section elastomeric gasket seal shall be per ASTM F 477, factory assembled and securely locked or cemented in the socket.
- C. GASKET, HIGH DENSITY POLYETHYLENE PIPE** - All HDPE pipe joints shall consist of integral bell and spigot with rubber gasket that meets specification requirements of ASTM F 477.

## 809 METAL PIPE AND FITTINGS

### 809.01 DUCTILE IRON PIPE AND FITTINGS

#### A. DUCTILE IRON PIPE

1. Pipe shall be ductile-iron meeting the requirements of AWWA C 151 with mechanical or push-on joints. Pipe shall be asphaltic coated outside and cement lined with double thickness and seal coated in accordance with AWWA C 104. Pipe shall be furnished in lengths of 18 to 20 feet and shall include all joining materials.
2. Unless otherwise specified, outside diameter of ductile-iron plain end shall be the same as for mechanical-joint cast or ductile-iron pipe.
3. Wall thickness class shall be per Table 809.01 unless otherwise specified on Contract Drawings.
4. Fittings or pipe not properly identified for pressure class, thickness, or weight as required by ANSI/AWWA Standard C 110, C 151, or C 153 shall not be used.

**TABLE 809.01 DUCTILE-IRON PIPE WALL THICKNESS AND PRESSURE CLASSES**

Diameter (Inches)	Pressure (PSI)	Pressure Class <sup>a</sup>	Special Thickness Class <sup>b</sup>	Thickness (Inches)
6	350	--	52	0.31
8	350	--	52	0.33
12	350	--	52	0.37
16	350	--	51	0.37
20	350	350	--	0.38
24	300	300	--	0.40
30	200	200	--	0.38
36	200	200	--	0.42
42	200	200	--	0.47
48	200	200	--	0.52
54	200	200	--	0.58
60	200	200	--	0.61

- a Pressure classes are defined as the rated water working pressure of the ductile-iron pipe in psi. Rated water working pressure for ductile-iron pipe calculations are based on a 2.0 safety factor times the sum of the working pressure indicated for each nominal size plus a surge allowance of 100 psi as per AWWA C 150.
- b Special thickness classes were designated as standard thickness classes prior to 1991.

#### B. JOINTS AND FITTINGS – DUCTILE IRON PIPE

1. Mechanical and push-on joints for ductile iron water main pipe shall be per AWWA C 111.
2. Fittings 48 inches and smaller in diameter shall be mechanical bell joint, ductile-iron in accordance with AWWA C 110, including dimensions and weights.
3. Fittings 54 inches and larger in diameter shall be push-on ductile-iron proprietary restrained joints in accordance with AWWA C 153.
4. Coatings for Fittings :
  - a. Provide exterior asphaltic coating per AWWA C-110 and interior cement-mortar lining as per AWWA C-104, or
  - b. Provide interior and exterior fusion bonded epoxy coating, 6 to 8 mils in thickness, conforming to AWWA C-116.
5. All fittings shall be complete with all joint accessories, rubber gaskets, bolts and nuts.



**C. JOINT RESTRAINT, DUCTILE IRON PIPE**

1. Unless otherwise noted, pressure ratings for pipe harnessing components shall not be less than the pipe working pressures shown in Table 809.01 for each size of pipe.
2. Push-on ductile-iron pipe with proprietary restraint shall be as follows:
  - a. For pipe 36 inches and smaller in diameter; “Flex-Ring Joint Pipe” by American Cast Iron Pipe Company, or “TR-Flex Pipe”, by U.S. Pipe and Foundry Company.
  - b. For pipe 42 inches and larger in diameter: “Lock-Ring Joint Pipe” by American Cast Iron Pipe Company, or “TR-Flex Pipe”, by U.S. Pipe and Foundry Company.
3. Retainer glands for restraint of mechanical joint, ductile-iron pipe 24 inches and smaller in diameter shall be designed to fit standard mechanical joint bells conforming to AWWA C 111. Glands shall be manufactured of ductile-iron conforming to ASTM A 536 with restraining mechanism of size and arrangement per manufacturer’s recommendations, of the following type:
  - a. Ductile-iron wedges in combination with special, heat-treated set screws with or without twist-off nuts, torqued per manufacturer’s recommendations, or
  - b. Hardened steel set screws with knurled and cupped points, with or without twist off nuts.
  - c. “Megalug Series 1100” by EBAA Iron Sales, Inc., or “Uni-Flange Series 1400” by Ford Meter Box Co., are considered acceptable.
  - d. Retainer glands shall meet working pressure ratings for pipe sizes shown in Table 809.01, except 20-inch and 24-inch diameter glands shall meet working pressure of 250 psi.

**D. SLEEVE TYPE COUPLINGS**

1. Couplings shall be designed, manufactured and installed in accordance with AWWA C 219 except as modified below:
  - a. The manufacturer shall provide an affidavit certifying compliance with the above standard.
  - b. Couplings shall be designed for the specified operating and test pressures of the lines in which they are used.
  - c. The manufacturer shall provide test data to verify that the couplings have been hydrostatically tested to the appropriate pressure.
  - d. The Contractor shall verify the outside diameters of the pipes to be connected, and shall select the correct diameter sleeve-type couplings to ensure a proper fit without utilizing pipe stops.
2. The entire sleeve assembly shall be lined and coated with factory-applied coating system as follows:
  - a. Fusion bonded epoxy per AWWA C 213, 12 mils minimum exterior coating thickness, 15 mils minimum interior coating thickness.
  - b. Liquid epoxy per AWWA C 210, 16 mils minimum, 25 mils maximum coating thickness.
  - c. Other coating systems as approved by the Engineer.
3. Bolts, nuts and harness tie rods shall be stainless or galvanized steel.
4. The Contractor may use mechanical joint sleeve at no additional cost to the District.

**E. BOSSES – DUCTILE IRON PIPE (30-INCH AND LARGER DIAMETER WATER MAIN)**

1. A boss connection shall be utilized only where indicated on the Contract Drawings.
2. Bosses shall be located within a range of 1-1/2 feet from the bell end to 4 feet from the spigot end of the pipe.
3. Bosses shall be ductile-iron, 60-42-10 grade, or mild to medium grade carbon steel castings, as per ASTM A 27.
4. Pipe sections selected to receive welded-on bossed outlets shall be ferrite grade ductile-iron per the following:
  - a. Minimum Charpy impact test of 10 ft-lbs per ASTM E 23 and AWWA C 151.

- b. Minimum thickness shall be Special Thickness Class 52.
  - i. Bosses shall be shop welded to ductile-iron pipe by the pipe manufacturer's certified welders, using nickel-iron electrodes such as Ni-Rod FC55 Cored Wire produced by Huntington Alloys, Huntington, West Virginia or approved equivalent. Field welding of bossed outlets is prohibited.
  - ii. All completed welds shall have 100 percent of their surface inspected at pipe Plant using the "Liquid Dye Penetrant Test Method" to insure integrity of welds.

- 5. Bosses shall be mechanical joint welded outlets with sockets conforming to AWWA C 110, unless otherwise shown on the Contract Documents. Interior and exterior surfaces of the outlet, including welds, shall be factory coated per 809.01(B).
- 6. Bossed outlets shall be rated at the same pressure as the main pipe but not less than 250 psi with a safety factor of 2.0. Certified results of hydrostatic tests on each bossed outlet shall be submitted to the Engineer prior to delivery.
- 7. Minor damage to pipe cement lining and coating shall be repaired at pipe Plant to meet AWWA C 104.
- 8. Bossed outlets manufactured by U.S. Pipe and Foundry Company or American Cast Iron Pipe Company are conditionally acceptable. The Contractor shall submit statements from the manufacturer stating that these products meet the above requirements.

**F. 2-INCH BLOWOFF VALVES** - 2-inch gate valve with pentagonal (5-sided) operating key nut shall be iron body, bronze mounted, epoxy coated inside and outside, 100 percent elastomeric-encapsulated symmetrical wedge, non-rising stem type with threaded ends (no flanges), 250 psi working pressure. Rotation of key nut to open shall be clockwise.

#### **809.02 CORRUGATED METAL CULVERT PIPE AND PIPE UNDERDRAIN**

Corrugated metal Culvert pipe shall meet the requirements of AASHTO M 36, for the Type, Class, base metal and gage as specified in the Contract.

Corrugated metal pipe under drain shall meet the requirements of AASHTO M 36, Type III and Class as specified.

#### **809.03 CAST IRON PIPE**

Cast iron pipe and fittings shall meet requirements of ASTM A 74, Extra Heavy type.

#### **809.04 STEEL PIPE**

Steel pipe shall meet the requirements of ASTM A 53 for the Type and Grade specified.

#### **809.05 COPPER TUBE**

Seamless copper water tube shall meet requirements of ASTM B 88, Type K wall.

- A. **SEAMLESS COPPER PIPE** - Seamless copper pipe shall meet the requirements of ANSI H26.1, ASTM B 42, FS WW-P-377d, or ASME SB-42.
- B. **THREADLESS COPPER PIPE** - Threadless copper pipe shall meet the requirements of ANSI H26.2 or ASTM B 302.
- C. **SEAMLESS COPPER TUBE** - Seamless copper tube shall meet the requirements of ANSI H23.3, ASTM B 75, or FS WW-T-797c.
- D. **COPPER DRAINAGE TUBE, TYPE DWV** - Copper drainage tube, Type DWV shall meet the requirements of ANSI H23.6, ASTM B 306, or CS 229-60.
- E. **SEAMLESS COPPER WATER TUBE** - Copper water tube, Types K, L, and M shall meet the requirements of ANSI H23.1, ASTM B 88, FS WW-T-799b-1970, or FS WW-T-799b-1963.

## 810 VALVES AND HYDRANTS

### 810.01 VALVES

- A. STANDARD GATE VALVES** - Standard gate valves shall be per AWWA C 500, hand operated, iron-body, bronze-mounted, double-disc, for water works service under operating pressure of 150 psi.

AWWA C 500 is modified or supplemented as follows:

1. Valves shall be per New York Pattern, Metropolitan Gate Valves.
2. **Size And Type** – Size shall be 12-inch and smaller. Type shall be iron-body, bronze-mounted, gate valves with double-disc gates having parallel seats and side wedges intended for ordinary water service. Each valve shall have a 1/2-inch diameter pipe plug in the bonnet for testing. Valves shall be non-rising stem inside screw type except for exposed valves at the Wastewater Treatment Plant (WWTP) which shall be rising stem, outside screw and yoke type.
3. **Intended Position Of Valve** – Valves shall be installed in the line in vertical position.
4. **Type Of Valve Ends** – Valves shall be furnished with mechanical-joint ends complete with bolts, nuts, retainer glands and gaskets.
5. **Orientation Of Bolt Holes In Flanges Of Mechanical Joint** – Manufacturer's option.
6. **Solid-Bronze Disc Gates** – Not required.
7. **Method Of Fastening Gate Rings** – Manufacturer's option.
8. **Type Of Stem Seal** – Double O-ring seals shall be furnished on all gate valves (stuffing boxes prohibited). O-ring seal plates shall be cast-iron; seal plate bolts and nuts shall be zinc coated per AASHTO M 232.
9. **Wrench Nuts** – Special pentagonal operating nut shall be furnished for 6-inch and 8-inch diameter valves; drawing furnished by the District upon request. Square operating nut furnished for 12-inch valves.
10. **Direction Of Wrench Nut Rotation To Open** – Right (clockwise) except for exposed valves at the WWTP which shall open left (counter-clockwise).
11. **Steel Gears** – Not permitted on gate valves.
12. **Cast-Iron Gears** – Not permitted on gate valves.
13. **Type Of Gear Case** – Not permitted on gate valves.
14. **Position Indicator** – Not required.
15. **Markings** – Insofar as practicable, markings shall be readable by an observer looking down on the valve in line position.
16. **Disc And Disc Seat Rings** – Cast-iron discs in valves 6-inch through 12-inch diameter shall be accurately machined to receive bronze disc seat rings. The disc seat ring surfaces in contact with the iron disc and the dovetail projections shall be fully machined and the disc rings rolled, peened, or pressed into the machine grooves on the iron disc and, when secured in place, a rough and finish cut shall be taken over the disc seat bearing surface.
17. **Minimum Diameter Of Stem And Minimum Thickness Of Body And Bonnet**

**TABLE 810.01 MINIMUM DIAMETER OF STEM AND MINIMUM THICKNESS OF BODY AND BONNET**

Valve Diameter (Inches)	Diameter of Valve Stem at Base of Thread (Inches)	Minimum Body/Bonnet Thickness (Inches)
6	1.125	0.625
8	1.25	0.6875
12	1.50	0.750

18. **Valve Stems** – Stem material shall be per ASTM B 584, alloy UNS No. 86700, or equivalent alloy with minimum 30,000 psi yield and approved for use in potable water service.
  19. **Valve Wedges** – Valve wedges for 6-inch and 8-inch valves shall be bronze; wedges for 10-inch and 12-inch valves shall be cast-iron.
  20. **Valve Stem Thrust Collar Housings** – Housings for valve stem thrust collars shall be carefully machined and fully bronze lined for all gate valves.
  21. **Painting** – Exterior surfaces of buried valves shall be coated with asphaltic varnish per AWWA C 500. Exposed valves shall be shop painted as directed.
- B. RESILIENT-SEATED GATE VALVES** - Resilient-seated gate valves shall be per AWWA C 509, modified and supplemented as follows:
1. **Size And Type** – Size shall be 12-inch and smaller. Valves shall be non-rising stem, inside screw type except for exposed valves at the WWTP which shall be rising stem, outside screw and yoke type.
  2. Waterway shall be smooth and shall have no depressions or cavities in seat area.
  3. **Type Of Valve Ends** – Valves shall be furnished with mechanical-joint ends complete with bolts, nuts, retainer glands and gaskets.
  4. **Type Of Stem Seal** – Double O-ring seals shall be furnished on all gate valves. O-ring seal plates shall be cast-iron; seal plate bolts and nuts shall be zinc coated per AASHTO M 232.
  5. **Valve Stems** – Stem material shall be per ASTM B 584, alloy UNS No. 86700, or equivalent alloy with minimum 30,000 psi yield and approved for use in potable water service.
  6. Gate shall seat against seating surfaces arranged symmetrically about centerline of the valve stem.
  7. **Wrench Nuts** – Special pentagonal operating nuts shall be furnished for 6-inch and 8-inch diameter valves; drawing furnished by the District upon request. Square operating nut furnished for 12-inch valves.
  8. **Direction Of Wrench Nut Rotation To Open** – Right (clockwise) except for exposed valves at the WWTP which shall open left (counter-clockwise). The number of turns for 6-inch valves shall be 20; the number of turns for 8-inch valves shall be 26; the number of turns for 12-inch valves shall be 38.
  9. If bonnet is 2-piece, parts shall be through-bolted; tapped holes with stud bolts prohibited.
  10. Valve body and bonnet shall be coated on all exterior and interior surfaces with a fusion-bonded epoxy per AWWA C 550. Painted surfaces and spray applied epoxy coatings are not acceptable.
  11. The manufacturer's name, pressure rating, year of manufacture and size shall be cast on valve body.
  12. Each valve shall be tested to 400 psi hydrostatic pressure.
- C. BUTTERFLY VALVES** - Butterfly valves shall be per AWWA C 504 except as otherwise supplemented herein. Butterfly valves of the "wafer type" are not acceptable.

The manufacturer shall be regularly engaged in the design, manufacture, and maintenance of butterfly valves. The manufacturer must furnish satisfactory evidence of adequate facilities for furnishing repair parts and for maintenance of valves furnished.

AWWAC 504 is modified or supplemented as follows:

1. **Size** – Size shall be 16-inch and larger as specified.
2. **Valve Bodies** – Butterfly valves 16-inches through 24-inches in diameter shall be furnished with mechanical joint ends complete with bolts, nuts, retainer glands and gaskets.

Butterfly valves 30-inches diameter and larger shall be furnished with flanged joint ends with accompanying flanges and plain-end pieces assembled to the valve's flanged ends with bolts, nuts and gaskets. Each flanged and plain-end piece shall have an overall laying length of not less than 12 inches nor more than 18 inches.

3. **Class** – All parts shall be designed for Class 150B for use on water mains carrying filtered water with an approximate average pH of 7.5.
4. **Valve Shafts** – Valve shafts shall be fabricated of either Type 316 or Type 304 wrought stainless steel and shall be either a 1-piece unit extending completely through the valve disc or be of the “stub shaft” type.
5. **Valve Discs** – Discs shall be cast-iron per ASTM A 48, Class 40 or ductile-iron per ASTM A 536, Grade 65-45-12.
6. **Valve Seats** – Seats shall be mechanically retained either in the valve disc or in the body:
  - a. 360 degree rubber seat edge on disc retained by corrosion-resistant disc retainer ring and Type 304 stainless cap screws. Mating seat in valve body shall consist of a Type 304 stainless steel separate ring, set integral with body.
  - b. 360 degree rubber seat in valve body retained by corrosion-resistant disc retainer ring segments and Type 304 stainless cap screws. Mating seat on valve disc shall consist of either Type 316 stainless steel or monel disc edge on the case or ductile-iron disc.
7. **Valve Bearings** – A jacking or adjusting device to provide axial adjustment of the shaft and attached disc shall be provided for valves larger than 24-inch diameter. The jacking or adjusting assembly shall be protected from break-off or thread damage by recessing, cover plate, or other approved method. As an alternate to the aforementioned, a factory adjusted and set thrust bearing may be provided to carefully center the disc in the valve body. The thrust bearing shall be of adequate strength to carry all axial loads.
8. **Shaft Seals** – Shaft seals shall be designed for use of standard O-ring seals only. Seals of the type utilizing a stuffing box and pull-down packing gland are prohibited.
9. **Type Of Installation** – Buried, except for WWTP which may be buried or exposed.
10. **Type Of Operator** – Manual unless otherwise specified.
11. **Direction Of Operating Stem Rotation To Open Valve** – Right (clockwise) except for exposed valves at the WWTP which shall open left (counter-clockwise).
12. **Valve Operators** – Unless otherwise approved or shown on the drawings, a manual operator shall be furnished, assembled to each valve. The operating stem shall be provided with a 2-inch square nut. Manual operators shall be totally enclosed worm gear or link lever design.
 

Operators on valves 24-inch and smaller diameter may be of the traveling nut design per AWWA C 504, but in either case, the valve operator shall require a minimum of 35 turns from closed to open position.

Operators shall have adjustable stop limiting devices, for open and closed position, that must withstand an input torque of 300 foot-pounds on the square key nut without damaging the valve or operator. Stop limiting devices shall be factory set at the time of valve testing.
13. **Valve Position Indicators** shall be totally enclosed with no exposed moving parts. A highly visible and corrosion resistant valve position indicator shall be provided on all valves. The valve position indicator shall be such that the position of the valve (open-closed) may be determined from above at the operating level. The valve-operating stem shall be in the vertical position at all times. Indicators shall be Beacon type or approved equivalent product manufactured by Westlock Controls Corporation, 280 Midland Avenue, Saddle Brook, New Jersey.
14. **Markings** – All identifying or data plates or markings bearing serial numbers, ratings, and other essential information shall be placed on the valve body or operator so they are readable from above.
15. **Painting** – Exterior surfaces of buried valves shall be coated with asphaltic varnish per AWWA C 504. Exposed valves shall be shop painted as directed.

## 810.02 FIRE HYDRANTS

Fire hydrants shall be compression type, hand operated for fire protection service under operating pressure of 200 psig manufactured per AWWA C 502. All fire hydrants furnished shall be tested to 300 psig operating pressure.

The manufacturer shall be regularly engaged in the design, manufacture and maintenance of fire hydrants. The manufacturer must furnish satisfactory evidence of adequate facilities for furnishing repair parts for hydrants furnished.

Hydrant Models – Mueller Centurion 200-Model No. A-423, (made by Mueller Company, Decatur, Illinois), Kennedy Guardian-Model No. K-81-A (made by Kennedy Valve, Elmira, New York), U.S. Pipe Metropolitan-Model No. 250 (made by U.S. Pipe and Foundry Company, Birmingham, Alabama), American-Darling – Model No. B-84-B, (made by American Flow Control, Birmingham, Alabama), Claw Medallion – Model No. 2545 (made by Claw Valve Company, Oskaloosa, Iowa), or approved equal.

Alternate fire hydrants shall be submitted in advance with the Contractor's Preliminary Construction Scheduling, 108.03, for approval.

AWWA C 502 is modified or supplemented as follows:

- A. When required, the Contractor shall furnish catalog and maintenance data.
- B. Certified drawings showing the principal dimensions, construction details, and materials shall be submitted for approval per 105.02.
- C. Affidavit of compliance required.
- D. **SIZE** – 5-1/4 inch minimum, nominal I.D. main valve opening.
- E. **BURY LENGTH** – 4-1/2 feet of cover.
- F. **BARREL SECTIONS** – Hydrants shall be “traffic” type fire hydrants with frangible cross section near the ground line designed to break on vehicle impact.
- G. **HYDRANT TOP** – Hydrants shall be permanently lubricated and require 1 man maintenance, no special tools.
- H. **OUTLET NOZZLES** – Two 2-1/2 inch nominal I.D. hose nozzles; one 4-inch nominal I.D. pumper connection.  
Threads for 2-1/2 inch nozzles per National Fire Standard Hose Coupling Screw Threads; threads for 4-inch pumper connection:
  - 1. **Major Diameter** - 5-3/32 inch
  - 2. **Thread Form** - V
  - 3. **Number Threads/Inch** - 4
- I. **OPERATING STEM AND MECHANISM** – Operating and outlet nozzle cap nuts shall be pentagonal in shape. The pentagon shall measure 1-51/64 inch from point to flat at the base of the nut and 1-47/64 inch at the top. Height of the nut shall be 1 inch. Direction of operating nut rotation to open: Left (counterclockwise). Drawings furnished by the District upon request.
- J. **O-RING SEALS** – O-ring seals shall be used in lieu of stuffing box.
- K. **GASKETS** – Material shall be rubber composition; asbestos prohibited.
- L. **HYDRANT INLET** – Boot side inlet shall be 6-inch diameter with retainer gland mechanical joint per 809.01(C)(3).
- M. **CAP CHAINS** – Hose cap chains and steamer cap chains are required with all hydrants.  
Chain links (zinc plated steel) shall be fabricated not less than 1/8 inch in diameter and with S hook device (zinc plated) attached.
- N. **PAINTING** – Above grade line, outside of hydrant shall be painted with 2 coats of zinc chromate primer and 2 finish coats of No. 209 medium green enamel manufactured by Purity Paint Products Corp., Brooklyn, New York; or approved equivalent product.
- O. **GRAVEL FOR DRY WELL** - Washed gravel.
- P. **FILTER FABRIC**
  - 1. Woven filter fabric shall be composed of polypropylene monofilament yarns woven into sheets of approximately 16 mil thickness. The tensile strength of the fabric shall be per ASTM D 1682. The weave of the fabric shall be dense and tight so the openings are barely visible.

2. The test results shall indicate the filter fabric can effectively retain particles coarser per opening of U.S. 140-sieve mesh for all conditions.
3. Tests shall also demonstrate that the filter permeability is between 3.3 and 3.8 x 100 centimeters per second.
4. Filter fabric shall be manufactured by Mirafi Company, P.O. Box 240967, Charlotte N.C. or approved equal.

## 811 PAINTS, COATINGS, AND PRESERVATIVES

### 811.01 GENERAL

- A. **CERTIFICATION** – All paints to be furnished shall be certified by the manufacturer to be in conformance with this specification prior to being shipped to the Project Site.
- B. **FACTORY TESTING REQUIREMENTS** – Unless otherwise specified, paint shall be factory tested in conformance with Federal Test Method Standard 141. Tests shall be performed at 75° F and 50 percent relative humidity unless otherwise specified.
- C. **MATERIAL AND PACKAGING REQUIREMENTS** – Only 1 formulation per color will be permitted per project. All paint shall be satisfactory for brushing, rolling, or spraying.

All paints within a system shall be from the same manufacturer and shall be tinted at the point of manufacture to differentiate between coats, existing coats, and bare metal. Paint shall be shipped in the original containers and all containers shall bear the identification of the paint, consisting of the manufacturer's name, the name or title of material, volume of contents, manufacturer's paint identification number, the date of manufacture, color name and number, handling instructions, precautions, and the batch number. A materials product safety data sheet shall also be provided.

- D. **APPROVED PAINT MANUFACTURERS** – The District shall consider only those manufacturers from either the states of Maryland or Virginia list of Approved Paint Manufacturers, subject to acceptance of the manufacturer's submitted Quality Control Plan.
- E. **QUALITY CONTROL PLAN** – The Quality Control Plan shall define the manufacturer's process to ensure that the quality of the products during and upon completion of the manufacturing process. As a minimum, the Quality Control Plan shall list the following information:
  - 1. Name of quality control tests and test procedures used.
  - 2. Detailed description of the test procedures if not a standard test.
  - 3. Frequency of quality control tests.
  - 4. Maintenance of quality control records and length of time that they will be maintained.
- F. **ACCEPTANCE** – The paint manufacturer shall furnish certified test results for each lot and color of paint as specified. Certified test results for each lot shall list the actual test results for the specified properties. The certification shall be approved by the Engineer prior to shipment, and a copy shall accompany each shipment.
- G. **ORIGINAL INFRARED SPECTROGRAM** – The manufacturer shall submit an original analysis of vehicle solids by infrared spectroscopy performed as specified in ASTM D 2621 as follows:
  - 1. For zinc primers coatings, infrared spectrum (2.5 to 15  $\mu\text{m}$ ) of each vehicle component.
  - 2. For 2 component coatings, infrared spectrum (2.5 to 15  $\mu\text{m}$ ) of each single component and each mixed component when applicable, in appropriate mixing ratios.
- H. **CERTIFICATION VERIFICATION TOLERANCES** – The Engineer shall be permitted to visit the manufacturer's facilities at random intervals to obtain his own test samples. A comparison will be made between the manufacturer's certified test results and the District's test results on the same batch. Any materials test results not within the established tolerances shall be cause for rejection of the material by the Engineer. The tolerances between these results shall conform to the following:



**TABLE 811.01 CERTIFICATION VERIFICATION TOLERANCES**

TEST	TOLERANCE	TEST METHOD
Total Solids by mass, %	± 2	ASTM D 2369
Pigment Content by mass, %	± 2	ASTM D 2698 or ASTM D 4451
Vehicle Solids by mass, %	± 2	ASTM D 2369
Viscosity, KU	± 10	ASTM D 562
Unit Weight, lbs/gal	± 0.5	ASTM D 1475
Volatil Organic Compound (VOC)	Maximum limits of VOC shall conform to the current regulations governing the point of application, whether in the District or in other jurisdictions; however, any one type of paint specified for both shop-field (District) application shall be subject to the more restrictive criteria of the 2 jurisdictions.	

- I. FIELD SAMPLING AND TESTING BY THE ENGINEER** – After delivery, the paint shall at all times be subject to field sampling and testing by the Engineer. The unit weight (minimum net weight per gallon) and color shall constitute minimum field acceptance requirements. The Engineer reserves the right to take a reasonable number and volume of samples from the supplied stockpile in the field as deemed necessary to conduct independent verification testing.

All rejected paint shall be so marked and immediately removed from the Work area to the satisfaction of the Engineer.

## 811.02 PRIME COAT

Included in this subsection are the requirements of shop and field applied primer coatings used for spot painting on properly prepared new and existing steel.

### A. GENERAL REQUIREMENTS

1. On areas to receive 2 coats of primer paint, the first coat shall be darkened with 1/4 ounce of lampblack paste per gallon of paint to provide a contrast between shades of the 2 coats.
2. All shop-applied primer coatings for steel shall conform to AASHTO M 300, Class B slip coefficient and creep testing criteria for use on faying surfaces of A-325 or A-490 bolted connections unless otherwise approved by the Engineer.

- B. INORGANIC ZINC RICH PRIMER** - Inorganic Zinc Rich Primer shall conform to AASHTO M 300, Type I or IA. Self-curing inorganic zinc-rich primers shall be solvent base vehicle type.

#### 1. Material Requirements

- a. The pigment used in the formulation shall be zinc dust and shall conform to the requirements of ASTM D 520, Type II. Small amounts of color and extender pigments may be used provided the quantitative requirements of the complete paints are met. The color of the inorganic zinc primer shall be such that a definite contrast is readily apparent between it and the color of blasted steel.
- b. Vehicle shall be a solvent solution with silicates, curing aids, tinting colors, suspension, and pot life control agents as selected by the manufacturer.
- c. The pot life of the mixed paint shall be a minimum of eight (8) hours at 77° F and 50 percent humidity. The vehicle of the paint shall show no thickening, curdling, gelling, gassing, or hard caking after being stored unmixed for nine (9) months from date of manufacture in a tightly covered unopened container at a temperature of 50° to 90° F. Storage life shall be in accordance with ASTM D 1849.

2. **Drying Time** - Set to touch time of mixed paint shall be determined in accordance with ASTM D 1640 and shall not exceed thirty (30) minutes at 77° F.

Cure hard to recoat time of mixed paint shall be determined by the methylethyl ketone (MEK) rub test. Using a wadded piece of cheesecloth saturated with methylethyl ketone, rub with a firm pressure over a 1 inch long section of primer 50 times. Examination of the surface of the primer shall show only burnishing, polishing, or trace removal of loose particles when the primer has been cured for twenty-four (24) hours at 80° F and 90 percent relative humidity.

- C. ALUMINUM EPOXY MASTIC** - Aluminum epoxy mastic primer shall have 1 component that is the condensation product of the reaction of epichlorohydrin with bisphenol A. Drying time shall be eight (8) hours maximum to touch, twenty-four (24) hours minimum to thirty (30) days maximum for recoat, and forty-eight (48) hours maximum to hard. Minimum pot life shall be three (3) hours. Solids shall be 90 percent minimum by weight and 80 percent to 90 percent by volume.

Viscosity shall be 95 to 140 KU and flexibility shall pass a 180° bend around a ¾ inch mandrel when tested in conformance with ASTM D 522. The material shall resist sagging when tested in conformance with ASTM D 4400 with no sagging at the manufacturer's recommended wet film thickness. The mixed paint shall weigh 13.0 ±0.5 lb/gal.

- D. ORGANIC ZINC RICH PRIMER** - Organic zinc rich primer shall conform to SSPC- Paint 20, Type II.

- E. ZINC RICH MOISTURE CURED URETHANE** - Zinc rich moisture cured urethane primer shall be 1-component having a minimum zinc pigment content in the dry film of 80 percent. Minimum solids shall be 80 percent by weight and 62 percent by volume. The viscosity shall be 95 to 105 KU. The primer shall be capable of being applied at 50 percent greater film build than required without runs or sags in conformance with ASTM D 4400.

The interval of application of next coat shall be eight (8) hours minimum and thirty (30) days maximum. The coating shall also conform to the Moisture Cured Urethane Additional Performance Criteria Table (see current Maryland SHA Standard Specifications) except that the maximum loss for Abrasion Resistance shall be 82.0 mg, and Salt Spray after one thousand (1000) hours shall be 1/32 in. maximum.

- F. MICACEOUS IRON OXIDE AND ALUMINUM FILLED MOISTURE CURED URETHANE** - Micaceous iron oxide and aluminum filled moisture cured urethane shall have a minimum solids content of 75 percent by weight and 60 percent by volume. The viscosity shall be 95 to 100 KU. The coating shall conform to the Moisture Cured Urethane Additional Performance Criteria Table (see current Maryland SHA Standard Specifications).

- G. PENETRATING SEALER** - Penetrating sealer shall have a viscosity of 75 to 101 KU and be able to penetrate and seal existing coatings and substrate. It shall be suitable for application over marginally prepared steel and most generic types of aged coatings. The sealer shall conform to one of the following:

1. Epoxy penetrating sealer shall be cross-linked amido-amine epoxy primer/sealer having 2 components mixed in conformance with the manufacturer's recommendation. It shall contain a minimum of 95 percent solids by weight.
2. Moisture cured urethane micaceous iron oxide filled penetrating primer/sealer shall be 1 component having a minimum of 75 percent solids by weight. It shall also conform to the Moisture Cured Urethane Additional Performance Criteria Table (see current Maryland SHA Standard Specifications).

- H. ZINC DUST-ZINC OXIDE PRIMER PAINT** - Zinc dust-zinc oxide primer paint shall conform to the requirements of the Federal Specification TT-P-641G, Type I (linseed oil-thinner vehicle). Pigment content shall be 78 to 81 percent of total weight. Minimum net weight of the finished paint shall be 23 pounds per gallon. This paint shall be used for priming galvanized metal prior to field painting with finish coats.

- I. PETROLATUM PRIMER** - Rust-inhibitive petrolatum primer shall conform to the requirements of the U.S. Maritime Administration Specification 52-MA-602, Type B Medium. This primer shall be used for coating field metal to metal contact surfaces, field weld areas, or other metal surfaces where a temporary rust-inhibitive coating is required. This primer may be removed by wiping with thinner (mineral spirits) conforming to requirements of 811.02H.

- J. WOOD PRIMER-SEALER** - Wood primer-sealer shall conform to requirements of the Federal Specification TT-P-25F. This primer-sealer shall be used for priming new wood surfaces and weathered, previously painted wood surfaces prior to field painting with finish coats.

- K. ZINC-CHROMATE, LOW-MOISTURE SENSITIVITY** - Factory-mixed zinc-chromate low moisture sensitivity primer shall conform to the requirements of FS TT-P- 1757, Composition L. This paint shall be used to coat surfaces of aluminum parts that will be embedded in concrete or masonry.

### 811.03 INTERMEDIATE (MID) COAT

The intermediate (mid) coat, if specified, shall be from the same paint manufacturer as the prime coat and shall be compatible with the primer and the topcoat.

- A. EPOXY POLYAMIDE INTERMEDIATE COAT** - Epoxy polyamide intermediate coat shall have 1 component that is the condensation product of epichlorohydrin with bisphenol A. The epoxy polyamide shall have a 3.0 minimum fineness of grind (Hegman Units), and maximum solids content of 75 percent by weight and 62 percent by volume. Maximum dry time to touch and recoat shall be six (6) and fifteen (15) hours, respectively.
- B. MICACEOUS IRON OXIDE MOISTURE CURED URETHANE INTERMEDIATE COAT** - Micaceous iron oxide moisture cured urethane intermediate coat shall have 1 component with minimum solids content of 80 percent by weight and 60 percent by volume. The viscosity shall be 90 to 100 KU. The interval for application of next coat shall be eight (8) hours minimum and thirty (30) days maximum. The coating shall also conform to the Moisture Cured Urethane Additional Performance Criteria Table (see current Maryland SHA Standard Specifications). The micaceous iron oxide content shall be a minimum of 3.0 lb/gal.

#### 811.04 TOPCOAT

- A. ALUMINUM TOPCOAT** - Aluminum paint used as a topcoat shall be a 2-component aluminum leafing paint composed of 1-1/2 pounds of aluminum pigment paste for each gallon of aluminum mixing varnish.

This aluminum mixing varnish shall be a long oil varnish and shall contain not less than 50 percent, by weight, of nonvolatile oil and gums. The varnish shall be free from sulphur, sulphur compounds, and rosin. The acid number of the varnish shall be not more than 10, based on the nonvolatile content.

The varnish shall pass a 100 percent Kauri reduction test.

The viscosity of the varnish shall be from A to D inclusive, as determined with Gardner Bubble Viscometer, Varnish Series.

The varnish, when mixed with paste, shall produce a paint showing satisfactory leafing and spreading properties, and shall not run nor sag when applied to a smooth vertical surface.

The paint shall set to touch in not less than two (2) hours nor more than six (6) hours, and shall dry hard and tough in not more than twenty-four (24) hours.

The aluminum paste and varnish shall be furnished in separate containers unless otherwise permitted by the Engineer. The container for the varnish shall be of such size as will permit the mixing of the paste and varnish in the proper proportion without overflow.

Leafing paint shall be mixed immediately prior to application, in the presence of the Engineer and shall be used within twenty-four (24) after mixing.

Leafing and non-leafing paint shall not be mixed together, and paints so blended will be rejected.

The paste shall conform to Federal Specification TT-P-320, Type II, Class 2, except the paste shall be non-leafing.

- B. ALIPHATIC URETHANE FINISH COAT** - Aliphatic urethane finish coat shall have minimum solids content of 70 percent by weight and 47 percent by volume. Drying time to touch and hard shall be the minimum recommended by the paint manufacturer.
- C. MOISTURE CURED ALIPHATIC URETHANE FINISH COAT** - Moisture cured aliphatic urethane finish coat shall be a single component with a maximum free monomer content of 0.7 percent. Minimum solids content shall be 75 percent by weight and 60 percent by volume, and the viscosity shall be 70 to 80 KU. The interval for application of next coat shall be eight (8) hours minimum and thirty (30) days maximum. The coating shall also conform to the Moisture Cured Urethanes Additional Performance Criteria Table (see current Maryland SHA Standard Specifications).
- D. OTHER TOPCOATS** - The following paints shall be used only in maintenance situations to overcoat existing paints of the same type. Colors shall match existing colors.
1. Factory mixed light-gray alkyd-gloss enamel paint shall conform to the requirements of FS TT-E-489G, Type I, Class A for brush application, or Class B for spray application (if gloss is not desired, paint shall conform to the requirements of FS TT-P-105), and shall be tinted with lamp black paste to match Paint Chip No. 26408 of FS-TT-C No. 595, "Colors." On areas to receive 2 coats of this paint, the first coat shall be darkened with additional lampblack paste in sufficient amount to provide a contrast between shades of the 2 coats, subject to approval by the Engineer.
  2. **White Paint** - Factory mixed white alkyd-gloss enamel paint shall conform to the requirements of FS TT-E-489G, Type I, Class A for brush application, or Class B for spray application (if gloss is not desired, paint shall conform to the requirements of FS

TT-P-105). On areas to receive 2 coats of this paint, the first coat shall be darkened with lampblack paste with the minimum amount of lampblack added.

3. **Gray Channel Paint (PEPCO)** - Paint to coat light standard installations after erection; all exposed shop painted surfaces shall be field painted with 1 coat of alkyd gloss enamel gray channel paint meeting the requirements of FS-TT-E- 489G and matching the gray paint color used by PEPCO.
4. **Asphalt Varnish Paint** - Factory-mixed asphalt varnish paint shall conform to requirements of FS TT- V-51, for "Varnish, Asphalt". This paint shall be used to thoroughly coat surfaces of aluminum parts that will come in contact with concrete or masonry surfaces, but excluding aluminum parts embedded in concrete or masonry.

### 811.05 SOLVENTS

Solvents used for solvent cleaning of metal surfaces shall include kerosene, varsol, naphtha, and mineral spirits. Substances not removable by these solvents shall be removed by methods and chemicals presented in Chapter 02-14 of Steel Structures Painting Council (SSPC) "Good Painting Practice," Volume I.

Solvents shall be approved by the Engineer before use.

### 811.06 GALVANIZING

Galvanizing shall refer to the coating of steel or iron parts with metallic zinc by the hot dip or mechanical process.

All metal parts to be galvanized shall be thoroughly cleaned before application of zinc, and for steel and iron castings, this cleaning shall include sandblasting.

Galvanizing of iron and steel hardware shall conform to the requirements of AASHTO M 232 for the hot-dip process or ASTM B 695, Class 50, for the mechanical process.

Galvanizing of rolled, pressed, and forged steel shapes, plates, bars, and strips shall conform to the requirements of AASHTO M 111.

### 811.07 WOOD PRESERVATIVES

- A. **PRESSURE TREATMENT FOR PARK TYPE WOODEN GUARDRAIL** - Pressure treatment shall be with pentachlorophenol petroleum solution in accordance with AWWA U1, with a minimum net retention of 0.4 pound per cubic foot. The pentachlorophenol solution shall have a minimum of 5 percent pentachlorophenol, meeting the requirements of AASHTO M 133 (AWPA-P8), in an oil-base vehicle, meeting the requirements of AASHTO M 133, and as nearly colorless as obtainable.
- B. **TIMBER PILES** - Timber piles shall conform to AASHTO M 133 and AWWA U1 except that creosote shall not be used.
- C. **WOOD SIGN POSTS** - Preservative shall conform to AASHTO M 133 and pressure treatment shall conform to the requirements of AWWA U1.

### 811.08 PREQUALIFIED COATING SYSTEMS

Pre-qualified coating systems for structural steel are listed in Table 811.08.

**TABLE 811.08 PREQUALIFIED COATING SYSTEMS FOR STRUCTURAL STEEL**

	New or Existing Steel Shop Painting	Existing Steel Field Painting
Prime Coat	Inorganic Zinc-Rich Primer	Organic Zinc-Rich Primer Epoxy
Intermediate Coat	Epoxy Polyamide	Epoxy Polyamide
Finish Coat	Aliphatic Urethane Topcoat	Aliphatic Urethane Topcoat

Note: Multiple applications of an individual coat may be necessary to achieve the total DFT required by the Contract.

## **812 REINFORCING STEEL AND WIRE ROPE**

### **812.01 WELDED WIRE FABRIC**

Steel welded wire fabric reinforcement shall consist of longitudinal main members with transverse members at right angles, thereto. Intersecting members shall be electrically welded in such a manner as to develop the full tensile strength across the welds. The steel wire fabric shall meet the requirements of AASHTO M 55, and shall conform to the weights and spacing as shown on the Plans.

### **812.02 DEFORMED REINFORCING STEEL**

Reinforcing steel shall meet the requirements of AASHTO M 31, Grade 60, as specified, except that reinforcing steel for sewer-water structures shall be Grade 60.

Reinforcement shall be newly rolled in an approved mill and accurately fabricated to the dimensions shown in the Contract Documents. Rail-steel bars are prohibited.

Hooks and stirrups shall be bent using dimensions and diameters defined by ACI Standard Hooks in the Manual of Standard Practice of CRSI.

All reinforcing steel radii bends regardless of size shall be dimensioned and payment will be made as correctly dimensioned.

### **812.03 EPOXY COATED REINFORCEMENT BARS**

Epoxy coated reinforcement bars shall meet the requirements of ASTM A 775 including the prequalification requirements of ASTM A 775, Annex A1. For acceptance purposes at least 90 percent of all recorded film thickness measurements shall be as per Section 8.1 of ASTM A 775.

## 813 FENCE AND GUARDRAIL

### 813.01 BARBED WIRE

Barbed wire shall conform to the requirements of AASHTO M 280 for the coating class specified.

### 813.02 WOVEN WIRE FENCE FABRIC

Woven wire shall conform to the requirements of AASHTO M 279 for the coating class specified.

### 813.03 CHAIN LINK FENCE

**A. GENERAL** - When the type of chain link fence is not specified, all chain link fence materials including chain link fabric, posts, rails, ties, bands, bars, rods, hardware and other fittings shall meet the requirements of AASHTO M 181. Type I shall be used unless otherwise specified in the Contract Documents.

1. **Chain Link Fence Fabric** - Chain Link Fence Fabric shall be a No. 9 gauge fence fabric, woven in a 2 inch by 2 inch diamond mesh and shall conform to the requirements of AASHTO M 181 unless otherwise noted in the Contract Documents. Type I fabric shall conform to Class D coating. Polyvinyl chloride (PVC) coated steel fabric shall conform to F 668, Class 2B, thermally fused. Polyvinyl chloride (PVC) color shall be warm gray or black as specified in the Contract Documents.
2. **Tie Wires, Wire Clips, Tension Wires, and Tension Wire Clips** - These items shall conform to AASHTO M 181. The galvanized coating shall have a minimum weight of 1.2 oz./sq. ft. These items, when used with aluminum coated steel fabric, shall be coated with aluminum at a minimum weight of 0.40 oz./sq. ft. The tension wire used with polyvinyl chloride (PVC) coated steel fabric shall have the same coating thickness and color requirements as the fence.
3. **Posts, Post Braces, Tension Bars, Truss Rods, Fittings, and Hardware** - These items shall conform to AASHTO M 181. When these items are specified to be PVC coated, they shall be thermally fused and bonded. The PVC thickness shall be 10 to 15 mil except that the bolts, nuts and washers shall be metallic coated steel.
4. **Gates** - Gate materials shall conform to AASHTO M 181. The fabric used for gates shall be identical to the fence fabric. The gate frame and other hardware shall conform to 813.03(A)(2) and 813.03(A)(3). When the gate frame is PVC coated, movable fittings, such as hinges and latches, shall be field coated with a PVC coating specifically prepared for this purpose.

**B. VINYL CLAD CHAIN LINK FENCE WITH REDWOOD SLATS** - The materials for this type of fence shall be chain link fence meeting 813.03(A).

**C. SAFETY FENCE SHIELDING** - Safety fence shielding shall be chain link fence meeting 813.03(A).

Plates shall meet the requirements of ASTM A 36.

Anchor bolts shall meet the requirements of ASTM A 307, Grade A.

### 813.04 METAL BEAM RAIL

The rail elements shall be corrugated sheet steel beams conforming to the requirements of AASHTO M 180 Class A, Type 1. Galvanizing shall be in accordance with AASHTO M 111.

### 813.05 TIMBER RAIL

The timber rail, including offset blocks, shall be cut from the specified grade of dry, well seasoned and dressed timber block of the species specified, which shall meet the applicable requirements of AASHTO M 168.

Where preservative treatment is specified this shall conform to the requirements for "Preservative Treatments for Timber" of the AASHTO Standard Specifications for Highway Bridges. Timber preservatives shall conform to the requirements of AASHTO M 133.

**813.06 FENCE POSTS**

- A. WOOD POSTS** - Wood posts shall conform to the details and dimensions indicated on the Plans. All wood posts shall be of sound, seasoned wood, peeled and with ends cut square or as indicated. The posts shall be straight and all knots trimmed flush with the surface. Where treated posts are specified, the kind and type of treatment shall conform to that indicated on the Plans. When red cedar posts or bracing is furnished, the requirements for peeling may be omitted.

All dimension timber and lumber required for fences or gates shall be sound, straight, and free from knots, splits, and shakes. It shall be of the species and grades indicated on the Plans and shall be dressed and finished on all 4 sides.

- B. CONCRETE POSTS** - Concrete posts shall be made of concrete, Class A, and shall contain steel reinforcement as shown on the Plans.
- C. STEEL POSTS** - Steel posts shall be galvanized in accordance with AASHTO M 111 except that tubular steel posts shall be galvanized in accordance with ASTM A 53. Fittings, hardware, and other appurtenances not specifically covered by the Plans and Specifications shall be standard commercial grade, and in accordance with current standard practice.

**813.07 GUARDRAIL POSTS**

Guardrail posts shall conform to the requirements of ASTM A 36. Galvanizing shall be as per ASTM M 111. Nuts, bolts, and washers for steel guardrail shall conform to the requirements of AASHTO M 180.

**813.08 BOX BEAM RAIL**

Steel beam rail elements shall conform to the requirements of ASTM A 500 Grade B or ASTM A 501 and shall be galvanized after fabrication in accordance with AASHTO M 111, except when corrosion resistant steel rail elements are specified. In which case rail elements shall be made of steel meeting the dimensional and mechanical requirements of ASTM A 500 or ASTM A 501 and having an atmospheric corrosion resistance approximately 2 times that of carbon structural steel with copper and shall not be painted or galvanized.

## 814 CONCRETE CURING MATERIALS AND ADMIXTURES

### 814.01 CURING MATERIALS

- A. **BURLAP** - Burlap shall meet the requirements of AASHTO M 182, Class 3.
- B. **POLYETHYLENE SHEETING** - Polyethylene sheeting for curing Portland Cement Concrete shall meet the requirements of ASTM C 171 and shall be opaque white.
- C. **WATERPROOF PAPER** - Waterproof paper for curing Portland Cement Concrete shall meet the requirements of ASTM C 171.
- D. **WHITE BURLAP-POLYETHYLENE SHEET** - White burlap-polyethylene sheet for curing Portland Cement Concrete shall meet the requirements of ASTM C 171
- E. **INSULATION BLANKET** - Insulation blanket used for curing Portland Cement Concrete shall be impervious to water, of uniform thickness and composition, and of a size acceptable to the Engineer for its intended use and shall conform to the requirements of ASTM C 553. A sample of material representative of that proposed for use shall be submitted by the Contractor and approved prior to use.

### 814.02 LIQUID MEMBRANE CURING COMPOUNDS

- A. Membrane curing compound shall meet the requirements of ASTM C 309, Type 1D with fugitive dye, Class B.
- B. For walls, membrane cure shall meet the requirements of ASTM C 309, Type 1 Class B.

### 814.03 AIR ENTRAINING ADMIXTURES

Materials to be incorporated in PCC to entrain air shall meet the requirements of AASHTO M 154.

### 814.04 CHEMICAL ADMIXTURES

- A. **ACCELERATOR** - Materials to be incorporated in the PCC mix as an accelerator shall meet the requirements of AASHTO M 194, Type C or E as specified, except that the accelerating admixture shall contain not more than 500 parts per million chloride ion.  
Admixtures causing accelerated setting of cement in PCC shall not be used in PCC for sewer-water structures.
- B. **RETARDER** - Materials to be incorporated into the PCC as a retarder shall meet the requirements of AASHTO M 194, Type B or D as specified.
- C. **WATER REDUCER** - Materials to be incorporated in the PCC as a water reducer shall meet the requirements of AASHTO M 194, Type A or D as specified.  
High range water reducing admixtures (super-plasticizer) shall meet the requirements of AASHTO M 194, Type F.

### 814.05 COLOR ADMIXTURES

- A. **CARBON POWDER** - Carbon powder for darkening PCC shall be Carbon Black (concrete grade) in accordance with ASTM C 979. The material shall be such that it will not float and will be uniformly and completely dispersed throughout the plastic PCC.
- B. **OTHER** - Materials other than carbon powder used for coloring PCC shall be as required by the Contract Documents and shall conform to appropriate requirements of ASTM C 979.



**815 METAL FOR STRUCTURES****815.01 STRUCTURAL STEEL**

The materials shall conform to the Specifications as listed in the following tabulation with modifications and additions as specified herein.

**A. STRUCTURAL CARBON STEEL - ASTM A 36.****B. HIGH-STRENGTH LOW ALLOY STRUCTURAL STEEL - High-strength low-alloy structural steel, high-strength low-alloy structural steel for welding, and high-strength structural steel for bolted construction shall conform to:**

1. **High-Strength Low-Alloy Structural Steel – AASHTO M 270.**
2. **High-Strength Low-Alloy Columbium-Vanadium Steels Of Structural Quality (Grades 42 and 50 For Welding) – ASTM A 572.**
3. **High-Strength Low-Alloy Structural Steel With 50,000 Psi Minimum Yield Point To 4-In. Thick – ASTM A 588.**

**C. HIGH-YIELD STRENGTH, QUENCHED, AND TEMPERED ALLOY STEEL PLATE**

1. **High-Yield Strength, Quenched And Tempered Alloy Steel Plate, Suitable For Welding - ASTM A 514.**
2. **Pressure Vessel Plates, Alloy Steel, High Strength, Quenched And Tempered-ASTM A 517.**
3. **Seamless Mechanical Tubing (Maximum Tensile Strength 145,000 Psi) – ASTM A 519.**

**D. HIGH-STRENGTH FASTENERS**

1. **Bolts – AASHTO M 164, or AASHTO M 253, and Table 815A**
2. **Nuts – AASHTO M 291, and Table 815A**
3. **Washers – AASHTO M 293 and Table 815B**
4. **Direct Tension Indicators - ASTM F 959**

**E. WELDING ELECTRODES - Welding electrodes, electrode testing, and certification shall conform to the requirements of the AASHTO AWS D 1.1 Structural Welding Code and AASHTO AWS D 1.5 Bridge Welding Code.****F. WELDED STUDS - Welding of studs shall meet the requirements of AASHTO AWS D Structural Welding Code and AASHTO AWS D 1.5 Bridge Welding Code.****G. PINS AND ROLLERS**

1. **Greater than 9 inches diameter – AASHTO M 102, Class E.**
2. **9 inches diameter or less – AASHTO M 102, Class E or AASHTO M 169, Grade 1022 to 1030 inclusive; with minimum Rockwell Scale B Hardness of 85 or minimum tensile strength of 72,000 psi and minimum yield point of 36,000 psi.**

**H. ANCHOR BOLTS - ASTM A 307.****I. CAST STEEL - AASHTO M 103, Grade 65-35, fully annealed.****J. TOUGHNESS - All structural steel plate within the tension zone shall meet the longitudinal Charpy V-notch impact requirements determined and specified in AASHTO M 270 for Zone 2:**

**TABLE 815.01 AASHTO AND SUPPLEMENTAL REQUIREMENTS**

<b>Material (AASHTO)</b>	<b>Supplemental Requirement</b>
M 161	S1
M 183	S3
M 188	S1
M 222	S1
M 223	S2
M 244	S3

**K. CARBON STEEL EXTERNALLY THREADED FASTENERS - ASTM A 307.****815.02 PRESTRESSING REINFORCEMENT**

Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength 7-wire strand, or high-tensile-strength alloy bars as specified in the Contract Documents.

All wire, strand, or bars to be shipped to the Site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished and, in the case of wire or strand, shall be taken from the same master roll.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

Where the Engineer intends to require nondestructive testing of 1 or more parts of the Structure, special Specifications shall be drawn giving the required details of the Work.

The vendor shall furnish for testing the following samples selected from each lot including heat and reel numbers for each sample. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's Plant by the Inspector.

**A. SAMPLES**

- 1. Pre-Tensioning Method** - For pre-tensioned strands, 1 sample at least 7 feet long shall be furnished in accordance with the requirements of paragraph 9.1 of AASHTO M 203.
- 2. Post-Tensioning Method** - The following lengths shall be furnished:
  - a.** *For wires requiring heading* – 5 feet.
  - b.** *For wires not requiring heading* – sufficient length to make up 1 parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished.
  - c.** *For strand to be furnished with fittings* – 5 feet between near ends of fittings.
  - d.** *For bars to be furnished with threaded ends and nuts* – 5 feet between threads at ends.
  - e.** *Anchorage assemblies* – 2 anchorage assemblies shall be furnished, complete with distribution plates of each size and type to be used, if anchorage assemblies are not attached to reinforcement samples.

- B. HIGH-TENSILE-STRENGTH STEEL** - The high-tensile-strength steel shall be made by the basic-oxygen, open hearth, or electric-furnace process. The wire shall be cold drawn to size and suitably stress-relieved after cold drawing by a continuous strand heat treatment to produce the prescribed mechanical properties.

High-tensile-strength steel wire shall conform to the requirements of AASHTO M 204.

- C. HIGH-TENSILE-STRENGTH SEVEN WIRE STRAND** - High-tensile-strength 7-wire strand shall conform to the requirements of AASHTO M 203, for the grade specified in the Contract Documents.

- D. HIGH-TENSILE-STRENGTH ALLOY BARS** - High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of 130,000 psi. After cold stretching, the physical properties shall be as follows:

**TABLE 815.02 PHYSICAL PROPERTIES**

Minimum ultimate tensile strength	145,000 psi
Minimum yield strength, measured by the 0.7 percent extension under load method shall not be less than	130,000 psi
Minimum modulus of elasticity	25,000,000 psi
Minimum elongation in 20-bar diameters after rupture	4 percent
Diameter tolerance	+0.03inches, -0.01inches

**815.03 STEEL CASTINGS**

- A. STEEL CASTINGS FOR HIGHWAY BRIDGES** - Steel castings for use in highway Bridge components shall conform to AASHTO M 103, Grade 70-36.
- B. CHROMIUM ALLOY-STEEL CASTINGS** - Chromium alloy-steel castings shall conform to AASHTO M 163, Grade CA-15.

**815.04 GRAY IRON CASTINGS**

Gray iron castings shall conform to the requirements of AASHTO M 105, Class 30 A.

Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes and other defects in position affecting their strength and value for the service intended.

Castings shall be boldly filleted at the angles and the arrises shall be sharp and perfect. All castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

**815.05 DUCTILE IRON CASTINGS**

Ductile iron castings shall conform to the Specifications for Ductile Iron Castings, ASTM A 536, Grade 60-40-18, unless otherwise specified. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, shall be tested for castings weighing more than 1000 pounds to determine that the required quality is obtained in the castings in the finished condition.

Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in position affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

All castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

**815.06 CARBON STEEL FORGINGS**

Steel forgings shall conform to AASHTO M 102, Class C.

**815.07 ALLOY STEEL FORGINGS**

Alloy steel forgings shall conform to AASHTO M 102, Class A.

**815.08 COLD FINISHED CARBON STEEL SHAFTING**

Cold finished carbon steel shafting shall conform to AASHTO M 169, Grade Designation 1016 to 1030, inclusive.

**815.09 COPPER-ALLOY PLATES**

Copper-Alloy Plates shall conform to ASTM B 100.

**815.10 SHEET ZINC**

Sheet zinc shall conform to ASTM B-69, Type II.

**815.11 COPPER FLASHING**

All copper flashing shall be made of 16 oz. copper conforming to the requirements of, soft. It shall be machine bent to shapes and widths shown on the Plans.

**815.12 TURNBUCKLES**

Turnbuckles for steel beam guardrail shall conform to AASHTO M 269.

Tensile properties shall be determined in accordance with ASTM A 370. Tensile tests of finished anchors and stud shall be made on units welded to test plates. If fracture occurs outside the middle half of the gage length, the test shall be repeated.

**TABLE 815.12(A) BOLT AND NUT DIMENSIONS<sup>a</sup>**

Nominal Bolt Sizes D	Heavy Hexagon Structural Bolts			Heavy Semi-Finished Hexagon Nuts	
	Width Across	Thread Width Across			
	Flats F	Height H	Length T	Flats W	Height H
1/2	7/8	5/16	1	7/8	31/64
5/8	1-1/16	25/64	1-1/4	1-1/16	39/64
3/4	1-1/4	15/32	1-3/8	1-1/4	47/64
7/8	1-7/16	35/64	1-1/2	1-7/16	55/64
1	1-5/8	39/64	1-3/4	1-5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1-7/64
1-1/4	2	25/32	2	2	1-7/32
1-3/8	1-3/16	27/32	2-1/4	2-3/16	1-11/32
1-1/2	2-3/8	15/16	1-1/4	2-3/8	1-15/32

a Dimensions in inches

**TABLE 815.12 (B) WASHER DIMENSIONS<sup>a</sup>**

Circular Washers					Square or Rectangular Beveled Washers for American Standard Beams and Channels		
Bolt Size D	Nominal Outside Diameter <sup>b</sup>	Nominal Diameter of Hole	Thickness		Minimum Side Dimension	Mean-Thickness	Slope of Taper in Thickness
			Min.	Max.			
1/2	1-1/16	17/32	.097	.177			
5/8	1-5/16	21/32	.122	.177			
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	1-3/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	1-3/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6

Circular Washers				Square or Rectangular Beveled Washers for American Standard Beams and Channels			
Bolt Size D	Nominal Outside Diameter <sup>b</sup>	Nominal Diameter of Hole	Thickness		Minimum Side Dimension	Mean-Thickness	Slope of Taper in Thickness
			Min.	Max.			
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178 <sup>c</sup>	.28 <sup>c</sup>	2-1/4	5/16	1:6
2	3-3/4	2-1/8	.178	.28 <sup>d</sup>	2-1/4	5/16	1:6
>2, #4	2D-1/2	D + 1/8	.24 <sup>d</sup>	.34 <sup>d</sup>			

- a Dimensions in inches  
b May be exceeded by 1/4 inch  
c 3/16 nominal  
d 1/4 inch nominal

## 816 PILES

### 816.01 TIMBER PILES

Timber piles shall meet the requirements of AASHTO M 168 for piling.

Timber piles shall be treated with creosote oil by the empty cell process. Creosote oil for piles shall conform to AASHTO M 133. The preservative treatment shall be in accordance with AASHTO M 133.

### 816.02 STEEL H-PILES

Steel H-Piles shall conform to ASTM A 36.

The piles shall be of the size and weight per foot indicated on the Plans, and shall conform at the time of driving to camber and sweep as permitted by allowable mill tolerances.

Piles including splice pieces shall be cleaned of all rust and other foreign matter prior to shipment.

Cap plates for H-Pile Thrust Block shall be steel plate per ASTM A 36 of appropriate size and thickness.

### 816.03 CAST-IN-PLACE PILES

Metal shells shall be made of structural steel having a minimum tensile yield strength of not less than 50,000 psi. The metal of shells driven with a mandrel shall have a minimum allowable thickness of No. 18 U.S.S.G. Metal shells directly driven without a mandrel shall have a minimum allowable thickness of No. 11 U.S.S.G. Metal shells shall be of sufficient strength and rigidity to permit driving, and to prevent distortion caused by soil pressures or the driving of adjacent piles, until filled with concrete. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

The piles shall preferably be tapered and shall have a minimum tip diameter of 8 inches and minimum butt diameter of 12 inches. Combination piles with a tapered section and a constant section, if used, shall have a minimum tip diameter of 8 inches and a minimum butt diameter of 12 inches. The tapers shall conform to the manufacturer's standards. Piles of constant section, if used, shall have a minimum diameter of 12 inches. All diameters referred to herein are outside diameters.

### 816.04 UNFILLED TUBULAR STEEL PILES

The metal for unfilled tubular steel piles shall conform to the requirements of ASTM A 252, Grade 2 and the chemical requirements of ASTM A 53, Grade B.

### 816.05 BITUMEN COATING FOR STEEL PILES

Canal liner bitumen (ASTM D 2521) shall be used for coating. The primer shall conform to the requirements of ASTM D 41.

**817 PORTLAND CEMENT CONCRETE MIXTURES****817.01 PCC MIX DESIGN**

- A. GENERAL** - Concrete shall be proportioned within allowable tolerances of an approved mix design. An approved mix design shall consist of an approved concrete producer, materials sources, class of concrete, and material types and proportions. Mix designs for each project must be approved by the Engineer. Approval of a mix design for a specific project, purpose, or use does not approve its use for any other project, purpose, or use. Information submitted shall have been obtained from measurements on a trial mix prepared with ingredients from the same source(s) as proposed for use. Mix designs shall have been prepared within twelve (12) months prior to the date submitted. In the event such a mix design is not in full compliance with applicable Specifications, further production of that PCC mix shall be suspended until an approved mix design has been obtained in accordance with these specification requirements. Any deviation from the approved mix design will require the approval of the Engineer.

Methods of proportioning mix designs shall be in conformance with ACI 211.1 for normal and heavy weight concrete, ACI 211.2 for lightweight concrete, and ACI 211.3 for no slump concrete.

Concrete producers should submit each mix design at the beginning of the calendar year to the Department for review and approval.

Ground granulated blast furnace slag should be used in all Class A and Class B mixtures and other mixes as required.

Each PCC mix design submitted for approval shall include the following:

1. Name and location of Project and Contract number
2. Name and address of Contractor
3. Name and address of concrete producer
4. Mix design designation(s)
5. Class(es) of concrete
6. Uses of concrete
7. Source name and location of fine aggregate, coarse aggregate, cement, admixtures and water.
8. Type of cement
9. Cement content in pounds per cubic yard of concrete
10. Saturated surface dry weight of coarse and fine aggregates in pound per cubic yard of concrete.
11. Water content, including free moisture in the aggregate, plus water in the drum, exclusive of absorbed moisture.
12. Dosage of admixture(s).
13. Sieve analysis of fine and coarse aggregate.
14. Absorption of fine and coarse aggregate.
15. Bulk specific gravity (dry and SSD) of fine and coarse aggregate.
16. Dry rodded unit weight of coarse aggregate in pounds per cubic foot.
17. Fineness Modulus (FM) of fine aggregate.
18. Materials certification for cement, admixtures and aggregates.
19. Slump of plastic concrete in inches.
20. Air content of plastic concrete in percent by volume.
21. Unit weight of plastic concrete in pounds per cubic foot.
22. Seven (7) day compressive strength of concrete in pounds per square inch.
23. Twenty-eight (28) day compressive strength of concrete in pounds per square inch.

Up to fifty (50) Calendar Days may be required for review of a proposed PCC mix design in Category 1 or 3 after it has been submitted for approval. In order to minimize the time between Notice to Proceed and completion of mix design reviews for Category 3 submittals, the apparently successful bidding Contractor may submit proposed mix designs for Project approval at anytime after bid opening date. Review of alternate mix designs may require longer than fifty (50) Calendar Days.

**B. PROPORTIONS** - Concrete mixtures shall be proportioned so as to secure a workable, homogeneous, placeable mixture which meets the requirements of 817.03 for its intended use. The concrete shall be proportioned by weight and shall consist of Portland Cement, fine aggregate, coarse aggregate, water, admixture(s) and other ingredients as may be specified. Unless specified otherwise, strength values are the average of 2 companion test cylinders.

### 817.02 MATERIALS

- 801.01: Portland Cement
- 801.04: Granulated Iron Blast Furnace Slag
- 801.02: Masonry Cement
- 801.05: Fly Ash
- Fine Aggregate
  - 803.01: Normal Weight
  - 803.07: Light Weight
- Coarse Aggregate
  - 803.02: Normal Weight
  - 803.07: Light Weight
- Admixtures
  - 814.03: Air Entraining
  - 814.04: Chemical Admixtures
  - 814.05: Color
- 822.01: Water
- 822.15: Formulated Latex Modifier

### 817.03 DESIGN CRITERIA

Proportions of concrete shall be such that the design criteria herein are met for the respective class of concrete.

**A. CLASSES OF CONCRETE** - Unless otherwise specified, the following classes of concrete shall be as specified in Table 817.03.A.

**TABLE 817.03 (A) CLASSES OF CONCRETE**

Class	Designation	Uses
A	Structural	Bridge decks, sidewalks, approach slabs, and medians for superstructures. Suitable for all uses specified for Class B, Structural.
B	Structural	Reinforced structures, footings, slabs, beams, girders, columns, piers, abutments, walls, arch ribs, box culverts, precast piles, traffic barriers, and cribbing. Sewer and water work except thrust blocks and pipe cradle.
C	High Early Strength	For special and emergency uses as approved by the Engineer.
D	Prestressed	Used for prestressed or post tensioned members.
E	Paving	Alleys, alley and driveway entrances, curbs and gutters, pavements, and base.



Class	Designation	Uses
F	General	For general use and in sidewalks, bike paths, or as specified.
H	Lightweight	As specified.
I	Latex Modified	As specified.

**B. DESIGN REQUIREMENTS** - Granulated slag may be used in an amount not to exceed 50 percent by weight of cement. Cement factor and water-cement ratio is determined on basis of combined ground granulated blast-furnace slag and Portland Cement weight.

Fly ash and granulated slag may not be used in the same mixture.

**TABLE 817.03 (B) PORTLAND CEMENT CONCRETE MIXTURES**

The Concrete Mixes Shall Conform to the Following:

Class Designation	Min. 28 Day Compressive Strength (psi) <sup>a</sup>	Min. Cement Content (Lbs/Yd <sup>3</sup> )	Max. Water (Lbs. Water Per Lbs. Cement)	Coarse Aggregate Size No. <sup>b</sup>	Slump (In.) <sup>c</sup>	Field Air Content (% by Volume)	Max. Unit Weight (Lbs./Ft. <sup>3</sup> )
A <sup>bdgh</sup> STRUCTURAL	4,500	640	0.44	57 or 67	2 – 3	5 - 8	
B <sup>bdgh</sup> STRUCTURAL	4,500	640	0.44	57 or 67	2 – 3	5 - 8	
C <sup>dj</sup> HIGH EARLY	3,000 <sup>(24 HRS)</sup>	800	0.38	57	0 – 3	5 - 8	
D <sup>dgh</sup> PRESTRESSED	5,000	680	0.43	57	0 – 4	5 - 8	
E <sup>bdgh</sup> PAVING	3,500	565	0.49	57 <sup>i</sup> , 57 & 4 or 67 & 4	0 - 3	5 - 8	
F <sup>gh</sup> GENERAL	3,500	565	0.49	67, 57, 57 & or 67 & 4	1 – 5	5 - 8	
G PIPE CRADLE (ONLY)	2,500	470	0.55	67, 57	1 – 5	5 - 8	
H1 <sup>dgi</sup> LIGHTWEIGHT	4,000	658	0.44	3/4 to 4	0 – 4	5 – 8	122 - PLASTIC 117-28 DAD*
H2 <sup>gi</sup> LIGHTWEIGHT	4,000	658	0.44	3/4 to 4	0 – 4	5 – 8	115 – PLASTIC 110-28 DAD*
I <sup>def</sup> LATEX MODIFIED	4,500	660	0.40	7	4 – 6	3 – 7	

\*DAD = Day Air Dry

- a The Materials Engineer may approve mix designs, pending twenty-eight (28) day strength results based on the seven (7) day compressive strength for which results equal or exceed 85 percent of the compressive strength and provided that no accelerator or early strength cements are used (except for Class “C”). The compressive strength is defined as the average of 2 cylinders made in the field and cured in the Laboratory.
- b Crushed trap rock and other non-polishing crushed stone may be approved by the Engineer for finished concrete bridge decks, sidewalks, median superstructures, and finished concrete roadways. Polish susceptible aggregates as defined in 803.02 shall not be used for concrete pavement surfaces.
- c A maximum slump as limited by the mix design will be allowed for concrete approved with water reducing admixtures. High range water reducer may be used for concrete to be placed at higher slump with the approval of the Engineer provided that there is no aggregate segregation and the entrained air of the concrete at point of placement is within acceptable range.
- d Polish susceptible fine aggregates shall not be used for concrete paving surfaces.
- e Latex emulsion shall not exceed 3.5 gallons per 94 pounds cement. The latex will weigh approximately 8.40 to 8.55 pounds per gallon.
- f Latex emulsion is included as part of the maximum water.
- g Fly ash may be substituted for cement such that not more than 15 percent by weight of cement is removed. The mix may require more fly ash added than cement removed. Cement factor and water-cement ratio determined on basis of

combined fly ash (replacing the cement) and cement weight. Granulated slag may be used in an amount not to exceed 50 percent by weight of cement. Cement Factor and water-cement ratio is determined on basis of combined granulated slag and cement. Fly ash and granulated slag may not be used in the same mixture for cement substitute.

- h The chert content of the combined coarse aggregate shall be less than 3.0 percent as per AASHTO M 80 Class A.
- i Coarse and fine aggregate shall conform to 803.07.
- j Must be approved by the Engineer prior to use.
- k Granulated Iron Blast Furnace Slag

1. The Engineer may approve, pending twenty-eight (28) day strength results, mix designs on the basis that seven (7) day compressive strength results equal or exceed 85 percent of the minimum average strength requirement as determined in 817.03(B) provided no accelerators or early strength cements are used.
2. Crushed trap rock and other non-polishing crushed stone may be approved by the Engineer for finished concrete bridge decks, sidewalks, median superstructures, and finished concrete roadways as per 803.02.
3. Consistency limits are those allowable with water. A maximum slump as limited by the mix design will be allowed for concrete approved with water reducing admixtures.
4. Fine aggregate shall conform to 803.01.
5. Light weight fine aggregate shall conform to 803.07.
6. Latex emulsion conforming to 822.15 shall be added in an amount of 3.5 gallons per 94 pounds of cement. The latex will weigh approximately 8.40 to 8.55 pounds per gallon. Proportions of cement to fine aggregate to coarse aggregate on a dry weight basis shall be 1 to 2.5 to 2.0 with a tolerance of 10 percent on the fine and coarse aggregate ratios.
7. Latex emulsion is included as part of the maximum water.
8. Fly ash may be substituted for cement such that not more than 15 percent by weight of cement is removed. The mix may require more fly ash added than cement removed. Cement factor and water-cement ratio determined on basis of combined fly ash and cement weight. Fly ash shall conform to the requirements of 801.05.

**C. PROTECTION OF CONCRETE AGAINST ALKALI REACTIVITY** - Fine and coarse aggregates for use in concrete that will be subject to wetting, extended exposure to humid atmospheric conditions or contact with moist ground shall not contain any material that is deleteriously reactive with alkalis in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts, the fine and coarse aggregates may be used with a cement containing less than 0.6 percent alkalis calculated as sodium oxide or with the addition of a material that has been shown to prevent harmful expansion due to the alkali-aggregate reaction.

When the concrete will be subjected to external sources of alkalis and/or chlorides, the aggregates used shall not contain more than 3 percent reactive constituents as defined by ASTM C 295, and pass at least one of the following criteria as may be applicable in accordance with ASTM C 1260 and C 1567.

#### 817.04 DESIGN ADJUSTMENTS

Concrete mix design can be revised to improve placement during cold, hot, or unusual weather as long as the requirements of 803 are met and the revision is approved by the Engineer.

When sources of materials change from those of the approved mix design or when the fineness modulus of the fine aggregate changes by more than 0.20 from the mix design, the mix design will be reviewed and may require a new design.

In the event concrete with the required workability or consistency cannot be obtained within the maximum water cement ratio with the materials furnished by the Contractor or producer, changes shall be made as necessary to secure the desired properties subject to the requirements of 817 and the approval of the Engineer.

#### 817.05 LOW PERMEABILITY STRUCTURAL CONCRETE

At least 2 trial batches shall be prepared using approved Portland Cement Concrete (PCC) mix design materials. Test specimens shall be cast by the Contractor and tested by a certified laboratory for permeability and strength at least thirty (30) Calendar Days prior to construction. The permeability samples shall be cylindrical, 4 inches in diameter and 6 inches in length. The samples shall be moist cured as per ASTM C 39, except that the last twenty-one (21) days shall be cured at a temperature of  $38^{\circ}\text{C} \pm 6^{\circ}$  ( $100^{\circ}\text{F} \pm 10^{\circ}$ ). Test cylinders

shall be tested at twenty-eight (28) Calendar Days as per ASTM C 1202 and reported as the average of 2 test specimens from each lot (100 cubic yards). Permeability values obtained for trial batches shall be 500 coulombs below the maximum values specified in Table 817.05.

**A. ACCEPTANCE TESTS** - A lot shall be a day’s production of PCC for the job. For each set of cylinders made for compressive strength tests, 2 additional cylinders shall be made for the permeability testing purposes.

For all classes of PCC, initially 1 set of permeability cylinders shall be tested in accordance with AASHTO T 277. If the average coulomb value for this test is less than the value shown in Table 817.05, the lot will be accepted at the full Contract unit price.

If the average test result exceeds the coulomb value in Table 817.05, payment for PCC in that element (in-place cost) shall be reduced 0.005 percent for each coulomb above the coulomb value given in Table 817.05. However, the reduction in price shall not exceed 5 percent of the bid price of the PCC. PCC with a coulomb value that exceeds the maximum allowed in Table 817.05 by 1000 coulombs shall be rejected. However, bridge deck PCC with a coulomb value exceeding the maximum by over 1000 coulombs or more may be accepted by the Engineer at 95 percent of the Contract bid price provided it meets the minimum compressive strength requirement, and the Contractor applies an epoxy PCC overlay at his own expense. In such cases, deck grooving will not be required. Any adjustments to the Roadway grade shall be made as required by the Engineer at the Contractor’s expense.

PCC abutments and pier caps with a coulomb value that exceeds the maximum required in Table 817.05 by more than 1000 coulombs may be accepted at 95 percent of the Contract bid price provided that the compressive strength meets the Contract minimum specified requirements and that the Contractor applies an approved epoxy overlay, at his expense.

The reduction in the bid price specified above shall be applied to the total volume of PCC in the Bridge members (deck slab of a single span, deck slab of a group of continuous spans, pier or abutments), of which any portion of the PCC in the member did not meet the permeability test requirements.

**TABLE 817.05 COULOMB REQUIREMENTS**

<b>PCC Class Requirement</b>	<b>Approved Use(s)</b>	<b>Coulomb</b>
Class A Structural	Bridge Decks, Sidewalks Approach Slabs, Medians For Superstructures, Suitable for all Class B Structural specified uses	1,500 Max
Class B Structural	Reinforced Structures- Footings, Beams, Girders, Columns, Piers, Abutments, Walls, Arched Ribs, Box Culverts Pre-cast Piles, Traffic Barriers, and Cribbing	2,000 Max.
Class H Lightweight	As Specified	1,500 Max.
Latex Modified	As Specified	1,500 Max

**817.06 CONSTRUCTION METHODS**

Aggregates and Portland Cement shall be proportioned by weight; water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determination performed by the Contractor. These moisture determinations shall be made at a minimum of every four (4) hours. PCC consistency shall be checked in accordance with 501.15.

All tolerances for measurement of materials will be applied to the approved mix design quantities. Tolerances for proportioning are as follows:

TABLE 817.06 TOLERANCES FOR MATERIALS

Material	Tolerance, Percent by Weight of Mix Design
Cement	+ 4, - 0
Coarse Aggregate	± 2
Fine Aggregate	± 2
Water	± 1
Admixtures	± 3

The approved mix design shall not be changed except as provided below:

- A. **ADJUSTMENT FOR VARIATION IN FINENESS MODULUS (FM)** - If the FM of the fine aggregate exceeds the limits specified in 803.01, the mix design shall be adjusted as provided in 817.04.
- B. **ADJUSTMENTS FOR NEW MATERIALS** - Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.

**818 BITUMINOUS CONCRETE MIXTURES****818.01 GENERAL**

The Contractor shall submit to the Engineer for approval a job mix formula for each type of bituminous mixture proposed for use. Approval of a job mix formula for a specific project, purpose, or use does not approve its use for any other project, purpose, or use.

The HMA producers should submit their mix designs to the Department for review and approval at the beginning of each calendar year.

Production of bituminous mixtures shall not commence until an approved job mix formula has been obtained in accordance with these specification requirements. Any deviation from the approved job mix formula or approved source of materials shall require the approval by the Engineer.

The Contractor shall allow a minimum of thirty (30) working days to receive approval or rejection of a proposed job mix formula after it has been submitted to the Engineer for approval.

It is the Contractor's responsibility to furnish the Engineer the necessary quantity of materials for each proposed job mix formula to yield 75 pounds of bituminous mixture, with each job mix formula submitted. Each job mix formula submitted for approval by the Contractor shall include the following information:

- A. Name of Project and location
- B. Name of Contractor
- C. Name of producer or supplier
- D. Name and class or type of bituminous mixture
- E. Proposed use of bituminous mixture
- F. Name, source, and amount (percent by weight of total mixture) of all ingredient materials proposed for use, including:
  1. Bitumen
  2. Coarse aggregate
  3. Fine aggregate
  4. Mineral filler
  5. Hydrated Lime or Liquid Anti Strip Additive
  6. Other
- G. Gradation of combined aggregate and mineral filler, expressed by percent passing required sieve sizes
- H. Mixing temperature
- I. Temperature of mix when delivered to the spreader and finisher
- J. Gradation test results for each aggregate size and source proposed
- K. Gradation test results of composite mixture
- L. Tests performed on the total mixture shall be prepared in conformance with AASHTO M 323.

A maximum of 1 primary and 1 alternate job mix formula per mix type will be approved per Contractor and/or supplier per calendar year. An alternate job mix formula is either an alternate supplier or a single supplier with different combinations of materials.

**818.02 DESIGN CRITERIA**

Job mix formulas for bituminous mixtures submitted for approval as required in 818.01 shall be based on the following:

- A. **MIX DESIGN** - The Contractor shall develop a mix design in conformance with AASHTO R 35. HMA Superpave mixes, i.e. 12.5 mm surface course, 9.5 mm leveling and surface course, and 19.0 mm and 25.0 mm base course or as directed by the Engineer, shall

conform to the Specifications for Superpave Volumetric Mix Design, AASHTO M 323, and shall be designed for 30 million Equivalent Single Axle Loading (ESAL).

**B. AGGREGATES** - Aggregates shall conform to 803.03, 803.04, and AASHTO MP 2, with the exception that the aggregate retained on the No. 4 sieve shall be tested for flat and elongated particles in conformance with ASTM D 4791.

**C. MIX DESIGN APPROVAL** - Documents containing the data from the Contractor's Laboratory study shall be submitted to the Engineer for tentative approval at least two (2) weeks prior to paving operations, using the Department-approved AASHTO software, and shall include the following:

1. Mix designation and Contract Number shall be on Contract Documents
2. Source and percentage of aggregate
3. Source, percentage, and grade of performance graded asphalt binder
4. Anticipated gradation and proportion of each component aggregate
5. Combined cold feed grading, extracted grading, or ignited grading
6. Plant where HMA mix will be produced
7. Plant target mixing temperature based on viscosity of 0.22 Pascal second
8. Percent passing No. 200 sieve removed by dust collection system
9. Ratio of dust to binder material on effective asphalt
10. Maximum specific gravity at the target binder content
11. Mix design grading plotted on 0.45 power gradation chart
12. Tensile strength ratio and worksheet
13. The gyratory compaction curve for N max
14. The bulk specific gravity at N Design gyrations
15. the air void content (percent Va) at N initial, N design, and N max gyrations
16. The voids in the mineral aggregate (percent VMA) and the voids filled with asphalt (percent VFA) at N Design gyrations (TP4)
17. The slope of the gyratory compaction curve

**D. ALL CONSENSUS AND SOURCE PROPERTIES**

1. Coarse aggregate angularity
2. Flat and elongated
3. Sand equivalent
4. Uncompacted void content of fine aggregate
5. Bulk and apparent specific gravity of coarse and fine aggregate
6. Absorption of coarse and fine aggregate

Mix designs submitted to the Engineer for approval shall be accompanied by a quantity of job mix formula aggregate and appropriate amount of required PG binder for ignition oven calibration.

If previous construction or performance experience has shown the proposed job mix design to be unsatisfactory, the Engineer may require the Contractor to submit a more suitable design.

If the Contractor proposes to change the source of aggregate used in the mix, the revised mix design shall be submitted with the information required. The conditions set forth above relative to initial submission shall apply. If a change in the Performance Grade binder source becomes necessary, the Department requires an anti-stripping additive test in conformance with ASTM D

4867 before giving the final approval; the Department approved anti-stripping is required in all AC mixtures.

**E. FIELD VERIFICATION OF MIX DESIGN** - After receiving the tentative approval for the mix design from the Engineer, the Contractor shall conduct a field verification of the mix at the beginning of production in each Plant. The Contractor’s certified personnel shall perform field verification. The verification samples shall be prepared as specified in AASHTO R 35. The Contractor shall notify the Engineer at least two (2) working days in advance of the scheduled verification.

**F. VERIFICATION EVALUATION**

1. Initial verification shall consist of 4 samples tested for the parameters of the approved mix design.

These samples shall be randomly drawn from the first days’ production. If the production of the first day is less than 500 tons, the Contractor may spread verification testing over the number of days needed to accumulate 500 tons. The verification testing shall be completed on the day when the production has reached 500 tons. The Contractor shall evaluate the verification test results.

2. If the mix produced by the Plant conforms to the parameters, production may proceed without any changes. If the Contractor has submitted mixes with identical aggregate combinations and differing asphalt contents associated with changes in ESAL loads, verification will be limited to volumetric analysis at the discretion of the Engineer.

3. If the mix produced by the Plant does not conform to the parameters, then an adjustment to the asphalt content or gradation may be made to bring the mix design requirements within acceptable levels.

Permissible adjustment limitations between approved Mix Design and Adjusted Mix Design are as follows:

**TABLE 818.02 (A) PERMISSIBLE ADJUSTMENT LIMITATIONS**

Test Property % <sup>a</sup>	Permissible Adjustment
Larger than ½ inch sieve	± 5
½ inch through No. 4 sieves	± 4
No. 8 through No. 100 sieves	± 3
No. 200 sieves	± 1
Binder content	± 0.2

<sup>a</sup>The permissible adjustment for all mixes shall establish a job mix formula having targets outside the restricted zone. Superpave mixes shall be within control points.

When an adjustment is made to the mix design, a second verification shall be performed to ensure that the modified mix conforms to all design requirements. The time and tonnage limitations shall be as specified in (E & F) above. Material produced during this verification will be subject to removal as specified at the discretion of the Engineer if it does not conform to Specifications.

If the adjusted mix conforms to the mix design parameters, production may proceed; if it does not conform, production shall be suspended and a new mix design shall be submitted to the Engineer for approval. The new mix design shall be designed as specified in AASHTO R 35-04.

4. Subsequent mix designs submitted due to non-conformance will be subject to removal at the discretion of the Engineer. If the mix does not conform to (2) above during initial verification, production for the mix shall be suspended until the Engineer takes corrective action.

**G. PAVEMENT CORES** - The Contractor shall obtain pavement cores as specified in 401.17 within twenty-four (24) after lay-down and hand the core over to the Engineer immediately after coring.

- H. STONE FILLED SHEET ASPHALT FOR REPAIR AND SPALLS** - The fine aggregate shall meet the requirements of 803.03 (B). Anti-strip additive or hydrated lime shall be added as needed to meet the requirements stated in 803.03(B). Stone filled asphalt shall have the following properties:

**TABLE 818.02 (B) SEIVE SIZE PERCENT PASSING BY WEIGHT**

Sieve Size	Minimum	Maximum
3/8 inch	100	
No. 4	95	100
No. 10	75	95
No. 40	40	70
No. 80	15	40
No.200 <sup>a</sup>	8	15

- a The maximum dust to asphalt ratio by weight shall be 1.5 for stone filled asphalt.

**TABLE 818.02 (C) PROPERTIES**

Properties	Minimum	Maximum
Stability Lbs (AASHTO T 245)	1000	
Flow; 0.01 in.(AASHTO T 245)	8	16
Air Voids, %	4	10
VMA, % Minimum		20
Plant Temperature, ° F Aggregate, Max		350
Plant Temperature, ° F Binder, Max		350
Plant Temperature, ° F Mixture, Max		350
Street Temperature, ° F avg		315 ± 25

Fine aggregates for stone-filled sheet asphalt surface shall meet the quality requirements of 803.03(A). The gradation of the fine aggregates or combination of fine aggregates shall be such that it will produce the specified bituminous mixture properties when combined with other mixed ingredients. The combined fine aggregates shall consist of not less than 40 percent by weight of crushed stones Grade No. 10 from an approved source containing from 8 to 15 percent fines passing the No. 200 sieve.

- I.** The potential moisture damage on all paving mixtures shall be evaluated in accordance with ASTM D 4867 without the freezing cycle. The minimum retained strength shall not be less than 75 percent of the unconditioned pair of test samples. When the minimum retained strength cannot be obtained with anti-strip additive, hydrated lime in slurry form shall be used in place of or in addition to the anti-strip additive.
- J.** Proposed bituminous job mix formulas shall be adjusted by the addition or change of an anti-strip additive or hydrated lime.



## 819 HIGH PERFORMANCE BITUMINOUS COLD MIX MATERIAL

### 819.01 DESCRIPTION

The material shall consist of plant mixed or bagged stockpile patching bituminous mixture composed of a blend of mineral aggregate coated with bituminous material. The material shall be capable of being stocked for at least six (6) months without stripping and shall be workable at all times.

The material must be able to be used at all times regardless of weather conditions. It must be suitable for use under adverse weather conditions and sub-freezing ambient road temperatures, and must bond equally well to dry, damp, or wet surfaces.

The material may not be used if it has stripped (more than 10 percent uncoated particles) or otherwise become unfit for use.

### 819.02 PERFORMANCE REQUIREMENTS

Material must be ready to use directly from stockpile. There will be no mixing or preparation of the material required. The product must be sufficiently workable for placing with shovels, rakes, or other hand tools.

### 819.03 CURING TIME

After application of material, traffic can immediately be directed over the repaired area. There is no need to block off or plate over the patched area. The material must be pressure-sensitive and cure faster with greater volumes of traffic.

### 819.04 RELIABILITY

When placed in a pothole or utility cut, the material shall maintain its integrity as long as, or longer than, the surrounding, existing paving.

### 819.05 MATERIALS

Coarse aggregates shall be crushed limestone from an approved source, dust free, and shall meet the quality requirements of 803.04(A), and the following grading requirements:

**TABLE 819.05 SIEVE SIZE PERCENT BY PASSING WEIGHT**

Sieve Designation	Percent Passing by Weight
1/4	100
No. 4	60-90
No. 8	5-30
No. 16	0-10
No. 50	0- 5
No. 200	1.5

Aggregates shall be delivered, handled and stored in a manner that prevents segregation, contamination and mixing of materials from other sources. If it is determined that the material source for previously approved material does not produce the required results, the material will be rejected.

The asphalt binder is to be added to the aggregate at a rate of approximately 5-1/2 percent by weight of mix in an approved Plant mixer. The liquid asphalt percentage shall not be lower than 5 percent or more than 6 percent; aggregates are to be thoroughly coated with asphalt binder.

The Contractor shall comply with the bituminous liquid manufacturer's application, handling, mixing and safety procedures.

## 820 STREETLIGHTING AND ELECTRICAL MATERIALS

### 820.01 GENERAL

- A. Fluorescent luminaires, LED luminaires, sign lighting luminaires, street lighting luminaires and standards, underpass luminaires, conduit, boxes, service control equipment cabinets, switches, circuit breakers, contractors, time switches, distribution panels, wire and cable, transformers, lamps, plugs, receptacles, and other necessary street lighting and electrical materials for complete systems shall meet the requirements herein and as shown on the Plans.
- B. The Contractor shall be responsible for submitting to the Department catalog cuts and/or samples of all materials to be furnished for traffic signal and street lighting work. Procurement of all such materials by the Contractor may not begin until written approval is obtained from the Department.

The Contractor will submit 1 catalog cut along with 1 sample for all parts and supplies that he proposes to use as part of this Contract, and for specialty items which are not specifically covered by the Material Specifications. The Engineer will return electronic copy of the approved catalog cut to the Contractor before any material is ordered. The sample will remain with the Engineer during the life of the Contract, and will be returned to the Contractor at the end of the Contract. Should the Contractor wish to make changes in the type or brand of material used, he will submit the catalog cuts and sample for approval as called for in this section before starting to use the material in the performance of the Contract.

### 820.02 LIGHTING STANDARDS

- A. Lighting standards including arms shall meet the requirements of AASHTO Specifications for the Design and Construction of Structural Supports for Highway Luminaires, shall conform to the District of Columbia Commissioners' Order 60-1090 and be fluted standard steel or aluminum as specified and shown on Standard Drawings, and installed at locations and in accordance with details shown on the Plans and connected in accordance with the wiring diagrams. The wiring, depending on locations, may be either series or multiple.

A strain-relief cable grip shall be provided inside the pole to support the pole cable.

As part of the catalog cuts, the Contractor shall submit copies of the following certifications:

1. That the welds meet the requirements of AWS D1.1.
  2. Material conforms to ASTM Specifications..
  3. Copy of factory certification that it meets the requirement of American Institute of Steel Construction (AISC) category.
  4. Copy of certifications that the materials meet Buy America requirements.
- B. **PENDANT POST WITH ARM** - The post will come with either a regular pendant arm or a decorative arm.

The post will be octaflute monotube 11 gauge steel, 8" x 4" x 28'-6" (in case of 28'-6" pole) or 9.5" x 5.65" x 38'-6" (in case of 38'-6" pole) with a continuous 0.14 inches per foot taper. The post shall conform to the Standard Drawings.

The shaft will be fabricated from 11 gauge steel meeting ASTM A 595 GR A with a yield point of a no less than 55,000 psi. A cast steel anchor base will be welded to the bottom of the shaft in an escalloped pattern. The base will have 4 bolt holes per the drawing. The base will be complete with ornamental bolt covers and the attaching screws. All posts will have a strain cable grip installed to support the post cables.

Poles that are not mounted on a transformer base will have a 3" x 5" hand hole with reinforced frame and cover provided 12 inches above the base.

All lighting standards for use on bridge structures shall be provided with a vibration damper and damper pads. A vibration damper consisting of a weighted device shall be attached inside the pole to dampen the vibration of the pole. The vibration damper shall be suitable for mounting in steel poles and shall be fabricated from corrosion-resistant materials. The dampers shall be factory installed and blocked in place during shipping. A damper pad shall be provided at the base of each pole. The vibration and damper pads shall be tested and approved design and certified copies of test reports shall be submitted together with installation details for approval.

The post shall be galvanized to ASTM A-123 and powder coated with a Urethane or Triglycidyl Isocyanurate (TGIC) polyester powder to a minimum dry film thickness of 2.0 mils. Prior to application, the surfaces to be powder coated are to be mechanically

etched by brush blasting (ref. SSPC-SP7) and the zinc coated substrates preheated to 232°C (450° F) for a minimum of one (1) hour in a gas-fired convection oven. The coating will be electrostatically applied and cured by elevating the zinc coated substrate temperature to a minimum of 177°C (350°F) in a gas-fired convection oven. The color of the poles depends on the Roadway (DC Gray to Federal Color #16099, or Black to Federal Color # 27038) and will be announced for each job or as directed by the Engineer.

The pole will be wrapped in either a 3/16-inch U.V. inhibited plastic backed packing foam or cradled in a 1-inch rubberized foam base. The arms will be wrapped in a 3/16-inch U.V. inhibited plastic backed packing foam.

1. **Arm Mounting Mechanism** - For regular pendant arm attachment, the 28'-6" posts will include a single welded simplex to accommodate 3 to 8 foot single member arm, or a double welded simplex to accommodate 3 to 8 foot truss type arm for post installed on structures; the 38'-6" posts shall include a double welded simplex to accommodate an 8, 10, 12 or 15 foot truss type arm. For decorative arm, the post will include necessary mounting mechanism to accommodate one or two 8 foot decorative arms.
2. **Regular Pendant Arm** - The arms will be fabricated from steel. The post and arm will be cleaned of all rolled-in mill scale, impurities and nonmetallic foreign materials. The welds will be cleaned of all weld flux. The post and arm to be degreased by immersion in a heated caustic solution, then pickled in a heated sulfuric acid solution. The base will then be rinsed in a fresh water bath to remove any residual effects of the caustic or acid baths. The post and arm will then be immersed in a concentrated zinc ammonium chloride solution and allowed to air dry before being galvanized. The post and arm are to be hot-dip galvanized to the requirements of either ASTM A 123 or ASTM A 153. The galvanized coating will be free of any debris or flux ash.
3. **Decorative Arm For Teardrop Fixture** - The lighting arm shall be 'DC Signature Decorative Type'. This upsweep arm will be made of aluminum (meeting the requirements of 6063-T6), or steel (meeting ASTM A53). The arm shall have the desired rise from the mounting bracket on the post. The arm shall be welded to a cast simplex mounting bracket or plate, for attachment to the post. The finish is to be Powder Coat DC Gray to Federal Color #16099, or Black to Federal Color # 27038. The color will be announced for each job or as directed by the Engineer. The Contractor must submit Shop Drawings of the hardware to be used to the Department for review and approval for use in the Contract. The arm shall include decorative wrap as detailed below in the next paragraph.
4. **Decorative Wrap or Shroud**- This is included in the Decorative Arm as noted above. The decorative wrap assembly shall be a combination (2) rotomolded halves, steel mounting bracket, foam inserts, stainless steel and black oxide hardware. The shroud shall have a height of 3'-8½" and be available for use with both single and twin arms. The color of the wrap shall match the color of the arm.

The 2 molded parts are to be produced from resin with long term UV8 stabilization. The parts shall include raised shiplap to prevent a visual gap and misalignment between the 2 parts when the unit is assembled and to ensure a proper fit. Recessed and bossed locations are necessary where the mating hardware is to be installed. Threaded inserts shall be molded into 1 side of the wrap to allow stainless steel hardware to secure the 2 halves together. Banding the 2 halves together will not be permitted.

Closed cell foam inserts shall be supplied on the wrap where the post enters the shroud and where the cross arm(s) exit the shroud. This foam will prevent creatures and debris from entering the molded shroud.

All molded parts shall be free from abnormal physical qualities, pores, cracks, shrinkage defects, or flaws.

A steel mounting bracket shall be supplied as 1 unit to fix the mounting locations on the cross arm for ease of installation. The ¼-20 stainless steel mounting hardware shall be used to secure the galvanized bracket together, secure the bracket to the post, and set the height of the shroud to allow the cross arm to be centered in the decorative shroud. The decorative shroud shall be attached to the mounting bracket with the 1/2 inch threaded rod and secured with a black oxide finished acorn nut.

- C. **DECORATIVE LIGHTING ARM FOR WOOD POLE** - The lighting arm shall be 'DC Signature Decorative Type'. The main portion of the upsweep arm shall be made of aluminum meeting the requirements of 6063-T6 or 6061-T6. The arm shall have welded mounting bracket to attach to a wood pole. The arm must have sufficient tilt flexibility so that the arm and fixture is labeled when installed. The finish is to be Powder Coat DC Gray to Federal Color #16099, or Black to Federal Color # 27038. The color depends on the type of roadway and will be announced for each job or as directed by the Engineer. The Contractor must submit Shop Drawings of the hardware to be used to the Department for review and approval for use in the Contract.
- D. **NO. 16 AND 18 CAST IRON POST** - The post shall be made up of 3 cast components as shown on the plan. All cast iron components, regardless of the method by which they are produced and assembled, shall be uniform quality and appearance; true to

pattern; fine surface texture; free from blow holes, porous spots, hard spots, shrinkage faults, wrap, buckle, cracks, die marks, and all other defects peculiar to the method of production used, which may adversely affect the use, appearance or strength of the component or post.

Each component shall be carefully and thoroughly cleaned of all sand, scale, fins, core anchors, welds, machine markings, projections, imperfections, etc., injurious to insulated electrical conductors or detrimental to its use or appearance.

Each separable component shall bear as pertinent a lot number, casting number, pattern number, or other identifying number for record purposes so that the production history may be traced and Contractor shall make such history available to the District of Columbia on demand. The components shall not bear any other mark, lettering, numbering or identifying device not specifically authorized in writing by the District of Columbia.

All ornamentation and markings shall be sharp and clearly defined. The desired finish for these components shall be the finest surface of high-grade fabrication with a minimum of grinding, machining, dressing, etc., in accordance with normal foundry practices. Excess dressing shall be cause for rejection. Bolt holes must be clean and true with good alignment in the companion pieces to permit the interchangeability of castings. The shafts shall be straight and true with not more than 3/8-inch deflection along the length when rotated on the end centers.

The castings shall be Heavy Wall Cast Iron per ASTM A 48-83 Class 30. All castings shall be true to pattern and of fine surface texture with a minimum of machining and/or grinding, and shall have a uniform wall thickness +/- 1/8 inch. All components shall receive a coat of iron oxide red both inside and out. The components shall be given 2 coats of a 2-part epoxy paint system. The color shall match appropriate Federal Color Chip (DC Gray to Federal Color #16099, or Black to Federal Color # 27038). The color will be announced for each job or as directed by the Engineer. The coats shall be allowed to cure according to the paint manufacturer's specification before recoating and/or shipping. The components shall be wrapped and crated to protect them during shipping and unloading. Any damage to the finish shall be repaired according to the paint manufacturer Specifications at no additional cost to the District.

**E. TWIN 20 STEEL AND CAST IRON POST** - The post shall consist of 5 components, a steel shaft, cast iron clamshell base, cross-arm and 2 casings.

The Shaft shall be fabricated from 11 gauge steel meeting ASTM A 595 GR A with a yield point of no less than 55,000 pounds per square inch, and have a 16 flat flute cross section. A cast steel anchor base shall be welded to the bottom of the shaft. A hand hole with reinforced frame and cover shall be installed 10 inches above the base. Directly opposite a 2"-13 sq. nut for the ground stud shall be welded to the pole wall. The flutes shall be of equal size, true and straight when observed from the base toward the tenon. Misaligned, uneven or waves in the flutes shall be cause for rejection of the pole. A 3 foot sample of the shaft must be submitted for approval before the start of fabrication. The sample must show the fluting, be galvanized and final coated.

The shaft shall be cleaned of all rolled-in mill scale, impurities and non-metallic foreign materials. The welds will be cleaned of all weld flux. The shaft is to be degreased by immersion in a heated caustic solution, then pickled in a heated sulfuric acid solution. The shaft will then be rinsed in a fresh water bath to remove any residual effects of the caustic or acid baths. The shaft will then be immersed in a concentrated zinc ammonium chloride solution and allowed to air dry before being galvanized. The hot-dip galvanizing shall meet the requirements of either ASTM A 123 or ASTM A 153. The galvanized coating shall be free of any debris or flux ash.

All galvanized exterior surfaces visually exposed are to be coated with a Urethane or Triglycidyl isocyanurate (TGIC) polyester powder to a minimum dry film thickness of 2.0 mils. Prior to application, the surfaces to be powder coated are to be mechanically etched by brush blasting (ref. SSPC-SP7) and the zinc coated substrate preheated to 450°F for a minimum of one (1) hour in a gas-fired convection oven. The coating shall be electrostatically applied and cured by elevating the zinc coated substrate temperature to a minimum of 350°F in a gas-fired convection oven.

The shaft shall either be wrapped in a 3/16-inch U.V. inhibited plastic backed packing foam or cradled in a 1-inch rubberized foam base.

The new post must accommodate existing D.C. #16 casing. Samples are available to Bidders for inspection. All components, regardless of the method by which they are produced, shall be uniform quality and appearance; true to pattern; fine surface texture; free from buckle, cracks, die marks, and all other defects peculiar to the method of production used, which many adversely affect the use appearance or strength of the component.

The components shall be carefully and thoroughly cleaned of all sand, scale, fins, cable anchors, welds, machine markings,

projections, imperfections, etc.

All ornamentation and markings shall be sharp and clearly defined. The desired finish for these components shall be of the finest surface with a minimum of grinding, machining, dressing, etc., in accordance with normal foundry practices. Excess dressing shall be cause for rejection. Bolt holes must be clean and true with good alignment in the companion pieces to permit the interchangeability of castings. The cast components shall receive a coat of primer and 2 finish coats of a 2-part epoxy paint system. The Bidder shall submit a sample of the paint system that he proposes to use. All cast components shall be wrapped and/or boxed to protect the finish during shipping and storage. All damage to the finish shall be repaired by the Contractor at no additional cost to the District. The color shall match appropriate Federal Color Chip (DC Gray to Federal Color #16099, or Black to Federal Color # 27038). The color will be announced for each job or as directed by the Engineer.

- F. CLASS 3 WOOD POLE** - All Class 3 wood poles for use will be Southern Yellow Pine cut from live trees. All poles shall conform to the requirements of ANSI Standard 05.1. For 35 feet tall pole, the minimum circumferences shall be 23 inches at the top and 34 inches at 6 feet from butt. All poles may be air-seasoned, shed-dried, kiln-dried or conditioned or seasoned in any manner that conforms to AWPA Standards U1, and M1, that will not materially damage the wood. The poles must be seasoned until a moisture content of 25 percent or less is reached. All poles shall be machine peeled and conform to ANSI Standard 05.1. All poles must be branded and the brand is to be located 12 feet from the butt end. The branding shall identify the supplier, pole length, class, year of treatment and preservative used, in accordance with AWPA Standard M6. The treatment charge number shall be stamped on the butt of the pole. The preservative used will be Creosote meeting requirement of AWPA P1, Pentachlorophenolin petroleum meeting requirement of AWPA P8 or water-borne preservative suitable for pole treatment meeting requirement of AWPA P5 and U1. All poles shall be free of evidence of bleeding or blooming regardless of the type of preservative used. There shall be no sludge depositions. Penetration of any preservative shall be a minimum of 3 inches or 90 percent of the sapwood depth. Poles with less than 3-inch of sapwood shall have 100 percent penetration of the sapwood. Retention of creosote will be in accordance with AWPA Standards A1 and U1. Retention of Pentachlorophenolin petroleum will be in accordance with AWPA Standards A1 and U1. The Contractor will supply the Department with copies of any test reports that he receives from the pole supplier.

### 820.03 LUMINAIRES, LAMPS AND GLOBES

- A. GENERAL** - Luminaires shall be suitable for use in a multiple circuit and shall provide for use of high pressure sodium vapor lamps, metal halide lamps or mercury vapor lamps as provided in the Plans. The luminaires shall consist of housing, reflectors, refractor holders, slip-fitters, and pole side mounted mogul lamp sockets, photocell receptacles, and integral, regulator time ballasts. The complete unit shall have uniform lines throughout, and thus aesthetically combine all components.
- B. DESCRIPTION** - The materials for luminaires, lamps and globes shall be in accordance with the following:
- 1. Mercury Vapor**
    - a. Physical**
      - i.** Wattage - As specified in the Contract document
      - ii.** Bulb Type - ED 37
      - iii.** Base Type - Mogul
      - iv.** Bulb Material - Hard glass
      - v.** Bulb Coating - White
      - vi.** Max Overall Length (in) - 11.31
      - vii.** Diameter (in) - 4.625
    - b. Photometric**
      - i.** Average Life in Hours - 24000+
      - ii.** Lumens (Initial) - Depends on the specified wattage
      - iii.** Lumens (Mean) - Depends on the specified wattage
      - iv.** Color Temperature (k) - 3900

- v. Color Rendering Index (Ra) CRI (> or =) - 50
- vi. Warm Up Time (min.) to 90% - 5-7
- vii. Hot Restart Time (min.) to 90% - 3-6
- viii. Effective Arc Length (in) - 3
- ix. Light Center Length (in.) - 7

c. *Luminaire*

- i. Fixture Type-Open/Enclosed - O
- ii. Operating Position Code - U

**2. Metal Halide**

a. *Physical*

- i. Wattage - As specified in the Contract Document
- ii. Bulb Type - ED 37
- iii. Base Type - Mogul
- iv. Bulb Material - Hard Glass Bulb
- v. Coating - Clear
- vi. Max Overall Length (in) - 11.5
- vii. Bulb Nominal Diameter (In.) - 4.62

b. *Photometric*

- i. Average Life in Hours - 15000H/20000V
- ii. Lumens (Initial) - Depends on the specified wattage
- iii. Lumens (Mean) - Depends on the specified wattage
- iv. Color Temperature (k) - 4000
- v. Color Rendering Index (Ra) CRI (> or =) - 65
- vi. Warm Up Time (min.) to 90% - 2-5
- vii. Hot Restart Time (min.) to 90% - 10-15
- viii. Effective Arc Length (in) - 1.2000
- ix. Light Center Length (in.) - 7

c. *Luminaire*

- i. Fixture Type-Open/Enclosed - S
- ii. Operating Position Code - U

d. *Ballast Related Information*

- i. Minimum Ballast Open Circuit Voltage-RMS-Lag Ballast (Ballast A/B/C) - 382
- ii. Minimum Ballast Open Circuit Voltage-Peak Lag Ballast (Ballast/A/B/C) - 540

**3. High Pressure Sodium (HPS) Vapor Lamp**

a. *Physical*

- i. Wattage - As specified in the Contract Document

- ii. Bulb Type - ED23.5
  - iii. Base Type - Mogul
  - iv. Bulb Material - Hard glass
  - v. Bulb Coating - Clear
  - vi. Max Overall Length (in) - 7.75
  - vii. Diameter (in) - 2.94
- b. Photometric**
- i. Average Life in Hours - 24000+
  - ii. Lumens (Initial) - Depends on the specified wattage
  - iii. Lumens (Mean) - Depends on the specified wattage
  - iv. Color Temperature (k) - 2000
  - v. Color Rendering Index (Ra) CRI (> or =) - 22
  - vi. Warm Up Time (min) to 90% - 4
  - vii. Hot Restart Time (min.) to 90% - 1
  - viii. Effective Arc Length (in) - 2
  - ix. Light Center Length (in) - 5

All lamps are to be new unused and in manufactures wrappers. The Contractor will submit all lamp data to the Engineer for approval before ordering. The Contractor will supply the Engineer with copies of all manufactures lamp warranties. The Contractor will store all lamps according to manufactures Specifications until installed and accepted by the District.

#### **4. Light Emitting Diode (Led) Lamp**

- a. Physical**
- i. Wattage - As specified in the Contract Document
  - ii. LED Color - White
  - iii. Driver - Input voltage 120-277v AC, or 347-480v (Auto-adjusting)
  - iv. Driver power factor - >0.90
- b. Photometric**
- i. Average Life in Hours - 100000+
  - ii. Lumens - Depends on the specified wattage
  - iii. Color Temperature (k) - 4000
  - iv. Color Rendering Index (Ra) CRI (> or =) - 70

#### **5. High Pressure Sodium (HPS) Vapor Luminaire** - The wattage is specified in the Contract Documents.

The luminaire shall have a die-cast aluminum housing with a hinged optical door. The ballast shall be mounted on a separate detachable die-cast door, which can be easily removed from the main housing. The ballast shall be pre-wired with quick disconnecting plugs to the lamp socket and dead back terminal block, requiring only connection of the phase conductors to the terminal block. The 1-piece pipe clamp shall contain 4 bolts that do not pass through the housing. Clamping with only 2 bolts is not acceptable. The clamp must be able to accept a 1-1/4 to 2 inch pipe bracket without having to rearrange the clamp.

The ballast shall be a 120-volt magnetic regulator type for all 70W through 150 W luminaires and a magnetic regulator multi tap 120/208/240/277 Volt for all 250W and 400W luminaires. The ballast shall start and operate the lamp in ambient temperatures down to -40 °F. The ballast shall be in full compliance with lamp-ballast Specifications from the lamp manufacturer at the time

of manufacture.

The interior components in the luminaire shall be arranged in such a manner that there is ample space for access to the wiring. Cables shall not be in close proximity to the ballast and shall be color-coded. The starter shall be placed in an open location for easy access.

The luminaire shall contain a formed aluminum reflector and a flat heat and impact resistant glass lens. The optical assembly shall not allow light above 90 degrees. The luminaire shall contain a non-wicking felt gasket for all 70W through 150W luminaires and a filter for all 250W and 400W luminaires.

The luminaire shall be provided with a photocell receptacle, which can be directionally adjusted without the use of tools.

The luminaire shall be set to provide an IES type 3 cut-off distribution pattern. The luminaire shall be marked, using standard EE-1 NEMA marking, showing the lamp type and wattage. The marking shall be affixed to the underside of the luminaire's housing and to the rear of the reflector. The luminaire shall be GE M-250A2 power-door or the Department-approved equal.

**6. Metal Halide Luminaire** - The wattage is specified in the Contract Documents.

The cut-off luminaire shall be a 2 door type with the ballast assembly mounted on a separate removable door. The ballast shall be pre-wired to the lamp socket and the dead back terminal block, requiring that the customer make only the connection of the phase conductors to the terminal block. The 1 piece pipe clamp shall contain 4 bolts that do not pass through the housing. The clamp must be able to except 1-1/4 to 2 inch pipe bracket without having to rearrange the clamp. The ballast shall be a 120/208/240/277 Volt Auto-regulator type, capable of starting and operating one 400W Metal Halide lamp within the limits specified by the lamp manufacturer. The ballast must start and operate the lamp in ambient temperatures down to -20° F for the rated life of thee lamp. Ballast primary current during starting must not exceed normal operating current. The lamp current crest factor shall not exceed 1.8 for +10 percent line voltage variation at and lamp wattage form nominal through life. Lamp ballast system power factor shall not drop below 90 percent for +10 percent line voltage variation at any voltage form nominal through life. The luminaire shall contain a formed aluminum reflector and a flat heat and impact resistant glass lens. The optical assembly shall not allow light above 90 degrees. The luminaire must contain a filter to keep out contaminates

**7. Twist Lock Photoelectric Controls** - Photoelectric controls shall meet or exceed all requirements of ANSI C 136.24 and shall meet the following:

- a. *Turn ON Light Level* - 1.5 + 0.5 ftc.
- b. *Turn OFF Light Level* - 3.0 ftc. (Maximum)
- c. *Turn-Off Ration* - 1.5: 1
- d. *Operating Voltage* - 105 to 305 VAC at 60 Hz.
- e. Control shall remove power from ballast and lamp after detecting 5 lamp cycles per night
- f. Control shall reset each dusk. Red flashing LED shall be visible in control window after the control detects HPS lamp cycling.
- g. *Operating Temperatures* - -40° C to 70° C (-40° F to 158° F)
- h. *Moisture Resistance* - 98% RH
- i. *Maximum Fixture Size* - 400 Watt HPS
- j. *Power Consumption* - 1.2 watts average
- k. *Method Of Failure* - Fail-off
- l. *Surge Protection* - Shall be in the form of a Metal Oxide Varistor (MOV) wired line to neutral. MOV shall be a minimum of 160 Joules.
- m. *Housing Cover* - High impact, UV Stabilized Polypropylene, Black in color.
- n. *Housing Marking* - Year of installation permanently marked, Serial Number, Voltage Range, Loading Rate to be clearly indicated.
- o. *Guarantee* – three (3) years for defective materials or workmanship.



**8. Electronic Button Type Photo Control**

- a. Photoelectric control must meet or exceed all requirements of ANSI C136.24.
- b. *Line Voltage Operating Range* - 105-130 VAC at 60 Hz.
- c. *Turn ON* - Calibrate at 1.5 + 0.5 ftc.
- d. *Turn OFF*: Maximum turn OFF 3.0 ftc.
- e. *Photosensor* - Cadmium Sulfide cell shall be sealed to prevent moisture and contamination damage.
- f. *Failure Mode (Per ANSI)* - Control will fail on.
- g. *Time Delay* - Control must have instantaneous "ON"; a five (5) to ten (10) seconds "OFF" delay is required.
- h. *Surge Protection* - Shall be in the form of a Metal Oxide Varistor (MOV) wired line to neutral. MOV shall be a minimum of 100 joules.
- i. *Calibration* - Each unit must be calibrated in production using a photometer whose accuracy is traceable to the NIST. 100 percent quality control inspection must be performed after calibration and final assembly.
- j. *Chatter* - Contact "chatter" on opening of contacts (turn OFF of photoelectric control) shall not exceed five (5) milliseconds.
- k. *Housing* - Housing of photoelectric control shall be opaque and of an impact and UV resistant material. Impact resistance of greater than 0.5 ft-lbs at -40° C is required. Maximum size, excluding nipple, is 2.3" x 1.3" x 1.3".
- l. *Drop Test* - Control must be capable of withstanding a drop of 3 feet to a concrete floor without causing damage to the housing or changing the electric operation.
- m. *Nipple* - 3/8 - 18 straight pipe thread (NPSM). Length is 0.80 inches. 2 plastic lock nuts and O-ring shall be supplied.
- n. *Lead Wires* - Leads shall be 18-inch long. #18 AWG stranded, type 1015 rated for 600 volts and 105° C. Color code is as follows: Black = line, Red = load, White = neutral.
- o. *Markings* - The following must appear on the control: month, year of manufacture, individual serial numbers, complete model description, operating voltage range, load range, and country of origin.
- p. *Warranty* - Four (4) years, 1 for control replacement.

**9. Shorting Cap** - The cap shall fit into a standard Photocell receptacle and be gasketed so as to form a seal to keep rain and snow from entering the receptacle. The cap should prevent a fixed "on" or shorted contact to the luminaire.

**10. Conversion Kits, Sodium Vapor** - The wattage is specified in the Contract Documents.

The kits shall be for 120 Volt operation. Kits up to 150 watts (70W, 100W and 150W) must fit into all casings of the Washington family upright poles (i.e., No. 14, No. 16, 716, No. 18 and Twin-20). Kits above 150 watts (i.e., 250W and 400W) must fit into all except No. 14 (i.e., No. 16, 716, No. 18 and Twin-20). The kit shall include a completely pre-wired magnetic regulator ballast for 100W thru 150W kits and a High Power Factor Reactor ballast for 250W and 400W kits, with Mogul base lamp socket, terminal block and the necessary brackets for mounting the kits into the casing. The ballast shall be a magnetic regulator type capable of starting the lamp at -30 °F. The lamp wattage shall not vary more than 18 percent over a + 10 percent voltage spread. The power factor shall not be less than 90 percent. The crest factor of lamp current shall not exceed 1.7 for +/-10 percent line voltage variation at any lamp voltage from nominal through life for 100W thru 150W kits.

The kits must be secured to the pole casing with 3 bolts through pre-drilled holes.

The ballast for the 250W and 400W, lamp wattage for nominal line voltage and nominal voltage the ballast design center will not vary more than 5 percent from rated lamp watts. At any lamp voltage, from nominal through life, the lamp wattage regulation spread at that lamp voltage shall not exceed 25 percent for +/-5 percent line voltage variation. The ballast must reliably start and operate the lamp in ambient temperatures down to -30 °F for the rated life of the lamp. Ballast primary current during starting may exceed normal operating current. The lamp current crest factor shall not exceed 1.8 for +/-5 percent line voltage variation at any lamp voltage, from nominal through life. The power factor of the lamp ballast system shall not drop below 90 percent for ±10 percent line voltage variations at any lamp voltage from nominal through life. The ballast shall be

capable of starting and operating one 250W (250W Kit) or one 400W (400W kit) High Pressure Sodium Vapor lamp from a nominal 120 volt 60 Hz power source within the limits specified by the lamp manufacturer. The ballast, including the starting aid, must protect itself against mogul lamp failure modes. The ballast shall be capable of operation with the lamp in an open or short circuit condition for six (6) months without significant loss of ballast life.

**11. Teardrop Fixture** - The wattage is specified in the Contract Document.

- a. *Housing* - Constructed of heavy cast aluminum with a cast "neck" mounting adapter welded to the housing which attaches to the mounting arm. Housing is split and hinged in 2 places for easy installation and maintenance. Housing is secured with a stainless steel lever snap latch for easy operation.
- b. *Globe* - Injection molded UV stabilized acrylic, or as directed by the Engineer.
- c. *Globe Door Frame* - 1-piece aluminum casting is hinged and mechanically retains the globe. An extruded silicone gasket provides a weather proof and dust-tight seal. Latching mechanism is lever-snap for easy operation. All latches and fasteners shall be stainless steel.
- d. *Optical Assembly* - Reflector is polished, etched, and anodized clear semi-specular hydro-formed aluminum for vertical lamping, or segmented for horizontal lamping. The reflector is attached to the cast housing with stainless steel screws.
- e. *Electrical Components* - Ballast assembly shall be mounted to a cast aluminum bracket assembly, which is key-slotted for easy removal by loosening two 1/4-20 stainless steel screws. Electrical wiring shall be provided with quick disconnects to allow easy removal.
- f. *Mounting Systems*
  - i. *Hanging Arm* - Mounting consists of a heavy-duty 2-piece cast aluminum half-collar clamp welded to the arm, and a heavy-duty cast neck welded to the housing. Mounting allows for a full 360° fixture rotation and can be locked in 1 orientation.
  - ii. *Horizontal Arm* - Cast aluminum mounting accessory slips over a 2-3/8 inch O.D. horizontal pipe tenon and locks using 2 set screws. Fixture mounting includes the 2-piece collar clamp described above.
- g. *Ballasts* - All HID ballasts are regulated with power factors better than 90 percent (HPF). Ballasts shall provide  $\pm 5$  percent lamp power regulation with  $\pm 10$  percent input voltage regulation.
- h. *Finish* - Thermoset polyester powder-coat, Laboratory tested for superior weatherability and fade resistance in accordance with ASTM B 117-64 and ANSI/ASTM G 53-77 Specifications.
- i. *Max Weight* - Acrylic - 46-1/2 lbs.
- j. *Globes*
  - i. *Globe No. 118* - The globe will be a 1-piece blow molded high-impact strength polycarbonate. The globe will sit in the No. 16 casing. The neck of the globe will be cut to a height of 7/16-inch  $\pm$  0.060 in order that the set screws of the casing will hold the globe in place. The globe will be shatter proof and ultraviolet stable. It will be stippled, clear glass in appearance with initial 90 percent light transmission.
  - ii. *Globe No. 192* - The No. 192 globe shall be 1 piece blow molded high impact strength polycarbonate. The globe shall sit in the No. 14 D.C. Casing. A returnable casing is available to prospective Bidders. The globe shall be shatter proof and ultra-violet stabilized. It shall be stippled clear glass in appearance with initial 90 percent light transmission.
- k. *Sign Lighting* - Sign lighting luminaires shall be HPS. A luminaire shall consist of a luminaire housing and refractor and door assembly constructed of die cast aluminum. The refractor shall be a single piece molded thermal shock resistant borosilicate glass convex lens with discrete prism patterns. The refractor shall be permanently sealed to the door assembly with silicone adhesive around its perimeter. The refractor shall be a single piece die form of sheet aluminum alloy 3002 or as approved by the Engineer, processed to Alcoa Class SI alzak finish. Heavy duty mogul lamp holder shall be securely mounted to the refractor with a galvanized steel bracket. The refractor and door assembly shall be nonpermanent sealed to the luminaire housing and refractor assembly with a single piece neoprene gasket to effectively seal the luminaire and locked in place by stainless steel spring-loaded latches. The refractor and door assembly shall open and be held captive by double pivot internally mounted stainless steel hinges, and it shall be removable.

Weep holes shall be provided in the bottom of the housing in the lowest area of the luminaire as normally mounted.

The sign lighting luminaire shall be designed to properly illuminate the sign with the lamp source type and size as specified in the Contract Documents. The Contractor shall submit for the approval of the Engineer, Working Drawings showing locations and aiming angles of luminaires with relation to each of the signs of the various sizes.

#### **820.04 HOUSING ASSEMBLIES**

The housing assemblies shall consist of durable lightweight aluminum alloy. The housings shall be die cast. The die cast aluminum slip fitter for 1-1/2 or 2-inch pipe bracket shall be integral parts of the castings and shall have not more than an 8-inch long nor less than a 5-inch horizontal insertion length on the 2-inch bracket arms and shall be adequately equipped with clamping and leveling devices or a similar mechanism to allow proper clamping and positioning of the luminaires on the bracket arms.

The optical system shall be filtered against entry of insects, rain, dust, and other offending foreign matter.

The lowest part of the luminaires shall be bottom castings of the same material as the housings, hinged and latched to the upper castings. In the closed position, the refractor supported by the casting shall be held against the gasketed reflector so as to form dustproof and weatherproof assemblies. In the open position, the units shall provide for access to the lamps, reflectors, and sockets and for easy adjustments of the mounting cradles and the lamps.

The housing assemblies shall be provided with separate detachable doors to which the ballasts (and starting aids if required) are mounted.

#### **820.05 BALLASTS AND DRIVERS**

Luminaires shall be provided with integral ballasts of regulator type, high power factor (or the closest factor value to 1) (refer to 820.03), operating from multiple circuits, and pre-wired to the luminaire assemblies.

LED luminaires shall be provided with LED driver as specified in 820.16.

#### **820.06 SOCKETS**

Mogul multiple sockets shall be of the standard low voltage design, except the terminals shall be of nickel-plated bronze construction with screw clamp type terminal with friction grips and provide for mounting on the pole side of the luminaries. The sockets shall be adjustable to produce IES specified time distribution with specified lamps and prismatic refractors.

#### **820.07 REFLECTORS**

Internal reflectors shall be precisely contoured and the inner surfaces shall be highly specular to give, with the refractor, optimum light output and control. Reflectors shall be self-aligning, held in position with snap-in fasteners, and shall require no tools for removal or replacement. The silicon rubber formed gaskets shall be so arranged as to insure proper setting of the refractors against the reflectors.

#### **820.08 REFRACTORS**

Refractors shall be pressed clean crystal glass of the borosilicate type to resist breakage due to heat and mechanical stresses, well annealed, and free from imperfection. The sides or beam sections of the refractors shall contain panels of prisms to accept light from the reflector and refract it to the desired beam direction.

The house side of the refractors shall have smooth inside surfaces and shall contain double duty prisms on the outside, consisting of small refracting prisms, superimposed on larger horizontal prisms to refract light back into the street area.

The street end of the refractors shall contain radial prisms on the inside to spread light along the street area, and outside prisms that lie approximately in a plane slanting down between the luminaire and opposite curb line to refract light downward into the street area for improved illumination uniformity and street side shielding.

The bottom sections of the refractors shall contain outside prisms on the back portion to refract downward light in a forward direction under the luminaire into the street area. The forward position of the bottom shall contain "exploding" prisms on the inside that are contoured in segments of circles to refract light out in all directions that would normally go directly beneath the luminaire, in order to reduce excess light under the luminaire.

Refractors shall be clearly embossed with the designation "street side." They shall be so contoured and of sufficient thickness to resist malicious breakage. Refractors shall have a minimum volume of 520 cubic inches.

### 820.09 JUNCTION BOXES AND COVERS

Junction boxes and covers shall be hot-dipped galvanized in accordance with AASHTO M 111. Junction boxes shall be NEMA Type 4 of the size specified, shall be UL approved, and shall be watertight. Conduit entrances shall be provided with threaded bosses. A neoprene gasket shall be cemented to the cover. Boxes shall be cast iron unless otherwise specified on the Contract Plans.

### 820.10 GROUND RODS

Ground rods shall be of copper encased steel, 15 feet long for pole foundation, 10 feet for manholes, and unless otherwise noted on the Plans, 3/4 inch in diameter. Extensions shall be 10 feet in length.

Ground rods conforming to 820.10 shall be driven at the location shown on the Plans. Copper wire conforming to 820.11 shall be secured to the upper end of the ground rod with an approved connection. If required by the Plans, the ground conductor shall be installed in a 3/4 inch rigid conduit between the ground rod and service and control equipment enclosure as shown on the Plans. The ground conductor connection to the ground rod shall be accessible for inspection after completion of installation.

Each ground rod shall be tested as specified in 615.46. If the Earth resistance measurement exceeds 25 ohms, a second ground rod shall be installed as shown on the Plans. The 2 rods shall be temporarily connected together with ground wire and the Earth resistance measured. If the Earth resistance still exceeds the above value, a 10-foot rod shall be exothermically welded to the top of the second rod to constitute a continuous 25-foot long rod. After this is driven into the Earth it shall be temporarily connected to the first rod and the Earth resistance measured. If the Earth resistance still exceeds the required value, this procedure of lengthening and driving the second rod shall continue until either an acceptable value of Earth resistance is obtained or the extended rod cannot be driven further.

If the measured Earth resistance still exceeds the required value after the last rod is driven and interconnected, the Engineer shall be contacted for his final determination and further instructions.

Where Rock is encountered and acceptable Earth grounds cannot be accomplished by driving as described above, a grounding grid utilizing direct buried messenger cable or rods exothermically welded end to end shall be used to bond light poles and Structures in continuous series to some point on a type of terrain that will permit obtaining an acceptable Earth ground. Payment for this change shall be made by supplemental agreement.

Connections between rods and cable shall be made by exothermic welds with 2 coats of insulating protectants applied over welds and exposed cable.

### 820.11 WIRES

All wires used shall bear the UL label. All single conductor cable shall be provided with permanent identification on the outer protective covering, showing size, type, style, and voltage. Unless specified otherwise in the Contract Documents, wires shall conform to the following:

- A. Wires for street lighting system and general wiring shall be minimum size No. 10 AWG, 600 volts, copper conductor, Class B Standard, Type RHW-2 or RHHW, meeting the requirements of latest publications of IPCEA Standard S-61-402.
- B. Wire used for service and feeder shall be Type XHHW, copper, Class B stranded.
- C. Wires used for vehicle detector loops shall be Type XHHN, copper, Class B stranded.
- D. Wire used for grounding shall be bare or insulated, copper, soft drawn, stranded, sized as noted on the Plans, and shall conform to ASTM B 33 or ASTM B 189. Stranded wire shall conform to ASTM B 8.

**E. WIRE COLOR CODE****TABLE 820.11 WIRE COLOR CODE**

<b>120/208 Volt</b>	<b>Color</b>	<b>277/480 Volt</b>	<b>Color</b>
Phase A	Black	Phase A	Yellow
Phase B	Red	Phase B	Brown
Phase C	Blue	Phase C	Orange
Neutral	White	Neutral	White
Ground	Green		
Switch Leg	Purple		

**820.12 ELECTRICAL CONDUIT**

Conduit and fittings shall conform to the following:

**A. METALLIC CONDUIT**

- Hot-dip galvanized steel conduit shall conform to the requirements of ASTM A 53, UL 6 and FS WW-C-581E, be rigid, and bear the UL label.
- Zinc-coated steel conduit shall conform to the requirements of UL 6 and FS WW-C-581E and bear the UL label, and shall be rigid.
- Plastic coated galvanized steel conduit shall conform to the requirements of UL 6 or ASTM A 53, be rigid and hot-dip galvanized, including threads and have a PVC plastic coating of at least 40 mils in thickness, intimately bonded to the outer galvanized surface. The threads and the interior surface shall be bonded with urethane coating.
- Corrosion resistant steel conduit shall conform to ASTM A 333, Grade 9, except that the chemical requirements are amended to read phosphorous, maximum .095 percent.
- Aluminum conduit shall conform to the requirements of UL 6 and bear the UL label.

**B. NON-METALLIC CONDUIT**

- Heavy wall PVC conduit, Type II or Schedule 40, shall conform to Federal Specification 1094A and UL 651, and bear UL label.
- High density polyethylene (HDPE) conduit, Type III, shall conform to UL 651 and bear the UL label.

**C. BITUMINOUS-FIBER CONDUIT** - Bituminous fiber conduit, Type II, shall conform to FS W-C-581 or W-C 575.

**D. FIBERGLASS REINFORCED EPOXY CONDUIT** - FRE conduit shall be heavy wall type and conform to NEMA TC-14 and bear the UL label.

**820.13 CONDUIT EXPANSION AND DEFLECTION FITTINGS**

The conduit expansion and deflection fitting shall be designed to compensate for 3/4 inch movement in any direction between 2 steel conduits and an angular movement of 30 degrees. The end coupling shall be bronze, and the sleeve shall be neoprene with internal copper bonding jumper.

Conduit expansion fittings shall be provided with a 4 inch minimum free length expansion chamber. This metal fitting shall be provided with an internal bonding assembly and external bonding jumper assembly approved by Underwriter's Laboratories, Inc. The body shall be malleable iron, hot dip galvanized, and the expansion head shall be bronze.

**820.14 CIRCUIT IDENTIFICATION MATERIALS**

Tags to be used as specified shall be circular in shape, 1-5/8 inch minimum diameter, 0.031 inch minimum thickness, copper, plastic,

brass, or fiber tags except that tags within switch and device cabinets shall be of nonmetallic material. Identifying bands shall be approximately 1/32 inch thick, 3/16 inch wide, and 4 inch minimum length nylon, self-clinching type with adequate sized tab for labeling. Tags shall be permanently fastened to cables by means of tying straps of the same material and dimensions as identifying bands without tabs. Each tag or band tab shall be marked using 1/4 inch minimum lettering dies, engraving device or other equivalent permanent marking process. Markings shall indicate "GRD" for all ground and grounded neutral conductors. Companion circuit conductors shall be marked "CKT" followed by the designated letter, numeral, or symbol as may be shown on the Plans.

### 820.15 STEEL TRANSFORMER BASE

The transformer base with a hinged door shall be fabricated with dimensions as detailed on the Standard Drawing. The base shall be fabricated from hot rolled carbon steel meeting ASTM A 36. The base shall be 20-inch high, 16-inch square at the base, and 13-inch square at the top. The top and bottom plates shall be made of 3/4-inch minimum thick steel plate. The body of the base shall be made of 7 gauge steel. The base shall be provided with 4 loose steel plate anchor clips to fasten the base to the anchor bolts. Each base shall be provided with 1" x 3" bolts with nuts and washers to connect the post shaft to the base. The door opening in the base shall be 8-1/2" x 9" x 13-1/4". The door shall be secured in place with a stainless steel piano hinge at the top with 4 stainless steel rivets and a latch locking device at the bottom. Each base will also include four 1-1/4" x 36" anchor bolts, nuts, and washers. The base will be cleaned of all rolled-in mill scale, impurities and non-metallic foreign materials. The welds will be cleaned of all weld flux. The base is to be degreased by immersion in a heated caustic solution, and then pickled in a heated sulfuric acid solution. The base will then be rinsed in a fresh water bath to remove any residual effects of the caustic or acid baths. The base will then be immersed in a concentrated zinc ammonium chloride solution and allowed to air dry before being galvanized. The base, door and anchor clips are to be hot dip galvanized to the requirements of ASTM A 123.

### 820.16 LIGHT EMITTING DIODE (LED) LUMINAIRE

Provide luminaires as indicated and complete with LED light source and power supply unit. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable.

#### A. LED LIGHT SOURCE AND OPTICAL REQUIREMENTS

1. Luminaire shall be full cutoff or fully shielded as defined by IESNA RP-8.
2. **Correlated Color Temperature (CCT)** -  $\geq 4500$  K.
3. **Color Rendering Index (CRI)** -  $\geq 70$ .
4. Light Distribution shall be Type II, III or IV. It will be as specified in the contact document.
5. Lumen Depreciation of LED Light Source - Must comply with IESNA LM-80. LED module shall deliver at least 70 percent of initial lumens, when installed for a minimum of fifty-thousand (50,000) hours.
6. Minimum Light Output shall be functionally 1-to-1 replaceable to up to 150, 250, and 400 watt (threshold may change in future) equivalent HPS Cobrahead producing the equal illuminance (fc) and uniformity ratio on the Alleyway.
7. **Minimum Luminaire Efficacy** - 70 lm/W
8. **LM-79 Test** - Provide Independent Testing according to IES LM-79 that provides efficacy, output, color, and photometric distribution of your product. An Integrating Sphere Test will be required to provide color information. A Goniophotometer test by itself is not adequate.
9. **Lifetime** - Provide written explanation of how L70 Lifetime of Product is determined using the LM-80 and In-situ temperature tests referenced below.
  - a. *LM-80 Test* - Provide LED Package Manufacturer IES LM-80 Test Report with results showing relative ( percent) light output over time at 55°C, 85°C and X°C (a third temperature at the manufacturer's choice).
  - b. *In-Situ Temperature Test* - Provide test report indicating the Temperature of the hottest LED In-Situ in ANSI/UL 1598-04 (hardwired) or ANSI/UL 153-05 (corded) environments. This temperature measurement will be used with LM-80 data to validate lumen maintenance and useful life of product. Note that this temperature measurement should be specially requested by the manufacturer as they are getting their UL testing.

10. Where LEDs are connected in series and a single LED failure results in greater than 5 percent light loss of the overall luminaire output, a bypass circuit shall be utilized. This bypass circuit shall allow the remaining LEDs in the series circuit to remain powered.
11. The light must appear to be a single source (regardless of the number of drivers) to the road users.
12. The luminaire for alleyway application shall be equivalent to LSG-LSR1 and LSR2 or approved equal. The luminaire for roadway application shall be equivalent to Philips 110W64LED4K-R and Philips 215W128LED4K-R or approved equal for cobrahead type fixture; King Luminaire K804 FARAD II 200 (SSL) 16000 120 KPL30 PR or approved equal for teardrop type fixture; and King Luminaire KCK118R-RAAR-III-100(SSL)-8000-120:277-HE4 or approved equal for Post-top fixture.

## **B. HARDWARE REQUIREMENTS**

### **1. Housing Assembly**

- a. Shall be primarily constructed of metal.
- b. Finish shall be grey or black in color, polyester powder coated and resists rust.
- c. Driver must be internally mounted and replaceable.
- d. Captive screws are needed on any components that require maintenance after installation.
- e. No parts shall be constructed of polycarbonate unless it is UV stabilized (Lens Discoloration shall be considered a failure under warranty).
- f. The luminaire must have a self leveling mechanism.
- g. The luminaire shall be filtered against entry of insects, rain, dust, and other offending foreign matter.
- h. The luminaire shall be marked, using standard EE-1 NEMA marking, showing the lamp type and wattage. The marking shall be affixed to the underside of the luminaire housing and to the rear of the reflector.

### **2. Mounting Arm Connection (For Cobrahead Only)**

- a. Luminaire shall mount on 1-1/4-inch to 2-inch arm and shall have not more than 8 inch long nor less than 5 inch horizontal insertion length on the 2-inch bracket arms and shall be adequately equipped with clamping and leveling devices or a similar mechanism to allow proper clamping and positioning of the luminaire on the bracket arms.
- b. The clamping mechanism shall contain 4 bolts that do not pass through the housing. Clamping with only 2 bolts is not acceptable. The clamp must be able to accept a 1-1/4 to 2-inch pipe bracket without having to rearrange the clamp.

### **3. Photoelectric (PE) Cell Receptacle**

- a. Shall have a 3-prong twist locking ANSI C136.10 photocell receptacle (for Cobrahead).
- b. Photocell adapter must be built into the housing and be directionally adjusted without the use of tools.

### **4. House Shield - Shall provide option for house side light control**

5. Luminaire shall not weigh more than 35 lbs.

### **6. Dimensions (Approx.) (For Cobrahead) - Luminaire shall not be larger than 30-inch long x 16-inch wide x 6-inch tall.**

### **7. Operating Environment - Luminaire shall be able to operate normally in temperatures from -40°F to 120°F**

### **8. Cooling System - Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids and must be resistant to debris buildup.**

9. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

10. The fixture must not contain any moving parts.

11. The driver must be located inside the housing, but should be easily accessible.

12. For all mast-arm-mounted luminaires, a wildlife shield shall be included on the fixture to prevent wildlife access.

13. Optical system for roadway luminaires, including the driver, shall be sealed and rated for IP65 as defined in IEC 60529. Wiring compartments shall be IP20 compliant, but individual internal electronic components must be rated at a minimum of IP54.
14. The coating shall be capable of surviving ASTM B 117 salt fog environment for five hundred (500) hours minimum without blistering or peeling.
15. The coating shall demonstrate gloss retention of greater than or equal to 90 percent for one thousand (1000) hours exposure QUV test per ASTM G 53 UVB313, four (4) hour UV-B 60°C/four (4) hour condensation 50 °C.
16. The luminaire shall have been certified compliant with ANSI C136.31 having been subjected to 100,000 cycles of 2G at the resonant frequency of the luminaire applied at the center of gravity of the luminaire on 3 primary axes without damage to the luminaire. The luminaire shall be fully functional upon completing the test.
17. The luminaire shall be fully functional after testing for thermal shock according to IEC 60068-2-14.
18. The luminaire shall be fully functional after testing for damp heat, steady state, high humidity, and high temperatures according to IEC 60068-2-78.
19. If a lens not integral to the luminaire is used, optical enclosure (lens/window) shall be constructed from clear and UV-resistant acrylic or tempered glass.
20. At least 80 percent of the luminaire material by weight shall be recyclable at manufacturer's stated end of life.
21. Luminaires shall incorporate modular electrical connections and constructed to allow replacement of all or part of the optics, heat sinks, power supply units, and electrical components using only a simple tool, such as a screwdriver.
22. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
23. The luminaire fixture weight and effective projected area shall not exceed the poles requirements for wind loading.
24. Roadway and area mast-arm-mounted luminaires shall have an integral tilt adjustment of  $\pm 6^\circ$ , ANSI C136.3.
25. Driver shall be protected against damage due to either an open circuit or short circuit fault condition on the driver output. The driver shall resume normal operation when the fault is removed.
26. Over-temperature protection shall be provided and cut-off output power if case temperature limit is exceeded.
27. Reduction of hazardous substances (RoHS) compliant.

### C. POWER SUPPLY AND DRIVER REQUIREMENTS

1. **Off State Power Consumption** - The power draw of the luminaire including PE devices must be zero watts when in the off state.
2. **On State Power Consumption** - The luminaire must use at least 40 percent less energy compared to its commercially available High Pressure Sodium counterpart.
3. **Power Factor (Pf)** -  $\geq 90$  percent
4. **Operating Voltage** - 120-240 volts
5. **Operating Temperature** - Shall operate between  $-40^\circ$  F and  $120^\circ$  F
6. **Frequency** - Output operating frequency must be  $\geq 120$  Hz and input operating frequency of 60 Hz.
7. **Interference** - Shall meet FCC 47 CFR Part 15/18
8. **Startup** - Must be instant restart
9. The maximum drive current to the LEDs shall not exceed that recommended by the LED manufacturer. Documentation from the LED manufacturer shall be provided showing maximum current allowed and where the current output from the driver is not what is flowing into the LEDs. A schematic with calculations shall be provided to show what driver current does flow to the LEDs.
10. Maximum case temperature and measurement location shall be clearly marked on the driver case.



11. Fluctuations in line voltage up to 15 percent shall have no visible effect on the luminous output.
12. **Operating Frequency** - 60 Hz  $\pm$  5 percent.
13. **Total Current Harmonic Distortion (THD) For Current** -  $\leq$  15 percent.
14. Drivers shall be UL 8750 compliant.

#### D. WIRING REQUIREMENTS

1. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts and tap-style stripless connectors are not acceptable.
2. Local area network (LAN), wireless, radio, modem, power line carrier, and other communication methods other than hard-wired switches for LED light fixture control shall be non-proprietary and compatible with control monitoring system available in the market.

**E. SURGE PROTECTION REQUIREMENTS** - The luminaire manufacturer shall provide surge protection on each luminaire and certify that it has been tested in accordance with ANSI/IEEE C62.41.2 guidelines. Surge rating 10 kV, 10 kA.

**F. WARRANTIES** - LED fixture warranties shall be provided in accordance with the following:

1. Luminaire must have a minimum five (5) year warranty due to any failure. The warranty shall provide for the repair or replacement of defective electrical parts including but not limited to the light source and power supplies and driver for a minimum of eight (8) years. Shipping shall be included.
2. The LED luminaire warranties shall begin on the date of final acceptance of the installation by the Engineer.  
  
The Contractor shall install luminaires in accordance with the design engineer's and manufacturer's requirements and shall obtain written concurrence from the luminaire manufacturer that the installation is compliant with their requirements. The signed memo, including post-installation field measurements, shall become part of the warranty package and be included in the final deliverables to the Department.
3. The Contractor shall provide to the Department Contracting Officer written documentation of its ability to satisfy a worst-case, catastrophic warranty claim. The documentation shall clearly disclose the country in which the factory of fixture origin is located and the name of the company or organization that owns the factory (including all parent companies and/or organizations and their respective countries of corporate citizenship).

### 820.17 REMOTE MONITORING SYSTEM (RMS)

**A. STREET LIGHT MONITORING WIRELESS ELECTRONIC LOCKING PHOTO CONTROL** - Wireless devices shall be able to report fixture malfunction such as lamp, ballast or starter failure, cycling, day burner, power or communication failure and other unspecified failures. The wireless electronic photo control should meet the following minimum requirements.

1. **Wireless Enabled Communication** - at least 2.4GHz - IEEE 802.15.4 compatible, FCC part 15 approved and range not less than 1,000 foot clear line of sight.
2. **Photocontrol** - shall meet or exceed the following requirements.
  - a. 70–1,000 watt fixtures; Voltage 100–305 VAC 60Hz
  - b. 320J MOV - 6500 amp surge protection
  - c. *Average Power Consumption* - 1.6 watts
  - d. *Maximum Power Consumption* - 2.2 watts
  - e. Complies with ANSI C136.10 and FCC part 15
  - f. -40 to +85°C ambient; up to 90° interface per ANSI; Base rated at 120°C
  - g. ANSI – standard two-and-a-half to five (2.5–5) second turn off/on delay

- h. Acrylic window, brass legs, black polypropylene cover, neoprene gasket
- i. Filtered silicon light sensor
- j. Optical indicator to alert line crew of problem or malfunction

**3. Wireless Control** - Shall consist of

- a. Remote on/off control
- b. Grouped scheduling (energy savings)

**B. GATEWAY DEVICE REQUIREMENTS** - Wireless Enabled Communication system with at least 2.4 GHz- IEEE 802.15.4 compatible, Cellular network uplink - GSM, GPRS, CDMA, modem, Ethernet link for optional WAN connection via internet, FCC part 15 approved, at least 1,000 foot clear line of sight and should support up to 2,000 Wireless Electronic Locking Photo Control devices.

**1. General Requirements**

- a. *320j Mov* - 9,500 amp surge protection
- b. *Voltage* - 100–305 VAC
- c. *Ambient Temperature* - -40 to +85° C
- d. Wall or Mast arm mounting (1–3 inch pipe)
- e. Power and activity indicators
- f. Powered through standard locking type receptacle on fixture with 3-foot cable and locking type plug included
- g. *Average Power Consumption* - 5.5 watts
- h. *Maximum Power Consumption* - 12 watts
- i. Maximum EPA of 1.87 sq. ft.
- j. Cast aluminum housing
- k. Cast aluminum articulating mounting bracket
- l. Fiberglass radio antenna

**821 LINE STRIPING MATERIAL**

**821.01 GENERAL**

The Contractor shall notify the District of the name, address, telephone number, and personal representative of the materials manufacturer(s) for materials supplied in accordance with this specification. Materials shall be sampled at the location of manufacture before their shipment. Conformance with the Specifications will include the evaluation of test data of the material from a test bed of the AASHTO National Transportation Product Evaluation Program (NTPEP). A certification from the manufacturer shall be submitted to the District, at time of materials delivery, which contains test results of materials delivered, that they conform to these specification requirements, and the date of manufacture and lot or batch number(s) of material delivered. Marking material supplied for applications on Project Roadways shall be the identical composition as the materials submitted for testing. The material may be provided in either granular or block form, whichever is specified. Furnishing the certification does not relieve the Contractor of responsibility to furnish material in full compliance with this specification. The line striping materials shall be lead free and for the limits on VOCs within the restrictions of use as required by the Environmental Protection Agency Code of Federal Regulations (CFR) 40, Section 261.24, Table 1 or current amendment to the CFR.

**821.02 HOT EXTRUDED LEAD-FREE THERMOPLASTIC COMPOUND**

A. White and yellow alkyd thermoplastic striping material shall conform to the requirements of AASHTO M 249, and these Specifications. The total of lead, cadmium and hexavalent chromium is restricted and shall not exceed 100 ppm when tested by X-Ray Fluorescence, ICP, or comparable method capable of this level of detection. Diarylide type pigments shall only be used when the manufacturer or pavement marking material application temperature does not exceed 392 degrees Fahrenheit.

**B. COMPOSITION**

**TABLE 821.02 (A) COMPOSITION**

COMPONENT	TEST METHOD	COLOR	
		WHITE	YELLOW
Binder, % min	Certified	18.0	18.0
Premixed Reflective Beads, % min	AASHTO T 250	30.0	30.0
Titanium Dioxide,% min	X-Ray Fluorescence	10.0	–
Calcium Carbonate Inert fillers, % max	D 34	42.0	–
Yellow Pigment, %	–	–	–

Note: Amount of yellow pigment, calcium carbonate and filler shall be at the option of the manufacturer, provided all other requirements are in conformance.

1. **Binders** - The binder shall be alkyd consisting of maleic modified glycerolester of resin and other plasticisers.
2. **Titanium Dioxide** - The titanium dioxide shall be rutile type.

**C. PROPERTIES**

1. **Physical Properties**

TABLE 821.02 (B) PHYSICAL PROPERTIES

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Bond Strength, psi min.	AASHTO T 250 ASTM D 36	180
Cracking Resistance		No Cracks
Softening Point, F		215 ± 15

2. **Specific Gravity** - The specific gravity of the white and yellow pavement marking material shall be 1.7 to 2.2 when tested in conformance with ASTM D 153, Method A at 77 degrees Fahrenheit.
3. **Color** - After heating for four (4) ± 0.5 hours at 425 ± 3 degrees Fahrenheit, the thermoplastic shall be as specified in ASTM E 1347 and the following:
- Production** - The color of the cured thermoplastic material film of the production sample shall match the Federal Standard 595 Color chips specified when compared by instrumental measurement.
  - Control** - Control color matching determinations will be made using a Pacific Scientific Color Machine, and an observation angle of 2 degrees, and the CIE Chromaticity Coordinate Color Matching System under light source Illuminate C, with the following tolerances permitted between the standard chip and the cured thermoplastic film sample:

TABLE 821.02 (C) CONTROL

	WHITE Color No. 17886		YELLOW Color No. 13538	
	X	Y	X	Y
Standard Chip	0.310	0.330	0.480	0.450
Delta Tolerance	± 0.020	± 0.020	± 0.030	± 0.030

- c. **Reflectance**

TABLE 821.02 (D) REFLECTANCY

COLOR	TEST METHOD	DAYLIGHT REFLECTANCE AT DEGREE	PERCENT MIN
White	Fed Std 595 No. 17886	45 - 0	80
Yellow	Fed Std 595 No. 13538	45 - 0	50

- d. **Yellowing Index** - The yellowing index of the white material shall not exceed 8 prior to QUV and 15 after QUV when tested in accordance with ASTM E 313.

Glass beads for use with thermoplastic striping materials shall conform to 821.10(A).

### 821.03 EPOXY LINE STRIPING MATERIAL

- A. **GENERAL** - The white and yellow lead free epoxy pavement marking material shall consist of a 100 percent solid 2-part system with glass beads embedded homogeneously throughout the depth of the film and the surface. All of these materials shall be lead free as defined herein.

Materials shall be supplied in block form.

#### B. EPOXY COMPONENTS

##### 1. Composition

**TABLE 821.03 (A) EPOXY COMPONENT COMPOSITIONS**

COMPONENT A	PERCENT BY WEIGHT	
	WHITE	YELLOW
Epoxy Resin	75 - 82	75 - 79
Titanium Dioxide	78 - 25	14 - 17
Organic Yellow	—	7 - 8

The entirety of the pigment of Component A white shall consist of D 476, Type II Rutile Titanium Dioxide. No extender pigments are permitted. Yellow pigments and tinting colors shall be added in proportions which will produce a color equal to the yellow color depicted in the color box described herein. Any Titanium Dioxide used shall conform to D 476, Type II Rutile.

The epoxy system shall contain no volatile solvents. The cured film shall be no less than 99.5 percent of the wet film thickness of the panel at the time it was prepared for test.

2. **Restrictions** - The manufacturer shall certify that the combined total of lead, cadmium, mercury, and hexavalent chromium shall not exceed 100 ppm when tested by X-ray diffraction, ICP, Atomic Absorption Spectroscopy, or a comparable method capable of this level of detection.
3. **Epoxy Number** - The weight per epoxy equivalent (WPE) as determined by D 1652 for both white and yellow of Component A, on a pigment free basis, shall conform to a target value  $\pm 50$  provided by the manufacturer and approved by the Engineer.
4. **Amine Number** - The amine value of the curing agent (component B) shall consist entirely of stable amines and shall be determined as specified in D 2074. The total amine value shall conform to a target value  $\pm 50$  provided by the manufacturer and approved by the Engineer.

**C. MIXED COMPOSITION**

1. **Mixing Ratio** - The mixing ratio for the epoxy pavement marking material shall be proportioned according to the manufacturer's recommendations. The ratio shall not vary more than 2.5 percent during any operation conducted in conjunction with these materials.
2. **Color (White and Yellow)**
  - a. *Production* - The color of the cured epoxy material film of the production sample shall essentially match the specified color chips conforming to Federal Standard 595 when visually compared or by instrumental measurement.
  - b. *Control* - Control color matching determinations will be made using a Pacific Scientific Color Machine at an observation angle of 2 degrees, and the C.I.E. Chromatically Coordinate Color Matching System under light source Illuminate C, with the following tolerances permitted between the standard chip and the cured epoxy film sample:

**TABLE 821.03 (B) COLOR**

	WHITE Color No. 17886		YELLOW Color No. 13538	
	X	Y	X	Y
Standard Chip	0.310	0.330	0.480	0.450
Delta Tolerance	$\pm 0.020$	$\pm 0.020$	$\pm 0.030$	$\pm 0.030$

3. **Yellowing Index** - After curing for seventy-two (72) hours, the yellowing index of the white material when tested in conformance with E 313, using the C.I.E. Scale Illuminate C and 45/2 degrees geometry, shall not exceed 8.0 preceding QUV, and shall not exceed 15.0 after seventy-two (72) hours in QUV.
4. **Toxicity** - After heating to the application temperature, the material shall not exude fumes which are toxic or injurious to persons or property.

5. **Directional Reflectance** - The directional reflectance when tested in conformance with E 1347 after QUV using the C.I.E. Scale Illuminate C and 45/2 degrees geometry, shall be minimums of 80 for white and 50 for yellow.
6. **Abrasion Resistance** - Abrasion Resistance of the mixed material without glass beads shall be 80 mg maximum loss when tested as specified in C 501 with a 1000 g load, 1000 cycles, CS-17 wheel and a  $15 \pm 0.5$  mil wet film thickness on a S-16 plain steel plate.
7. **Hardness** - The Type D Durometer Hardness of the material shall be a minimum of 75 when tested in conformance with ASTM D 2240. Test films shall be cast on a suitable substrate at  $20 \pm 1.0$  mil wet film thickness. The film shall be cured twenty-four (24) to seventy-two (72) hours at  $75 \pm 2$  F prior to testing.
8. **Tensile Strength** - The average tensile strength shall be a minimum of 6000 psi when tested in conformance with D 638, Type IV molded specimens. Specimens shall be cured twenty-four (24) to seventy-two (72) hours at  $75 \pm 2$  degrees Fahrenheit with a relative humidity of  $50 \pm 3$  percent prior to testing.
9. **Compressive Strength** - The compressive strength of the catalyzed epoxy marking material shall be a minimum of 12 000 psi when tested in conformance with ASTM D 695. The test specimen shall be cured seventy-two (72) hours at  $75 \pm 2$  degrees Fahrenheit with a relative humidity of  $50 \pm 3$  percent prior to testing.
10. **Adhesion to Concrete** - The catalyzed epoxy paint pavement marking materials, when tested in conformance with ACI Method 503, shall have a 4000 psi minimum adhesion to the specified concrete surface with 100 percent concrete failure in the performance of this test. The prepared specimens shall be conditioned for twenty-four (24) to seventy-two (72) hours at  $75 \pm 2$  degrees Fahrenheit prior to the performance of the tests.
11. **Infrared Spectroscopy** - Both component A and component B shall be analyzed to verify for control purposes that materials submitted for use are of an identical formulation as originally approved. Deviations as determined by comparison with the original sample shall be cause for rejection.
12. **Curing** - The epoxy material shall be fully cured at a surface temperature of  $35^\circ$  F or above. The pavement marking material shall exhibit a no-tracking time of less than ten (10) minutes, when mixed in the proper ratio and applied at  $20 \pm 1.0$  mil film thickness at  $75 \pm 2$  degrees Fahrenheit and with the proper saturation of beads when tested in conformance with D 711. The manufacturer shall furnish a table depicting typical no-track time versus various temperatures in the recommended application temperature range.

#### 821.04 TRAFFIC PAINT

- A. **DESCRIPTION** - White and yellow paint material shall be a fast drying water based, nonleaded, acrylic resin paint suitable for use on both asphalt and Portland Cement Concrete surfaces. The paint shall not contain any hazardous material listed in the Environmental Protection Agency Code of Federal Regulations (CFR) 40, Section 261.24, Table 1.
- B. **PROPERTIES**
  1. **Hiding Power** - Paint shall show a dry hiding quality that will give a contrast ratio of at least 0.96 at 0.38 mm (15 mil) wet film thickness.
  2. **Settling Properties**: Settling shall be no less than a rating of 8 when tested in accordance with ASTM D 869.
  3. **Freeze** - Thaw and Heat Stability: Paint shall show no coagulation or change in viscosity greater than  $\pm 5$  KU.
  4. **Water Resistance** - Paint shall show no blistering, peeling or wrinkling, softening or loss of adhesion.
  5. **VOC** - The Volatile Organic Compound content shall be no greater than 150 grams/liter when tested in accordance with EPA Method 24.
  6. **Flash Point** - Paint shall have a flash point of at least  $140^\circ$  F when tested in accordance with ASTM D 93, Pensky-Martens Closed Cup.
  7. **No-Track Time** - Paint shall have a sixty (60) second maximum vehicle no-track time when measured in accordance with the NTPEP Field Test Procedures.
  8. **Maintained Retroreflectivity and Durability** - Maintained retroreflectivity and durability shall conform to the following requirements after being installed on the test deck for one (1) year:

- a. *Maintained Retroreflectivity* - Photometric quantity to be measured is coefficient of retroreflected luminance (RL) in accordance with the requirements of ASTM E 1743 for 15 meter geometry and ASTM E 1710 for 30 meter geometry. RL shall be expressed in millicandelas per square foot per foot-candle and shall be at least either 150 for 15 meter or 100 for 30 meter when measured in the skip line or centerline areas.
  - b. *Durability* - Paint shall have a durability rating of at least 4 when determined in the wheel path area.
9. **Flexibility** - The pigmented binder shall not display cracking or flaking when subjected to the flexibility test of TT-P-85, with the exception that the panels shall be 35 to 31 gauge 0.0078 to 0.0112 in.) tin plate approximately 3 x 6 inches. The tin plates shall be lightly buffed with steel wool and thoroughly cleaned with solvent and dried before being used for the test.
10. **Total Solids** - Total solids shall be a minimum of 70 percent by weight when tested in conformance with Federal Test Method 4041.1, Volatile and Nonvolatile Content (ordinary lab oven).
11. **Weight/Gallon** - The paint shall be 12.0 pounds/gallon minimum and be within 0.2 pounds/gallon of the original qualification sample approved hereunder.
12. **Viscosity** - Viscosity shall be 80 ± 10 KU when tested in conformance with D 562 at 77° F.
13. **Dry Opacity** - Dry opacity shall have a minimum contrast ratio of 0.98 when tested in conformance with Federal Test Method 4121, Procedure B using a 0.015 in. Bird Applicator or 0.030 Doctor Blade.
14. **Color**
- a. *Production* - The color of the dry paint film of the production sample shall essentially match Federal Standard 595, color chips Nos. 37886 (white) or 33538 (yellow), when compared instrumentally.
  - b. *Control* - Control sample color matching determinations will be made using a color machine and the C.I.E. Chromaticity Coordinate Color Matching System under light source Illuminate C, with the following tolerances permitted between the standard chip and the dry paint film sample:

**TABLE 821.04 COLOR**

	WHITE Color No. 37886		YELLOW Color No. 33538	
	X	Y	X	Y
Standard Chip	0.32	0.33	0.49	0.44
Delta Tolerance	± 0.02	± 0.02	± 0.03	± 0.03

15. **Glass Bead Adhesion** - The paint with drop-on type beads, applied at the rate of 6 pounds-per- gallon of binder shall require not less than 550 liters of sand for removal of the beaded film. The test for bead adhesion shall be conducted in accordance with the Abrasion Resistance Test (10 above) and differing there from only in that the glass spheres shall be uniformly applied by gravity flow so as to obtain 6 pounds glass spheres per gallon of binder. The application of the glass spheres is to be a separate operation, but applied at the same time as the paint. Glass beads shall conform to 821.10.
16. **Field Application** - The paint shall not be applied at surface temperatures and air temperatures under 60° F.

**821.05 POLYESTER LINE STRIPING MATERIAL**

- A. **DESCRIPTION** - Polyester-resin is a 2-component pavement marking material suitable for use on Portland Cement Concrete surfaces.

**TABLE 821.05 RESIN FOR PCC**

Composition (uncatalyzed material)	Min.	Max
Pigment	36.0	40.0
Acrylic monomer	8.5	
Polyester resin	55.5	

**B. REQUIREMENTS**

1. **Viscosity** - Viscosity (25 degrees C), ASTM D 562, shall be 80 to 90 Krieb units.
2. **Weight Per Gallon** - Weight per gallon shall be at least 11.5 pounds.
3. **Drying Time** - The catalyst/resin ratio shall be adjusted by the operator so that the applied line shall dry to a no-tracking conditioning in fifteen (15) minutes or less when applied at an application temperature of 77 degrees F to 100 degrees F, a substrate temperature of at least 60 degrees F, a wet thickness of 15 to 25 mils, and with 10 to 15 pounds of glass beads, conforming to the requirements of 821.10 applied per gallon. No-track time shall be determined by passing over the line with a passenger car or pickup truck at a speed of 25 to 35 miles per hour (mph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing "no track" and conforming for time to "no-track".
4. **Catalyst** - The catalytic component of the system shall be commercially available type recommended by the manufacturer of the polyester. The peroxide shall not be exposed to any form of heat, such as direct sunlight, radiators, open flame, or sparks. Heat may cause the organic peroxide to decompose violently or burn if ignited. The peroxide shall not come into contact with easily oxidized metals, such as copper, brass, or mild steel or galvanized steel as this can also initiate a violent reaction.
5. **Weight Loss** - Beaded catalyzed material shall not have a weight loss of more than 125 milligrams after 1,000 revolutions when abraded according to Federal Test Method Standard No. 141b, Method 6192, using CS-17 wheels with a 1,000-gram load on each wheel.
6. **Shelf Life** - The shelf life of uncatalyzed material shall be at least six (6) months when stored in a cool area below 85 degrees F.
7. **Durability And Wear Resistance** - Material shall be designed to provide a life expectancy of at least three (3) years under an average daily traffic count per lane of approximately 9,000 vehicles.
8. **Hiding** - The marking shall show a dry hiding quality that will give a contrast ratio of at least 0.96 with the Merest Black and White Power Chart, Form 03B when drawn down at a 15 mils wet film thickness. Readings will be determined in accordance with the requirements of ASTM E 1349 using CIE1931 2 degrees standard observer and CIE standard Illuminant D65.

**821.06 PERMANENT PREFORMED LINE STRIPING MATERIAL**

- A. GENERAL** - The materials shall remain in place on the asphaltic concrete or Portland Cement concrete pavement surfaces without being displaced by traffic, and shall not be affected by weather conditions.

The material shall be of good appearance and free from cracks. Edges shall be true, straight and unbroken. Line marking material shall be in rolls having no more than 3 splices per 150 ft of length. All marking materials shall be packaged in conformance with accepted commercial standards and shall have a minimum shelf life of one (1) year.

- B. DESCRIPTION** - Permanent preformed pavement marking materials shall conform to the requirements of the MUTCD and the following:

1. **Composition** - The marking material shall consist of a mixture of polymeric materials, pigment, and glass or ceramic beads distributed uniformly throughout the surface. The material, without adhesive, shall be a minimum of 60 mils thick.
2. **Color** - The color of the marking materials shall match Federal Test Standard Number 595 for the following:  
 White - 17886  
 Yellow - 13538
3. **Tensile Strength** - The tensile strength of the material shall be at least 175 psi when tested as specified in ASTM D 638 using a 1 x 6 in. specimen.
4. **Elongation** - The elongation of the material at break shall be 15 to 90 percent when tested as specified in ASTM D 638 using a 1 x 6 in. specimen.
5. **Flexibility** - When the material is bent 180 degrees around a 1/4 in. mandrel, it shall show no signs of cracking or loss of surface dressing beads.
6. **Skid Resistance** - The British Pendulum Number shall be a minimum of 45 BPN when tested as specified in ASTM E 303.



7. **Patchability** - The material shall be capable of patching worn areas of the same material type in accordance with the manufacturer's instructions.
8. **Freeze-Thaw** - The adhesive quality of the material will be considered satisfactory if it has a minimum of 65 percent adhesive bond after 100 cycles of freeze-thaw action when tested as specified in ASTM C 666, Method B.

#### 821.07 PERMANENT PREFORMED PATTERNED LINE STRIPING MATERIAL

- A. **GENERAL** - The material shall be capable of adhering to asphaltic concrete and Portland Cement Concrete surfaces, and to any existing pavement markings in accordance with manufacturer's recommendations by a pre-coated pressure sensitive adhesive. A primer shall be used to precondition the surface if recommended by the manufacturer. The markings shall be capable of being inlaid in new hot mix asphalt surfaces during the paving operation.

The material shall be highly durable and retro-reflective and shall be fabricated of a polymeric material designed for longitudinal and legend/symbol markings subjected to high traffic volumes and severe wear conditions, such as shear action from crossover or encroachment on typical longitudinal configurations, and where high levels of reflectivity are required to ensure the safety of the motoring public.

The material shall be of good appearance and free from cracks. Edges shall be true, straight and unbroken. Line marking material shall be in rolls having no more than 3 splices per 150 ft of length. All marking materials shall be packaged in conformance with accepted commercial standards and shall have a minimum shelf life of one (1) year.

The material shall remain in place on the pavement surface without being displaced by traffic, and shall not be affected by weather conditions.

#### B. DESCRIPTION

1. **Composition** - The material shall consist of a mixture of polymeric materials, pigments, and reflective spheres distributed throughout the base cross-sectional area and reflective spheres bonded to the topcoat surface to provide immediate and continuing retro-reflection. The marking material may include a black perform patterned film border.
2. **Restrictions** - The combined total of lead, cadmium, mercury, and hexavalent chromium shall not exceed 100 ppm. Diarylide based pigments and non-leachable lead pigmentation are not acceptable. The presence of these compounds shall be tested for compliance to the specification by X-ray diffraction, ICP, or another comparable method, capable of this level of detection.
3. **Reflectance** - The manufacturer shall certify that the white and yellow materials shall have the minimum initial retroreflectance values of 350 mcd/L/m<sup>2</sup> for white and 250 mcd/L/m<sup>2</sup> for yellow markings in any 528 foot section. Reflectance shall be measured using a reflectometer with CEN 30-meter geometry (88.76 degree entrance angle and 1.05 degree observation angle).
4. **Color** - The color of preformed markings shall essentially match the 37886, 33538 or 37038 color chips for white, yellow or black respectively as shown in Federal Standard 595A.
5. **Skid Resistance** - The British Pendulum Number shall be a minimum of 45 BPN when tested as specified in ASTM E 303.
6. **Thickness** - The material, without adhesive, shall be a minimum of 65 mils thick.

#### 821.08 PERMANENT PREFORMED LINE STRIPING MATERIAL – HEAT APPLIED

- A. **GENERAL** - The material shall be a highly durable retro-reflective, white or yellow, thermoplastic product with uniformly distributed glass beads throughout the entire cross sectional area, designed for use as transverse lines, numbers, legends, or symbols subjected to high traffic volumes and severe wear conditions such as the shear action from crossover or encroachment. The applied material shall be capable of conforming to pavement contours, breaks, and faults; shall not be affected by weather conditions, and shall remain in place on pavement surfaces without being displaced by traffic. The markings must be resistant to the detrimental effects of motor fuels, lubricants, hydraulic fluids, antifreeze, etc. The material shall have a minimum shelf life of one (1) year. The applied material shall adhere to asphaltic concrete pavement, Portland Cement Concrete (PCC), and new or old thermoplastic when applied using normal heat from a propane fueled heat torch in conformance with manufacturer's recommendations.

1. **Manufacturing Control And ISO Certification** - The manufacturer must be ISO 9001:2008 certified and provide proof of current certification. The scope of the certification shall include manufacture of preformed thermoplastic marking materials.

**B. DESCRIPTION** - The material shall conform to the requirements of the MUTCD and the following:

1. **Composition.** The material shall consist of an ester modified rosin resistant to degradation by motor fuels, lubricants etc. in conjunction with materials, pigments, binders, and glass beads distributed throughout the entire cross-sectional area. The thermoplastic material shall conform to M 249 with the exception of the relevant differences for the material being supplied in the preformed state.
  - a. *Restrictions* - Individual totals of lead, cadmium, mercury, and hexavalent chromium shall not exceed 100 ppm when tested by X-ray diffraction, ICP, or comparable method capable of this level of detection. Non-leachable lead based pigments will not be permitted.
2. **Color** - Preformed markings shall consist of film with pigments selected and blended to match:
  - a. *White* - The material shall be manufactured with sufficient titanium dioxide pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected.
  - b. *Yellow* - The material shall be manufactured with sufficient pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected. The yellow pigments must be organic and must be heavy-metal free. Other colors shall be available as required.
3. **Skid Resistance** - The surface of the applied material shall provide a minimum average skid resistance value of 45 BPN when tested in conformance with ASTM E 303.
4. **Patchability** - The material shall be capable of use for patching worn areas of the same type in conformance with manufacturer's recommendations.
5. **Thickness** - The minimum thickness, without adhesive, shall be 120 mils.
6. **Heating Indicators** - The top surface of the material (same side as the factory applied surface beads) shall have regularly spaced indents. These indents shall act as a visual cue during application that the material has reached a molten state so satisfactory adhesion and proper bead embedment has been achieved and a post-application visual cue that the installation procedures have been followed.
7. **Graded Glass Beads**
  - a. The material must contain a minimum of 30 percent intermixed graded glass beads by weight. The intermixed beads shall conform to AASHTO designation M 247, with minimum 80 percent true spheres and minimum refractive index of 1.50.
  - b. The material must have factory applied coated surface beads in addition to the intermixed beads at a rate of 1 lb. ( $\pm$  10 percent) per 10 sq. ft. These factory applied coated surface beads shall have a minimum of 90 percent true spheres, minimum refractive index of 1.50, and meet the following gradation.

**TABLE 821.08 GLASS BEAD GRADATION REQUIREMENTS**

Size Gradation		Retained, %	Passing, %
US Mesh	$\mu\text{m}$		
12	1700	0 - 2%	98 - 100%
14	1400	0 - 3.5%	96.5 - 100%
16	1180	2 - 25%	75 - 98%
18	1000	28 - 63%	37 - 72%
20	850	63 - 72%	28 - 37%
30	600	67 - 77%	23 - 33%
50	300	89 - 95%	5 - 11%
80	200	97-100%	0 - 3%

8. **Durability** - The material shall retain a minimum of 65 percent adhesive bond after 100 cycles of freeze-thaw when tested in conformance with C 666, Method B.

**9. Application**

- a. *Asphalt* - The materials shall be applied using the propane torch method recommended by the manufacturer. The material must be able to be applied without minimum requirements for ambient and road temperatures and without any preheating of the pavement to a specific temperature. The material must be able to be applied without the use of a thermometer.
- b. *Portland Cement Concrete* - The same application procedure shall be used as described for Asphalt. However, a compatible primer sealer shall be applied before application to assure proper adhesion.

- 10. Retroreflectivity** - The material, when applied in accordance with manufacturer's guidelines, must demonstrate a uniform level of sufficient nighttime retroreflection when tested in accordance to ASTM E 1710. The applied material must have an initial minimum intensity reading of  $500 \text{ mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$  for white and  $300 \text{ mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$  for yellow as measured with an LTL-2000 or LTL-X Retroreflectometer.

Note: Initial retroreflection is affected by the amount of heat applied during installation. When ambient temperatures are such that greater amounts of heat are required for proper installation, initial retroreflection levels may be affected.

- 11. Packaging** - The preformed thermoplastic markings shall be placed in protective plastic film with cardboard stiffeners where necessary to prevent damage in transit. Linear material must be cut to a maximum of 3 foot long pieces. Legends and symbols must also be supplied in flat pieces. The cartons in which packed shall be non-returnable and shall not exceed 40 inches in length and 25 inches in width, and be labeled for ease of identification. The weight of the individual carton must not exceed 70 pounds. A protective film around the box must be applied in order to protect the material from rain or premature aging.
- 12. Technical Services** - The successful Bidder shall provide technical services as required.
- 13. Performance** - The performance thermoplastic markings shall meet District Specifications and be approved for use by the appropriate District agency.

**821.09 REMOVABLE PREFORMED LINE STRIPING MATERIAL**

- A. GENERAL** - Removable preformed pavement marking material shall remain in place on the pavement surface without being displaced by traffic or affected by weather conditions. The material shall be capable of being removed without the use of heat, solvents, grinding or sand blasting, and shall not leave an objectionable residue.

The material shall be of good appearance and free from cracks. Edges shall be true, straight and unbroken. Line marking material shall be in rolls having no more than 3 splices per 150 ft of length. All marking materials shall be packaged in conformance with accepted commercial standards and shall have a minimum shelf life of one (1) year.

- B. DESCRIPTION** - White and Yellow. Removable preformed pavement marking materials shall conform to the requirements of the MUTCD latest edition and the following:

1. **Composition** - The marking material shall consist of a mixture of polymeric materials, pigment, and glass beads distributed uniformly throughout the surface.
2. **Color** - The color of the marking materials shall match Federal Test Standard No. 595A, latest edition for the following:
  - White - 17778
  - Yellow - 13538
3. **Glass Beads** - Glass beads shall conform to the General Requirements of AASHTO M 247.
4. **Skid Resistance** - The British Pendulum Number shall be a minimum of 50 when tested as specified in ASTM E 303.
5. **Retro-Reflectance** - The marking material shall have the initially the same retro-reflectance values under wet or dry conditions. Retro-reflective Luminance shall be a minimum of 750 for white and 450 for yellow when tested under ASTM D 4061, dry conditions, and ASTM E 2176 and E 2177 for wet conditions.
6. **Black** - Removable preformed pavement marking materials shall conform to the requirements of the MUTCD latest edition and the following:
  - a. *Composition* - The non-reflective, patterned black line masking tape shall not contain metallic foil and shall consist of a mixture of high quality polymeric materials, pigments and inorganic fillers distributed throughout its base cross-sectional

area, with a matte black non-reflective top layer. The patterned surface shall have a minimum of 20 percent of the surface area raised and coated with nonskid particles. The channels between the raised areas shall be substantially free of particles. The film shall be pre-coated with a pressure sensitive adhesive. A nonmetallic medium shall be incorporated to facilitate removal.

- b. *Skid Resistance* - The surface of the patterned, non-reflective black line mask shall provide an initial average skid resistance value of 60 BPN when tested in conformance with ASTM E 303.
- c. *Thickness* - The patterned material, without adhesive, shall have a minimum caliper of 0.065 inches at the thickest portion of the patterned cross-section, and a minimum caliper of 0.02 inches at the thinnest portion of the cross-section.
- d. *Adhesion* - The manufacturer shall demonstrate that the properly applied black line mask adheres to the Roadway and existing stable roadway markings under climatic and traffic conditions normally encountered in the construction work zone.
- e. *Removability* - The manufacturer shall show that the black line mask can be manually removed after its intended use, intact or in large pieces, at temperatures above 40° F without the use of heat, solvents, grinding or sand or water blasting. The black line mask shall remove cleanly from existing markings that are adequately adhered to the pavement surface.
- f. *Performance Requirements* - When applied in accordance with the of the manufacturer's recommendations, the black line mask shall provide a neat, durable masking that will not flow or distort due to temperature if the pavement surface, or underlying markings remain stable. The black line mask shall be weather resistant and, through normal traffic wear, shall show no lifting or shrinkage which will significantly impair the intended usage of the tape throughout its useful life, and shall show no significant tearing or other signs of poor adhesion.

#### 821.10 GLASS BEADS

Glass Beads shall meet the requirements of AASHTO M 247 Type 1 with a moisture resistant coating. The beads shall be colorless, clean, transparent, free of milkiness, excessive air bubbles and free of sharp angular scarring or scratching. The beads shall be spherical in shape and shall contain a minimum of 60 percent of silica. Roundness shall be 75 percent as tested as specified in ASTM D 1155. The glass beads shall have a reflective index of a minimum 1.50 when tested by the liquid immersion method (beck line method of equal) at a temperature of  $77 \pm 9$  degrees F. The glass beads shall be lead free and not contain more than 200 ppm of antimony and 200 ppm of arsenic. Materials Compliance Certification shall conform to 106.03

- A. **FOR HOT EXTRUDED THERMOPLASTIC** - Glass beads shall meet the requirements of AASHTO M 247, Type 1. Moisture resistance coatings shall be applied.
- B. **FOR EPOXY AND POLYESTER LINE STRIPING** - Glass beads shall be premixed and shall meet the requirements of AASHTO M 247, Type 1. Moisture resistance does not apply.
- C. **FOR TRAFFIC PAINT** - Glass beads shall be drop- on and shall meet the requirements of AASHTO M 247, Type 1. Moisture resistance coatings shall be applied.

**822 MISCELLANEOUS MATERIALS**

**822.01 WATER**

Water for use in Portland Cement Concrete or mortar shall be free from injurious amounts of oil, acid, alkali, vegetable substance, or other deleterious matter and shall be tested in accordance with AASHTO T 26 “Quality of Water To Be Used in Concrete”. On District contracts, the Water and Sewer Authority representative will issue permits for attachment to public hydrants for the use of water. Concrete suppliers that want to use well water should test the well water by an independent certified laboratory every six (6) months and submit certified test results to the Department for review, that the quality of well water meets the requirements of AASHTO T 26.

**822.02 BEARING PADS**

**A. PREFORMED FABRIC PADS** - Preformed fabric pads shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the lamination of not less than 10,000 pounds per square inch without detrimental reduction in thickness or extrusion.

**B. ELASTOMERIC BEARING PADS** - Elastomeric bearing pads less than 1/2 inch in thickness shall be either laminated or all elastomeric. Pads 1/2 inch or over in thickness shall be laminated. Stacking of individually laminated pads to attain thicknesses over 1/2 inch will not be permitted; however, cold bonding of individual laminated pads will be permitted providing the bond between the pads has a minimum peel strength of 20 pounds per inch. Laminated pads shall consist of alternate layers of elastomer and metal or fabric reinforcement bonded together. The top and bottom layers of reinforcement shall be uniformly covered with a maximum of 1/8 inch of elastomer. The edges of metal reinforcement shall be fully coated with elastomer not more than 1/4 inch in thickness.

Elastomeric bearing pads, elastomer, and reinforcement shall conform to the requirements of AASHTO M 251, except that the elastomer shall show no cracks when subjected to ozone resistance at 20 percent strain for one hundred (100) hours ± 2° F in accordance with ASTM D 1149, except 100 ±20 parts per 100,000,000 ozone.

**C. NEOPRENE PADS** - Neoprene pads shall be cast in molds under pressure and heat. Pads shall meet the requirements listed herein. A certification from the manufacturer shall be required that includes test results showing conformance to these specification requirements.

**TABLE 822.02 NEOPRANE PADS SPECIFICATIONS**

Grade (durometer)	50	60	70
Original properties hardness, ASTM D 676	50 ± 5	60 ± 5	70 ± 5
Min. tensile strength, psi, ASTM D 412	2500	2500	2500
Min. elongation at break, % ASTM D 573, 70 hrs at 212°F	400	350	300
Hardness, max, points change	0 to +15	0 to +15	0 to +15
Max. tensile strength change, %	± 15		± 15
Max. elongation at break change, %	-40	-40	-40
1 PPM ozone in air by volume at 20% Strain and 100 ± 2°F, ASTM	No Cracks	No Cracks	No Cracks
Compression set for 22 hrs at 158°F, ASTM D 395, Method B, max %	25	25	25
Min. tear, pounds per linear inch, ASTM D 624, Die C	225	225	225
Laminated	Yes	No	

**822.03 LIME**

- A. Hydrated lime used as an anti strip additive in bituminous mixtures shall conform to the requirements of AASHTO M 216, Type I, Grade A.
- B. Lime used in seeding shall consist of an agricultural calcic or dolomitic ground limestone containing at least 85 percent of total calcium and magnesium carbonates. Limestone shall be per standards of the Association of Official Agricultural Chemists and ASTM C 51.  
Lime shall meet following sieve analysis: At least 40 percent passing a No. 100 sieve, and at least 95 percent passing a No. 8 sieve.
- C. Crown vetch lime for agriculture use shall be ground limestone with 90 percent passing a 20 mesh screen and 40-50 percent passing a 100 mesh screen. It shall contain a minimum of 85 percent total carbohydrates.
- D. Hydrated lime used in masonry mortar shall meet the requirements of AASHTO M 216, Type I or II, as specified in the Contract Documents.
- E. Hydrated lime for use in masonry mortar for glazed ceramic wall tile shall conform to the requirements of ASTM C 207, Type S.

**822.04 PRECAST PCC SEWER-WATER UNITS**

Precast PCC sewer and water manhole and casing units, basin tops with cover, grade rings, drip stones, and cheek blocks shall be as per AASHTO M 199.

**822.05 ADAPTER RINGS**

- A. **CONCRETE** - Concrete for concrete adapter rings shall meet the requirements of PCC mix design as specified in 817. The rings shall be of the size and dimensions as indicated on the Plans.
- B. **CAST IRON** - See 815.04.

**822.06 ANCHOR BOLTS**

- A. **PAVING** - Anchor bolts shall be 9/16 inch in diameter and at least 11 inches long. The bolt shall be equipped with an expansion device on one end and a hook on the other. The bolts shall meet the requirements of AASHTO M 31, plain bars, Grade 40.
- B. **MISCELLANEOUS** - Self-anchoring bolts shall be per FSS FF-S-325 for Group I, Type 2, Styles 1 and 2; Group II, Type 4, Class 1 and 2; or Group III, Types 1 and 2. Bolts shall be galvanized per AASHTO M 232 and be capable of withstanding a proof test load 4 times greater than the design working load.

**822.07 MANHOLE STEPS**

Manhole steps shall be reinforced plastic steps composed of ASTM A 615, Grade 60 reinforcing bar (#4) completely encapsulated in copolymer polypropylene per ASTM D 2146, Type II, Grade 43758, as made by M. A. Industries, Inc., Peachtree City, Georgia, Model PSI-B for brick selections and model PSI-PF for concrete riser sections, or approved equivalent reinforced plastic step.

**822.08 EPOXY**

- A. **GENERAL** - Epoxy for use as a binder with aggregates or for bonding hardened concrete, plastic concrete, wood, metals, masonry, and most plastics shall conform to the requirements of ASTM C 881-90 or AASHTO M 235-91 for the Type, Grade, Class, and color specified. A certificate of compliance shall be required for each epoxy used. Types I and II epoxy shall not be used. This specification shall not be used for bonding surfaces of polyethylene, TFE, fluorocarbon, cellophane, or surfaces which are greased or waxed. The stoichiometric ratio of epoxy base and hardener shall be by volume and shall not exceed a 4 to 1 ratio.

The following guide shall be used for determining acceptable epoxies for use:

- *Type III* - For use in bonding skid-resistant materials to hardened concrete, and as a binder in epoxy mortars or epoxy concretes used on traffic bearing surfaces (or surfaces subject to thermal or mechanical movements).
- *Type IV* - For use in load bearing applications for bonding hardened concrete to hardened concrete and other materials and

as a binder for epoxy mortars and concretes.

- *Type V* - For use in load bearing applications for bonding freshly mixed concrete to hardened concrete.
- *Type VI* - For bonding and sealing segmental precast elements with internal tendons and for span-by-span erection when temporary post tensioning is applied.
- *Type VII* - For use as a nonstress carrying sealer for segmental precast elements when temporary post tensioning is not applied as in span-by span erection.
- *Grade 1 - Low Viscosity*: For use where a fluid epoxy is required for application such as for mixing and penetration.
- *Grade 2 - Medium Viscosity*: For use on surfaces not requiring penetration such as bonding new to old concrete.
- *Grade 3 - Non-sagging consistency*.
- *Class A*: For use on surfaces or with materials below 40° F.
- *Class B*: For use on surfaces or with materials between 40° F and 60° F.
- *Class C*: For use on surfaces or with materials above 60° F.

## **B. EPOXY ADHESIVE**

- 1. For Bonding New PCC to Existing PCC** - Epoxy resin for bonding new PCC to existing PCC shall conform to the requirements of ASTM C 881, Type V, Grade 1 or 2, Class B and C.
  - 2. For Embedment of Dowels and Anchor Bolts in Drilled Holes in Existing PCC**
    - a.** In cases where drilled holes are positioned such that the liquid epoxy material will not run out, epoxy resin adhesive for embedment of dowels and anchor bolts in drilled holes in existing PCC shall conform to the requirements of ASTM C 881, Type IV, Grade 1 or 2, Class B and C.
    - b.** In cases where drilled holes are positioned such that the liquid epoxy material would run out, epoxy resin adhesive for embedment of dowels and anchor bolts in drilled holes in existing PCC shall conform to the requirements of ASTM C 881, Type IV, Grade 3, Class B and C.
  - 3. For Repair of Cracks by Injection of Epoxy Resin Adhesive**
    - a.** Epoxy resin adhesive for surface sealing cracks prior to epoxy injection shall conform to the requirements of ASTM C 881, Type IV, Grade 3, Class B and C.
    - b.** Epoxy resin adhesive for epoxy injection into cracks shall conform to the requirements of ASTM C 881, Type IV, Grade 1, Class B and C.
- C. EPOXY MORTAR** - Epoxy resin adhesive for preparing epoxy mortar shall conform to the requirements of ASTM C 881, Type IV, Grade 1, Class B and C. Fine aggregate for epoxy mortar shall conform to 803.06.

Pourable epoxy mortar shall consist of 1 part epoxy resin adhesive and 1 part by volume dry fine aggregate; trowelable epoxy mortar shall consist of 1 part epoxy resin adhesive and 3 parts by volume dry fine aggregate.

- D. CERTIFICATION** - The manufacturer shall certify that epoxy resin adhesive meets the requirements of this specification. Certification shall consist of a copy of the manufacturer's test results and a statement by the manufacturer that the material represented by lot or batch number has been sampled and tested, meeting the requirements of this specification. The statement shall indicate the date of testing and shall be signed by an authorized agent of the manufacturer of formulator.

## **822.09 GEOTEXTILE FABRICS AND MEMBRANES**

Geotextile fabrics used for subsurface drainage, sub-grade stabilization, erosion control, sediment control, and as a permeable separator, including filter fabric, shall meet the materials and certification requirements of AASHTO M 288. Fabric used for subsurface drainage shall be of the non-woven type with a minimum flow rate of 0.1 gallon per square foot per minute and minimum tensile strength (20 percent elongation) of 25 lbs./linear inch for standard strength and 50 lbs. per linear inch for extra strength listed above.

- A. SILT FENCE** -Class F geotextile fabrics for silt fence shall have a 50 lb./in. minimum tensile strength and a 20 lb./in. minimum tensile modules when tested in accordance with ASTM D 4595. The material shall also have a 0.3 gal. square foot minimum flow rate and 75 percent minimum filtering efficiency when tested in accordance with ASTM D 5141.

Geotextile fabrics used in the construction of silt fence shall resist deterioration from ultraviolet exposure. The fabric shall contain sufficient amounts of ultraviolet ray inhibitors and stabilizers to provide a minimum of twelve (12) months of expected usable construction life at a temperature range of 0 to 120 degrees F.

### 822.10 DAMPPROOFING AND WATERPROOFING MEMBRANE

The adhesive side of the membrane shall be protected with a special release paper that can easily be removed for installation. The membrane shall conform to the following requirements:

**TABLE 822.10 TEST PROPERTIES FOR DAMPROOFING AND WATERPROOFING MEMBRANES**

Test Property	Test Method	Specification Limits
Grab Tensile Strength, lb/in at 12 in/minute rate of loading, min	D 5034	70
Pliability, 180° bend, 1 in. Mandrel at 20° F	D 146	unaffected
Resistance to Puncture, lb min	E 154 (square mounting frame method)	40
Permeance, perm (kg/Pa*s*m <sup>2</sup> ), Max	E 96 Method D	0.1
Weight, oz/yd <sup>2</sup> min	D 3776	40
Primer	--	as specified by the manufacturer

Roll and sheet waterproofing membrane may be accepted on certification. The manufacturer shall furnish certification. With actual test results showing that the material conforms to these Specifications.

### 822.11 LOOP SEALANT

The loop slot sealant shall be a 1-component, moisture-curing, flexible polyurethane, formulated to encapsulate loop wires embedded in asphaltic cement and Portland Cement Concrete pavements. The sealant shall remain flexible at all temperatures of -40°F and higher to protect the wire or cable from the stress of pavement movement. The flow characteristics of the sealant shall allow full depth wire encapsulation and resist flow-out on inclined roadways. Application equipment shall be capable of filling slots from the bottom up.

The sealant shall permit the Roadway to be opened to traffic over the slot immediately after application without tracking, sticking to vehicle tires, or pulling out of the slot. The cured sealant shall have the following performance characteristics when tests are conducted on de-aerated, 20 mil (0.020 inch) thick, dry film liquid immersion, after curing for twenty-eight (28) days at 77° F.

**TABLE 822.11 SPECIFICATIONS FOR LOOP SEALANT**

Description	Specification Limits	Test and Conditions
Hardness (Indentation)	65- 85	ASTM D 2240 Rex, Type A, Model 1770, at 77°F and 50% relative humidity
Tensile strength	500 psi (minimum)	ASTM D 412 Die C, pulled at 20 fpm
Elongation	400% (minimum)	ASTM D 412 Die C, pulled at 20 fpm
Flex	No Cracks at -40° F	25 Mil Free Film Bend (180 degrees) over 1/2 inch mandrel.
Weathering resistance	Slight Chalking	ASTM D 8122 Weatherometer, 350 hours. Cured 7 days at 77° F and 50 percent relative humidity.



**822.12 WOOD**

Unless otherwise specified wood and wood products shall meet the specification requirements of AASHTO M 168 for the grading and classification required.

- A. WOOD FOR PERMANENT TYPE WOODEN BARRICADE** - Posts and rails shall be of the dimensions shown on the Plans and shall be finished lumber, either dense southern pine or dense douglas fir of minimum stress grade 1400 psi.
- B. WOOD FOR PARK TYPE WOODEN GUARDRAIL** - The timber for rails and posts shall be dense southern pine or dense douglas fir, of minimum stress grade 1400 psi, rough sawn with scantness not exceeding 1/2 inch in any dimension, and pressure treated. No boxed heart pieces shall be allowed for posts and rails of douglas fir. Boxed heart pieces are defined as timber so sawed that at any point in the length of a sawed piece the pith lies entirely within the 4 faces. The timber shall be air seasoned or artificially seasoned until the amount of moisture in the wood will not prevent the adequate penetration and retention of the specified amount of preservative.

Pressure treatment shall be per 811.07(A).

- C. WOOD FOR TIMBER GROUND MOUNT SIGN POSTS** - Timber posts shall consist of douglas fir or southern yellow pine, coast region, select structural grade, or approved equivalent, meeting requirements of AASHTO M 168, seasoned, treated, and painted in conformance with Plans and these Specifications. Grading shall strictly meet requirements of the Western Pine Association, except that boxed-heart wood will not be permitted.

Preservative for treatment shall be per 811.07(C).

- D. WOOD FOR TREE SUPPORT STAKES** - Stakes for tree support, bracing, and dead men shall be rough cypress, cedar, locust or other approved wood, free from unsound and loose knots, rot, cross grain, or other defects that may impair strength of stake. All portions of wood stakes in contact with, or under, the ground shall be treated with an approved preservative. Exposed portions of wood stakes shall be stained an approved green color. Cedar stakes shall be round with bark intact; stain or preservative is not required.

**822.13 RAISED REFLECTIVE DELINEATORS**

- A. PAVEMENT DELINEATORS** - Pavement delineators shall be raised, single or double faced, either direction plowable and all-weather reflective. Delineators shall consist of a replaceable prismatic retro-reflector set in a steel protective saddle encased in concrete. The delineator shall be fastened to the road surface with an epoxy adhesive compound recommended by the delineator manufacturer.

- 1. Casting** - The casting shall weigh not more than 4 pounds and its overall dimensions shall be approximately 8 inches long by 6 inches wide by 2 inches high. It shall be shaped to deflect the blade of a snowplow driven from either direction. The surface of the casting shall be free of scale, oil, dirt, or any contaminant which might reduce the bond to the pavement materials. Casting shall be marked with manufacturer's name and model number.

The steel protective saddle for the reflector shall be of abrasive resistant steel plate, AR 360 or AR 380. The crossbar shall be of 1 inch by 0.125 inch stock, and the longitudinal bars shall be at 1 inch by 0.375 inch stock.

The concrete shall consist of 1 bag of Type III Portland cement, 4 bags of Taggart Special sand, 3 gallons of water, 1 fluid ounce of air entraining admixture, and 15 fluid ounces of Mighty 150 Superplasticizer. This mixture will make 63 units. The concrete shall be mixed for three (3) minutes minimum and vibrated for not less than five (5) seconds.

**2. Reflectors**

- a. Design and Fabrication** - Reflectors shall consist of an acrylic plastic shell filled with tightly adherent potting compound. The shell shall contain 1 prismatic reflective face as required to reflect incident light from a single direction. The outer surface of the shell shall be smooth except for purposes of identification.

The reflector shall be in the shape of a shallow frustrum of a pyramid. The bottom of the reflector shall be equipped with pressure-sensitive adhesive to permit its attachment to the primed surface of the casting. Dimensions of the reflector shall be 4 x 2 x .460 inches. The slope of the reflecting surface shall be 30 degrees and the area of the reflecting surface shall be 1.7 square inches.

- b. *Materials* - The shell shall be molded of methyl methacrylate conforming to FS L-P-380A, Type 1, Class 3. Filler shall be a potting compound selected for strength, resilience, and adhesion adequate to pass the necessary physical requirements.

The adhesive shall be pressure-sensitive, 100 percent solid, .040 inch thick with closed cell release paper on the bottom. Pressure-sensitive adhesive shall possess adhesion and physical qualities necessary to pass test requirements as specified in 822.13(A) (3) (c).

- c. *Physical Requirements and Testing for Reflectors* - From the delineators supplied a random sample of 10 shall be selected. A reflector shall be placed top side up on a steel plate not less than 1/2 inch thick. The load to the top of the delineator shall be applied slowly through a 1-inch diameter, 1-inch high metal plug, centered on top of the delineator.

Breakage or deformation of the delineator at any load less than 2000 pounds shall constitute failure of the delineator. Failure of more than 6 of the delineators shall be cause for rejection of the lot.

- d. *Optical Requirement*

- i. Definitions

Horizontal Entrance Angle - The angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the reflector.

Observation Angle - The angle at the reflector between observer's line of sight and the direction of the light incident to the reflector.

Specific Intensity (S.I.) - The candlepower, in foot-candles, of the returned light at the chosen observation and entrance angle for each foot candle of illumination at the reflector on a plane perpendicular to the incident light.

- ii. Optical Performance

Steel Wool Abrasion Procedure - Form a 1-inch diameter flat pad using #3 coarse steel wool per FS FF- W-1825A. Place the steel wool pad on the reflector lens. Apply a load of 50 pounds and rub the entire lens surface 100 times.

Specific Intensity - After abrading the lens surface, using the above steel wool abrasion procedure, the specific intensity of each crystal reflecting surface at 0.2 degrees observation angle shall not be less than the following, when the incident light is parallel to the base of the reflector:

HORIZONTAL ENTRANCE ANGLE	SPECIFIC INTENSITY
0 degrees	3.0
20 degrees	1.2

For yellow reflectors, the specific intensity shall be 60 percent of the value for clear crystal.

- iii. *Optical Testing Procedure.* A random lot of 10 reflectors shall be tested. The reflector to be tested shall be located with the center of the reflecting face at a distance of 5 feet from a uniformly bright light source having an effective diameter of 0.2 inches.

The photocell width shall be an annular ring .37 inch I.D., or .47 inch O.D. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21 inches. If a test distance of other than 5 feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

Failure of more than 6 of the reflecting faces tested shall be cause for rejection of the lot.

- 3. **Reflector Bonding** - Fastening shall be accomplished by bonding the reflector to the casting through use of the pressure-sensitive tape permanently adhered to the reflector. Bonding shall be done at ambient temperatures of 50° F (10° C) or higher.

- a. *Casting Preparation* - Clean casting in reflector pad area. Apply a thin coat of primer to clean, dry area and allow it to dry.

- b. *Bonding Reflector* - Remove the reflector release paper from the bottom of the reflector and place the reflector on the casting with the proper lens facing traffic. Apply a load of 1,000 pounds to 2,500 pounds for three (3) seconds minimum.
- c. *Pressure-Sensitive Adhesive*
  - i. Strength Requirements. Pressure-sensitive adhesive, when applied with minimum application pressure of 60 psi must possess a minimum tensile or shear strength of 15 psi at 70° F (21° C) ambient temperature.
  - ii. Strength Testing Procedure. A standard 4 x 2 x .46 inch reflector with pressure-sensitive adhesive on the bottom shall be adhered to appropriate flat 12 inch carbon steel test plate, properly primed, with 60 psi minimum application pressure. Both the top of the reflector and the bottom of the flat plate shall have fastened to it an appropriate coupling device to ensure compatibility with the tensile testing device. The test sample shall be tested in the tensile mode at 2 inches/minute pull rate. Minimum load to produce failure shall be 125 pounds at 70° F (21° C). Any figure below 125 pounds constitutes system failure.
- d. *Prime*
  - i. Strength Requirements. The primer shall provide for the proper surface condition to promote optimum adhesion between the substrate and pressure-sensitive adhesive.
  - ii. Strength Testing Procedures. Prime test plate with primer and allow to dry. Apply pressure-sensitive adhesive between primed test plates with 60 psi application pressure. The primer shall be judged as acceptable if after subjecting specimen to tensile loading at 70° F (21° C) ambient, the failure is cohesive.

**B. BARRIER DELINEATORS.** The delineator shall consist of an ABS housing with a flat acrylic plastic retro-reflective lens, hermetically sealed to it, capable of reflecting incident light from wide angles. The delineator shall be mounted to the top or side of the barrier with a butyl pad, epoxy or solvent cement.

1. **Physical Requirements** - The delineator shall be white and the reflective surface shall be either crystal or yellow. The housing dimensions shall be approximately 3 inches high, 5-1/4 inches wide and 2-1/2 inches deep. The projected reflecting surface area shall be approximately 9.5 square inches. The body surface shall be smooth, except for identification, to facilitate self cleaning.

The material for the housing shall be acrylonitrile butadiene styrene (ABS). The material used for the reflective area shall be methyl methacrylate plastic and must conform to FS LP-380, Type 1, Class 3.

After exposure for one (1) hour to an ambient temperature of 125°F (52° C) maximum the assembly shall meet all optical and physical requirements.

2. **Optical Requirements**

- a. *Definitions*

**Horizontal Entrance Angle** - The angle in the horizontal plane between the mounting plane (concrete barrier) and the incident light. The horizontal entrance angle shall be considered as plus in the direction from the mounting plane toward the normal to the reflector face. Only plus angles shall be measured.

**Observation angle** - The angle formed between the line from the light source to the reflector and the line from the reflector to the observer's eye.

**Specific intensity** - The candlepower, in foot-candles, of the returned light at the chosen observation and entrance angles for each foot candle of illumination at the reflector face on a plane perpendicular to the incident light.

- b. *Optical Performance* - When the delineator is oriented in the photometric device with its long axis vertical and mounted to simulate mounting on the vertical side of a concrete barrier, the specific intensity of the crystal (white) reflecting surface at 0.1 degree observation angle shall be as follows:

HORIZONTAL ENTRANCE ANGLE	SPECIFIC INTENSITY
+ 0 degrees	140
+ 20 degrees	55

For yellow delineators, the specific intensity shall be 60 percent of the value for white.

- c. *Optical Testing Procedure* - The delineators to be tested shall be located with the center of the reflective area at a distance of 100 feet from a uniformly bright light source having an effective diameter of 2 inches. The photocell shall have an aperture of 0.5 inch diameter, and shall be shielded to eliminate stray light. The distance from the center of the light source to the center of the photocell aperture shall be 2.09 inches. If a test distance of other than 100 feet is used, the source and receiver dimensions along with the distance between source and receiver shall be modified in the same proportion as the test distance. In no case shall the test distance be less than 10 feet.

Determination of acceptability shall be based on MIL-STD-105D using an AQL of 2.5.

- d. *Delineator* - Barrier delineators such as Model H962 manufactured by the Signal Products Division, Amerace Corporation 7542 No. Natchez Street, Niles, Illinois 60548; Models JD-1 or JD-2 as manufactured by Astro Optics Corporation, 924 Morse Street, Schaumburg, Illinois 60192; or approved equivalent are acceptable.

- C. **GUARDRAIL DELINEATORS.** The guardrail delineator shall consist of an ABS housing with a flat acrylic plastic retro-reflective lens, hermetically sealed to it, capable of reflecting incident light from very wide angles. The housing shall be attached to the guardrail with butyl pads, epoxy or solvent cement.

1. **Physical Requirements** - The delineator shall be white and the reflective surface shall be either crystal or yellow. The housing shall be approximately 5-5/16 inches high, 2-3/8 inches wide and 15/16 inches deep. The projected reflecting surface shall be a minimum of approximately 6-1/2 square inches.

The 1/2 inch x 3-1/2 inch wing of the device will emit a signal from -5 degrees to +70 degrees. The wide angle reflector performance shall be retained in all conditions, rain, fog, or snow.

The material for the housing shall be acrylonitrile butadiene styrene (ABS). The material used for the reflective area shall be methyl methacrylate plastic and conform to FS-LP-380C, Type 1, Class C.

## 2. Optical Requirements

### a. Definitions

**Horizontal Entrance Angle** - The angle in the horizontal plane between the mounting plane (guardrail) and the incident light. The horizontal entrance angle shall be considered as plus in the direction from the mounting plane toward the normal to the reflector face.

**Observation angle** - The angle formed between the line from the light source to the reflector and the line from the reflector to the observer's eye.

**Specific Intensity** - The candlepower, in foot-candles, of the returned light at the chosen observation and entrance angles for each foot candle of illumination at the reflector face on a plane perpendicular to the incident light.

- b. *Optical Performance* - When the delineator is oriented in the photometric device with its long axis vertical and mounted to simulate mounting within a guardrail, the specific intensity of the crystal (white) reflecting surface at 0.1 degree observation angle shall be as follows:

**TABLE 822.13 OPTICAL PERFORMANCE SPECIFICATIONS**

HORIZONTAL ENTRANCE ANGLE (degrees)	SPECIFIC INTENSITY
-5 (OR)	10
0 (HV)	20
+5 (RS)	20
+10 (RS)	20
+20 (RS)	20
+45 (RS)	25
+50 (RS)	25
+70 (RS)	10

Note: OR - Off Roadway Side  
 RS - Roadway Side  
 HV - Horizontal, Vertical axis of reflector

For yellow delineators, the specific intensity shall be 60 percent of the value for crystal (white).

- c. *Optical Testing Procedure* – The delineators to be tested shall be located with the center of the reflective area at a distance of 100 feet from a uniformly bright light source having an effective diameter of 2 inches. The photocell shall have an aperture of 0.5 inch diameter, and shall be shielded to eliminate stray light. The distance from the center of the light source to the center of the photocell aperture shall be 2.09 inches. If a test distance of other than 100 feet is used, the source and receiver dimensions along with the distance between source and receiver shall be modified in the same proportion as the test distance. In no case shall the test distance be less than 10 feet.

Determination of acceptability shall be based on MIL- STD-105D using an AQL of 2.5.

- d. *Delineator* - Guardrail delineators such as Model #962 manufactured by the Signal Products Division, Amerace Corporation 7542 North Natchez Street, Niles, Illinois 60548; Model GR-1 as manufactured by Astro Optics Corporation, 924 Morse Street, Schaumburg, Illinois 60193; or approved equivalent are acceptable.

**822.14 IMPERVIOUS SUBGRADE MATERIAL**

Polyethylene sheeting used as an impervious sub-grade material shall conform to the requirements of AASHTO M 171 except the color shall not be restricted and the moisture retention and apparent daylight reflectivity requirements will not apply. The average thickness of the sheeting shall not be less than 1 mil (0.001 inch).

**822.15 FORMULATED LATEX MODIFIER**

Latex shall be a non-toxic, film forming, polymeric emulsion to which all stabilizers have been added at the point of manufacture and shall be homogeneous, uniform in composition, and free from chlorides. The latex modifier shall conform to the following requirements:

**TABLE 822.15 LATEX MODIFIER SPECIFICATIONS**

PROPERTY	VALUE
Butadiene Content	30-40%
Solids	46-53%
Weight	8.40-8.47 lb/gal
pH	9.0-12.0
Coagulum	Max. 0.10%

PROPERTY	VALUE
Surface Tension	Max. 50 dynes/cm
Mean Particle Size, polymer A	1400-2500
Freeze-Thaw stability	Max. 0.10%
Color	White
Shelf Life	Min. 2 years

Each shipment of latex modifier shall be accompanied by a report of tests performed in accordance with the Certification Program contained in Section VII of Report No. FHWA- RD-78-35. The report shall include date of manufacture, batch or lot number(s), quantity represented, manufacturer's name, place of manufacture, and the date on which the one (1) year certification period will expire. Values for viscosity and density spectrographs of the solid portion and volatile portion shall be provided in the report.

### 822.16 PIPE JOINTING COMPOUND

**A. PHYSICAL PROPERTIES** - Pipe jointing compound shall have a bituminous base and shall adhere firmly to the glazed surface of pipes. It shall melt freely at 250°F. When set hard it shall be sufficiently elastic to permit a slight movement of the pipe without injury to the joints or breaking of the adhesion of the compound to the pipes.

### B. CHEMICAL PROPERTIES

**TABLE 822.16 CHEMICAL PROPERTIES**

	Minimum	Maximum
Specific gravity at 77°F	1.00	1.50
Bitumen soluble in CS <sub>2</sub> percent	50	-----
Loss in weight, 5 hrs., 50 gm at 400°F	-----	1.00
Melting point (Ring and Ball), °F	200	-----

The compound must withstand five (5) days immersion in 5 percent solution of KOH and five (5) days immersion in 1 percent solution of HCl.

**823 ROADSIDE IMPROVEMENTS****823.01 TOPSOIL**

- A. Topsoil shall be natural, surface soil, in a friable condition, and shall contain not less than 3 percent subsoil. The topsoil shall be free of hardpan material, stones and clods larger than ½ inch in diameter, sticks, tree or shrub roots, debris, toxic substances (i.e., residual pesticides), and other material detrimental to plant growth. The area to be planted and the topsoil shall be free of plants, plant seed, or plant parts of undesirable plants such as, but not limited to, Bermuda grass, nut sedge, mugwort, Johnson grass, quack grass, Canada thistle, or noxious weeds as set forth in the Federal Seed Act.
- B. The Contractor shall notify the Engineer of the location of all sources of the topsoil and shall furnish the Engineer a certified report from the agricultural experiment station or approved agricultural Laboratory of an analysis performed not more than sixty (60) Calendar Days prior to the date of submission. The topsoil shall be certified to meet the following requirements:
1. Soil shall be a natural, original surface soil of a sandy loam texture with a mechanical analysis of 60-65 percent sand, 15-25 percent silt and 10-15 percent clay.
  2. Soil shall be at least 2 percent, but not more than 5 percent, organic matter.
  3. Soil pH shall be from 5.5 to 6.6 inclusive unless otherwise specified.
  4. Soil salinity, measured by electrical conductivity, shall not exceed 500 parts per million (ppm) as determined by "Method of Soil Analysis" Part 2, published by the American Society of Agronomy, 1965.
- C. The soil nutrient level shall be greater than 100 lbs/acre of magnesium, 150 lbs/acre of phosphorus and 120 lbs/acre of potassium. Limestone as per 823.02(F) may be used to adjust an acidic condition and shall be thoroughly mixed by volume. No more than 5 pounds of limestone per cubic yard of topsoil may be used for this purpose.
- D. Topsoil that has been synthesized by blending materials that do not individually meet the requirements of this specification will not be accepted even though the resulting blend meets the organic matter, mechanical analysis, pH and soluble salts requirements.
- E. The Engineer reserves the right to inspect and sample all topsoil at the source and/or at the time of delivery.
- F. Topsoil shall not be delivered or handled in a frozen or muddy condition.
- G. All topsoil shall be approved by the Engineer before delivery to the job Site.
- Material not meeting requirements of this specification may be rejected on or after delivery.

**823.02 FERTILIZERS**

- A. **FERTILIZER FOR SEEDING** - Fertilizer shall be a standard commercial grade as per standards of the Association of Official Analytical Chemists and shall contain the equivalent of 10 percent nitrogen, 6 percent phosphoric acid, and 4 percent potash by weight, and shall be applied to all seeding and sodding areas at the rate of 1,000 lbs. per acre.
- Fertilizer shall be furnished in new, clean, sealed, and properly labeled bags.
- B. **FERTILIZER FOR HYDROSEEDING (CROWNVETCH)** - Standard quality commercial 0-20-20 farm grade fertilizer shall be applied at the rate of 500 pounds per acre (12 pounds per 1,000 square feet) combined with Ureaform (38-0-0) or Blue Chip Nitroform, Kapco-38, or equivalent, applied at the rate of 400 pounds per acre (9 pounds per 1,000 square feet). Ureaform 38-0-0 shall meet the following additional requirements:

**TABLE 823.02 FERTILIZER SPECIFICATIONS FOR HYDROSEEDING**

Total nitrogen (TN)	38.0 percent minimum
Water-insoluble Nitrogen	27.0 percent minimum
Activity Index (AI)	40.0 percent minimum
Urea Nitrogen	3.5 percent maximum

- C. STABLE MANURE USED FOR PLANTING** - Manure shall be well rotted, unleached horse and/or cow manure, free from shavings, sawdust, or refuse, and shall not contain material harmful to plant growth. It shall be not less than six (6) months old or more than two (2) years old.
- D. UREAFORM FERTILIZER FOR PLANTING** - Ureaform fertilizer shall be granular or pelletized with a 38-0-0 analysis.
- E. MICROPORE FERTILIZER RELEASE PACKETS** - Micropore fertilizer release packets shall be used during the planting in accordance with packet manufacturer's instructions, or as specified. Each packet shall be sealed in a polyethylene laminated envelope and shall contain a minimum soluble fertilized analysis of 16 percent nitrogen, 8 percent phosphorus and 16 percent potash. Packets shall be 4 ounces, eight (8) year release packages as approved by the Engineer.
- F. LIME** - Lime, if necessary to adjust soil pH for grass renovation, shall consist of an agricultural calcic or dolomitic ground limestone containing at least 85 percent of total calcium and magnesium carbonates. Limestone shall be per standards of the Association of Official Agricultural Chemists.

Lime shall meet the following grading analysis:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
No. 100	40
No. 8	95

Lime shall be applied to all grass areas at the rate of 3,000 lbs. to the acre. It shall be evenly spread and well incorporated into the soil.

### 823.03 SEED

- A. SEED FOR GRASS** - Seed mixes and seed shall meet the requirements listed in Table 823.03. The germination portion of Crown vetch seed shall consist of 35 percent normal sprouts and 35 percent hard seed.

Seed sown from March 1 to April 30 and from August 15 to October 31 shall be Seed Mix No. 1, Seed Mix No. 2, or Seed Mix No. 3, as specified in the Special Provisions. However, the Engineer reserves the right to specify a special seed mix for highly disturbed sites, riparian sites and deep slopes. If not specified or directed in writing, Seed Mix No. 1 shall be used.

Seeding with the above mixes at other than the indicated dates may be allowed upon written approval.

Seed Mixes No. 1 and No. 2 shall be sown at the rate of 100 pounds per acre or 2-1/2 pounds per 1,000 square feet.

Seed sown from May 1 to July 31 shall be Korean Lespedeza (*Lespedeza stipulacea*). This seed shall be sown at the rate of 40 pounds per acre.

Korean Lespedeza (*Lespedeza stipulacea*) may be sown from February 15 through March 31. This seed shall be sown at a rate of 30 pounds per acre or 1 pound per 1,000 square feet. Apply 200 pounds of 10-10-10 fertilizer per acre and apply lime if pH is less than 5.5.

- B. CROWN VETCH SEED FOR HYDROSEEDING** - Seed Mix No. 3 shall be used.

Crown vetch seed, sown at the rate of 20 pounds per acre, shall be 95 percent pure with 70 percent germination of which a minimum of 35 percent shall be normal sprouts and the remaining hard seed. The total mixture, including the companion nurse grass seed, shall be sown at the rate of 80 pounds per acre or 1-3/4 pounds per 1,000 square feet.



All seed shall be from the last available crop. No seed shall be accepted with a date of test of more than nine (9) months prior to date of sowing. All seed shall be labeled, tagged, or marked in accordance with the best practice and according to law.

**TABLE 823.03 SEED MIXTURES**

		Purity (percent)	Germination (percent)	Maximum Weed Seed (percent)
SEED MIX NO. 1	75% Kentucky Blue Grass( <i>Poa pratensis</i> )	85	75	0.75
	20% Red Fescue ( <i>Festuca rubra</i> ) (Illahee Strain)	95	80	0.50
	5% Red Top ( <i>Agrostia alba</i> )	92	90	1.00
SEED MIX NO. 2	70% Kentucky 31 Fescue( <i>Festuca elatior</i> )	98	90	0.50
	30% Red Fescue ( <i>Festuca rubra</i> ) (Illahee Strain)	95	80	0.50
SEED MIX NO. 3	35% Perennial Rye Grass( <i>Lolium perenne</i> )	98	90	
	35% Kentucky 31 Fescue ( <i>Festuca elatior arundinaceae</i> )	98	90	0.50
	30% Crownvetch ( <i>Coronilla varia</i> Var. Penngift)	95	70	0.50
OTHER SEEDS	Korean Lespedeza( <i>Lespedeza stipulaces</i> )	98	70	0.75

#### 823.04 MULCH

- A. MULCH FOR SEEDING** - Material used for mulching in seeding areas shall be wheat or oat straw, rye or other approved hay or stems resulting from harvesting seed or approved herbaceous mowings. All mulch material shall be reasonably free from weed seed, mold, and foreign matter and shall not contain sticks larger than 1/4-inch in diameter.

Straw mulch shall be in an air-dry condition and suitable for placing with mulch blower equipment.

- B.** Hydromulch shall be wood cellulose fiber mulch. Degradable green dye wood cellulose fiber or 100 percent recycled long fiber pulp, free from weeds or other foreign matter toxic to seed germination and suitable for hydromulching.

- C. MULCH FOR PLANTING** - Mulch shall be double ground hardwood premium grade and free from matter injurious to plant growth. No weed seeds or low quality dyed pallet chips are allowed.

#### 823.05 SOD

Sod for residential areas shall be well rooted Kentucky Blue Grass (*Poa pratensis*) containing a growth of not more than 30 percent of other grasses and clovers and free from noxious weeds, Bermuda grass, wild mustard, and crabgrass. Soil adhering to roots shall be not less than 1 inch thick and as uniform as practicable.

Sod for non-residential roadside areas shall be a certified grass mixture of 90 percent Tall Fescue and 10 percent Kentucky Blue Grass, or a percentage acceptable to the Engineer. Improved Tall Fescue varieties such as Avenger, Cochise III, Inferno, and Titanium are acceptable. Sod shall be free from noxious weeds such as Bermuda grass, wild mustard and crabgrass.

Sod shall be well rooted and field grown for a minimum of twelve (12) months. Sod shall be placed within forty-eight (48) hours of being cut and rolled. It shall be cut into strips not less than 14 inches or more than 20 inches in width. Sod shall be machine cut to a uniform thickness of 3/4 inch,  $\pm 1/4$  inch, at the time of cutting. Thickness shall exclude top growth and thatch. Sod shall be relatively free of thatch (3/8 inch or less) at time of cutting.

#### 823.06 PEAT

Peat humus for plants and planting shall be a natural peat or peat humus from fresh water saturated areas, consisting of sedge, sphagnum, or reed peat deposits in which the organic matter consists of incompletely decomposed residues containing a minimum of 70 percent organic material by weight. Humus shall be free from sticks, stones, roots, and other objectionable materials. Samples taken at the source of supply shall show the following analysis:

**TABLE 823.06 PEAT CHARACTERISTICS**

pH range	4.0 to 7.5
Water absorption ability	200 percent by weight min. on oven-dry basis
Organic content:	60 percent min. when dried at 105° C

**823.07 PLANT MATERIALS**

- A. QUALITY** - All plants, unless otherwise specifically permitted, shall conform to the standards of the current edition of “American Standard for Nursery Stock” as approved by American Standards Institute, Inc.

All plant grades shall be those established in the current edition of American Standards for Nursery Stock manual. Only 1 size per grade will be listed rather than a size range. The one size shall mean the minimum size for that grade and shall include plants from that size up to but not including the next larger grade size.

- B. PLANTS** - Plants shall be defined as trees, shrubs, vines and plants of all descriptions.

Unless otherwise specified, all plants shall be nursery grown stock that has been transplanted or root trimmed 2 or more times, according to the kind and size of plants. Furnished plant material shall be certified by State or Federal Department of Agriculture to be free from disease or infestation.

All plant materials shall have normal, well developed branches and a vigorous root system. The branch system shall have normal development and be free from disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, insect eggs and infestations, or other objectionable disfigurements. The plants shall be healthy and free from physical defects, plant diseases, and insect pests. Plant materials grown in fields or blocks that show evidence of containing any parts of Johnson grass or Canada Thistle will be rejected.

- C. PLANT NAMES** - All scientific and common plant names shall per “Standardized Plant Names” as adopted by the American Joint Committee on Horticultural Nomenclature. All plants shall be true to name and legibly tagged with the names and sizes of material.

- D. GRADING STANDARDS** - Grading of plants, including Balled and Burlapped Specifications, Bare Root Specifications, Nursery, Collected, Container Grown and Seedling Stock shall be as per American Standard for Nursery Stock, as approved by the American Association of Nurserymen, Inc., latest edition (ANSI Z60.1).

- E. PLANT DIGGING AND HANDLING** - All plants shall be dug in conformance with the digging Specifications in the current edition of American Standard for Nursery Stock, unless otherwise specified.

All bare root deciduous plants shall be shipped in a dormant condition. Roots shall be adequately protected and kept moist.

- F. PLANT SUBSTITUTION** - No substitutions shall be made without prior permission of the Engineer.

In cases where plant materials are not available at the time of planting, the Contractor shall submit written evidence that the plants are unavailable. The Engineer may determine a suitable substitution.

**823.08 PLANTING MATERIALS**

- A. PEAT HUMUS** - shall meet the requirements of 823.06.

- B. STABLE MANURE** - shall meet the requirements of 823.02 (C).

- C. STAKES** - Stakes used to support trees shall be rough sawn, straight grain hardwood reasonably free from knots, bark, wane, warp and splits, as determined by the Engineer. Stakes shall be full cut 2x2 inch thickness. The stake lengths shall be as indicated in the Contract Documents.

- D. ARBOR TIE** – Arbor Tie Flat woven polypropylene material may be used in lieu of wood stakes. It shall be 3/4 inches (2 cm) wide; 900 lbs. (409 kg) break strength.

- E. ANTIDESICCANT** - Antidesiccant, for retarding excessive loss of plant moisture and inhibiting wilt, shall be an approved emulsion that will provide a film over plant surfaces permeable enough to permit transpiration. Antidesiccant shall be used only after approval by the Engineer.
- F. HERBICIDES** - Herbicide shall be an EPA-approved chemical to control and prevent re- growth of undesirable vegetation. The herbicide will be subject to approval by the Engineer.

## 824 SIGNAGE

### 824.01 SIGN POSTS

- A. **GROUND MOUNTED WOOD SIGN POSTS** - See 822.12(C).
- B. **STEEL SIGN POSTS** - See 824.03.

### 824.02 REFLECTIVE SHEETING

Reflective sheeting for sign panel faces shall meet the requirements of AASHTO M 268 (D4956-01a) for Type III, Type VI and/or Type IX as required by the Contract Documents. The Backing for the reflective sheeting shall meet the requirements of AASHTO M 268 (D4956- 01a) for Class 1, 2 and 5. The colors of the reflective sheeting shall conform to the standard traffic colors per the Manual of Uniform Traffic Control Devices current edition.

- A. Type III Retro-reflectivity requirements shall conform to AASHTO M 268 and the following.

**TABLE 824.02 (A) MINIMUM REFLECTIVE INTENSITY VALUES FOR TYPE III SHEETING**

Minimum Coefficient of Retroreflection (RA) cd/(lx · m<sup>2</sup>)

Observation Angle°	Entrance Angle°	White	Yellow	Red	Orange	Green	Blue	Brown
0.2	+50	75	40	8.4	25	10.3	2.9	1.6
0.5	+50	35	20	6.8	10	6.4	2	1.1

- B. Type VI Retro-reflectivity requirements shall conform to AASHTO M 268 as specified.
- C. Type IX Retro-reflectivity requirements shall conform to AASHTO M 268 and the following.

**TABLE 824.02 (B) MINIMUM REFLECTIVE INTENSITY VALUES FOR HIGH PERFORMANCE WIDTH ANGLE PRISMATIC LENS SHEETING**

Minimum Coefficient of Retro-reflection (RA) cd/(lx · m<sup>2</sup>)

Observation Angle°	Entrance Angle°	White	Yellow	Red	Orange	Green	Blue	Fluorescent Yellow	Fluorescent Green	Fluorescent Orange
0.2	-4	380 <sup>a</sup>	300	98	145 <sup>a</sup>	45	22	240	325	140
0.2	+30	225	180	65	82 <sup>a</sup>	28	14	150	200	90
0.5	-4	275	220	70	90 <sup>a</sup>	32	17	165	235	105
0.5	+30	135 <sup>a</sup>	100 <sup>a</sup>	32	50 <sup>a</sup>	16	8	75	105	50
1.0	-4	80 <sup>a</sup>	60 <sup>a</sup>	20	30 <sup>a</sup>	9	4.5	45	65	30
1.0	+30	45 <sup>a</sup>	35 <sup>a</sup>	11	11 <sup>a</sup>	6	3	24	35	15

a AASHTO M 268 - Table 3

- D. Temporary Roll Up Warning Signs shall conform to AASHTO M 268 Type VI.
- E. Black Sheeting shall be nonreflective.

### 824.03 STEEL SIGN STRUCTURES

The following material requirements apply:

Steel Pipe - ASTM A 53, Type F; galvanized per ASTM A 386, Class B-1 plus ASTM A 384 and A 385; with 25,000 psi minimum yield stress; used for diagonals and verticals 4-1/2 inches O.D. and under.

- ASTM A 53, Types E and S, Grade B galvanized per ASTM A 386, Class B-1 plus ASTM A 384 and A 385; with 35,000 psi minimum yield stress; used for truss chords, columns, and ground mount sign posts 4-1/2 inches O.D. and over.

Equivalent galvanized tapered tube sections may be used in place of above requirements provided there are no alterations to other sign structure detail.

Steel Plates & Shapes - AASHTO M 183 and galvanized per AASHTO M 111.

Steel Castings - AASHTO M 103, Grade 65-35 and galvanized per AASHTO M 111.

Catwalk Gratings - Borden Type B-7, Blaw-Knox Type 8N21, Irving Type A-A; or approved equal.

Pipe Connections and Couplings - Victaulic Turnpike type or approved equal and galvanized per ASTM A 153.

Post Caps - Cast post caps shall be black iron per ASTM A 48 or carbon steel per ASTM A 27 and galvanized per ASTM A 153.

Turned and U Bolts and Nuts per ASTM A 307 and galvanized per ASTM A 153.

Anchor Bolts and Nuts and Washers - Carbon steel high strength bolts per AASHTO A 325, or Alloy Steel high strength bolts per ASTM A 490, and galvanized per ASTM A 153.

#### **824.04 GUIDE SIGN PANELS, TRAFFIC SIGN PANELS, HAZARD DELINEATORS, DEMOUNTABLE CHARACTERS AND DELINEATORS**

Sheets and plates for sign panels shall be 6061-T6 aluminum alloy meeting requirements of ASTM B 209, Alloy GS 11A, Condition T6.

Angles, zees, and lock tabs for sign panel framing shall be extruded shapes of 6061-T6 aluminum alloy meeting requirements of ASTM B 221, Alloy GS11A, Condition T6.

Support angles shall be AASHTO M 183 steel galvanized to requirements of AASHTO M 111.

Panel hardware, unless otherwise specified on the Plans or herein, shall be stainless steel meeting requirements of ASTM A 276, Series 300 or clear anodized 2024-T4 aluminum alloy rod meeting requirements of ASTM B 211, Alloy CG42A. Reflective Sheeting shall meet requirements of 824.02.

Insulation shall be laminated insulating sheets meeting the requirements of Military Specification MIL-P-15035, Type FBM, FEG, FBE, or insulation sleeves meeting requirements of Military Specification MIL-I-3190B, Type FBM, FEG, or FBE. Samples of 9 insulating materials shall be submitted to the Engineer for approval prior to use.

Demountable characters and borders shall consist of embossed aluminum frames which are covered with reflective sheeting. As required, reflector buttons shall be mounted on the characters and borders.

Characters shall be fabricated from 0.04 inch sheet aluminum conforming to AASHTO M 290. All demountable letters and numerals shall be Federal Highway Administration Standard Alphabet, Modified Series E. Mounting holes shall be provided for fastening to sign panel; spacing of mounting holes shall be determined by character size and shape, but in no case shall holes be spaced more than 8 inches on center.

Reflector buttons shall conform to AASHTO M 290 and shall be designed to be mounted on demountable characters and demountable sign borders by mechanical means that require no adhesive.

Hazard delineators and delineator reflectors shall consist of minimum 3 inch diameter, amber or colorless reflector units, as specified, meeting reflector button requirements as specified above. Specific brightness per amber reflectors shall be 60 percent of values shown for colorless reflector buttons.

Each reflector shall be mounted in a 5032-H32 aluminum housing formed to enclose the circumferential edge and back of reflector. Housing shall contain a single center mounting hole into which an aluminum grommet shall be expanded to an inside diameter of 3/16 inch. Mounting hardware shall be 2024-T4 aluminum alloy of vandal resistant design.

Non-demountable characters shall consist of cutouts of reflective sheeting applied directly to sign background. Reflective sheeting shall meet requirements of 824.02. Non-demountable letters and numerals shall be Federal Highway Administration Standard Alphabet Series specified on the Plans. Where interstate route delineators are required for guide signs using non-demountable characters, the delineator shields also shall be cutouts of reflective sheeting applied directly to sign face.

Silk screen paste for traffic signs shall be high quality black opaque face or transparent overlay type suitable for exterior use. The dry

film shall be tough, smooth, hard, and free from all defects such as sagging, checking, wrinkling, and orange peeling.

Black silk screen paste shall be opaque, and formulated so that paste will not dry in the screen in less than two (2) hours. It shall flow out and level uniformly over the screened area without running, sagging, or streaking.

Silk screen paste for transparent overlay shall be of such formulation that it can be applied by silk screen process to reflective sheeting so as to produce a true color, both under direct and reflected light. Paste ingredients shall be compatible with reflective sheeting surface so proper adhesion will result with no deterioration to the reflective sheeting. Green, red, and blue transparent overlay silk screen paste shall be approved and shall match the color standards of the MUTCD.

## 825 TRAFFIC SIGNAL MATERIALS

### 825.01 TYPE 170 MICROPROCESSOR-BASED TRAFFIC SIGNAL CONTROLLER AND CABINET ASSEMBLY

#### 825.01.01 GENERAL

- A.** The Contractor shall supply Type 170 Traffic Signal Controller System-Hardware compliant with Specifications provided by the Federal Highway Administration, Implementation Package FHWA-IP-78-16, including all subsequent addenda. The controller assemblies shall consist of a type 170E Controller, a cabinet, a cabinet base, and auxiliary equipment necessary for a complete electrical system, all mounted in the controller cabinet. Specifications for auxiliary equipment, which may be purchased separately, are contained within this document.
- B.** All equipment furnished under these Specifications shall be of solid-state design. Use of vacuum gaseous tube or electro-mechanical devices with the equipment is not acceptable unless otherwise indicated.

The equipment to be furnished shall be in compliance with the State of California Department of Transportation (CALTRANS) publication "Transportation Electrical Equipment Specifications" (TEES), except as modified in these Specifications. All references to CALTRANS TEES shall be defined as the most recent version of the document or equal as approved by the Department. In the event of a conflict these Specifications shall prevail. The Department utilizes this CALTRANS specification and other CALTRANS documents for procurement of Traffic Signal Materials.

- C.** All components supplied shall be listed on the CALTRANS Qualified Product List (QPL). All references to the CALTRANS Qualified Product List (QPL) shall be defined as the most recent version of the CALTRANS QPL or equal as approved by the Department. In the case of the enhanced conflict monitor, and 170E controller, the vendor's enhanced monitor and 170E controller shall be listed on the CALTRANS QPL. In the case of the modified 336SS and 332 cabinets, the vendor shall have a standard 336 cabinet, 332 cabinet, or 332A cabinet that is listed on the CALTRANS QPL. (All references to 336 shall mean 336SS cabinet). The modified equipment shall be of substantially similar design and production quality, as determined by the District of Columbia or its designated representative, as those standard items that are listed on the CALTRANS QPL. For each piece of equipment that is covered by this requirement, the vendor shall submit, at time of bid, a notarized certification the equipment is listed on the QPL. Failure to provide this certification shall cause the bid to be rejected as unresponsive. If during the course of the Contract, any piece of equipment ceases to be listed on the current QPL, the District may, at its option, require the vendor to provide a suitable replacement that is listed on the then current QPL at no additional cost.
- D. DOCUMENTATION AND EQUIPMENT ACCEPTANCE** — An electronic version and a hardcopy version of the Users Manual shall be supplied with each item.

Each manual shall include the following:

1. General Description
2. General Characteristics
3. Installation
4. Adjustments
5. Theory of Operation
6. Systems Description (include block diagram)
7. Detailed Description of Circuit Operation, with Signature Analysis
8. Maintenance
9. Preventive Maintenance
10. Trouble Analysis
11. Trouble Shooting Sequence Chart

12. Wave Forms and Description
13. Voltage Measurements
14. Alignment Procedures
15. Parts List (to include circuit and board designation, part type and class, power rating and component manufacturer and original manufacturer's part number)
16. Electrical Interconnection Drawing
17. Schematic and Logic Diagram
18. Assembly drawings and a pictorial diagram showing physical locations and identification of each component
19. The serial numbers and revision numbers of equipment covered by manuals shall be printed on the front cover of the manuals.
20. Manuals for the Model 170E Controller Unit, 332 cabinets, 336 cabinets, and all plug in units shall be furnished with the item and enclosed in the shipping container.
21. Prior to final printing, a preliminary draft of all manuals shall be submitted to the Engineer for approval. The vendor also shall submit 1 prototype of each piece of equipment that is being provided. Within sixty (60) days, the District will review the documentation and equipment for compliance with Specifications. After the review is complete, the District will notify the vendor of any changes or corrections that may be required. The vendor shall remedy the defect and shall re-submit the equipment and documentation within ten (10) days. The District will complete subsequent reviews within forty-five (45) days. No equipment may be shipped until the District has approved all equipment designs and associated documentation. The District, at its discretion, may cancel the order after any failure of the equipment or documentation to meet specification requirements. No payment shall be made for any equipment or associated shipping costs for any piece of equipment that does not meet specification requirements.

## 22. Training

- a. On orders of 100 or more cabinets, the contractor selected shall provide experienced instructors and training material in order to present formal classroom as well as "hands-on" training in the operation and maintenance of equipment being supplied as part of this Contract.
- b. 2 training courses shall be conducted in the area of 170E controller and cabinet operations and 170 controller and cabinet maintenance. Thirty (30) hours of instruction shall be provided for each course. The courses shall be held in the District of Columbia at facilities provided by the District or at leased facilities provided by the Contractor. The courses shall be conducted at a time mutually agreed upon by the District and the Contractor. The training material generated for each course shall contain "hand-outs" for each attendee, which shall serve not only as subject guidance, but also as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following the course completion.
- c. At least sixty (60) days prior to the commencement of the training courses, the Contractor shall submit to the Engineer, a detailed course curriculum, draft manuals and materials, and a resume of the instructor(s). The Engineer will review the course submittal data within thirty (30) days and will return his comments to the vendor. The vendor shall make the indicated corrections and re-submit the materials. Training courses shall not commence until thirty (30) days after the Engineer's approval of the course submittals.

The Contractor shall provide 15 copies of the approved course materials (or copies for all scheduled attendees and 2 spare copies, whichever is greater) at least fifteen (15) days in advance of the scheduled course.

- d. Each of the 2 training courses shall consist of five (5) consecutive days of six (6) hours each of classroom and "hands-on" training in accordance with the approved training curriculum. No more than 12 operational and maintenance personnel will attend each course.



- e. Manufacturer's personnel shall conduct 2 Model 170E Controller training courses. The courses shall completely cover the operation and maintenance of the controller, cabinet, and all auxiliary equipment. The course shall provide all necessary instruction to ensure complete operations, troubleshooting, and repair training.

**E. SUPPLEMENTARY EQUIPMENT TRAINING** - When supplemental equipment is required per 825.01.02.B the Contractor(s) selected shall provide a one-time minimum of twelve (12) hours of formal classroom as well as "hands-on" training for District of Columbia personnel in the operation and maintenance of equipment being supplied as part of this Contract. The training shall be conducted over a period of two (2) consecutive days.

Manufacturer's personnel shall conduct Supplementary Equipment Training. The Supplemental Equipment Training shall provide sufficient "hands-on" training for proper application of this equipment in the maintenance of the 170E Controller, Cabinet Assemblies, and Auxiliary Equipment.

Training shall be coincidental with the delivery of the first piece of equipment and completed within three (3) months after the first delivery.

**825.01.02 MODEL 170E CONTROLLERS**

**A. GENERAL** - The Model 170E Controller Units shall conform to the provisions of Chapter 2 of Specification FHWA-IP- 78-16, and these Specifications.

The Model 170E Controller Units shall conform to the provisions of the CALTRANS TEES, except as modified in these Specifications. In the event of a conflict these Specifications shall prevail.

**B. EQUIPMENT** - Each controller assembly supplied shall include the following equipment:

**TABLE 825.01.02 (A): CONTROLLER EQUIPMENT**

QUANTITY	DESCRIPTION
1	Model 336-SS Cabinet with Base Adapter
1	Type 170E HC11 Controller Unit with Program Module
1	Pull-out Drawer
2	Model 496 Modem
2	Fluorescent Lamp Fixtures
18	Model 200 Switch Packs (Load Switch)
2	Model 204 Flasher Units
2	Enhanced Conflict Monitor Unit (Model 218 DC or Model 225)
4	Model 242 Two-Channel D.C. Isolators
4	Model 222 Two-Channel Loop Detector Amplifiers
4	Cabinet Anchor Rods and Bolts (for new foundations)
1	Input File
1	Output File with Hard-wired Option
1	Auxiliary Output File with Hard-wired Option
1	Power Distribution Assembly (PDA #2) with Circuit Breaker Option
1	Communications Assembly
7	Model 430 "Heavy Duty Relays"
20	Jumper Plugs for Output File Flash Programming (12 Red, 4 Yellow, 4 White)

QUANTITY	DESCRIPTION
1	STEP Diagnostic Program with Manuals
1	LADIAG R3F Diagnostics with Manuals
1	PC Downloading Cable
1	PC Extension Cable – to Extend PC Downloading Cable

**C. 170E HC11 CONTROLLER UNIT** - This specification pertains to the 8HC11 CPU Module and Model 412HC Program Module.

The model 170E traffic controller unit shall meet all requirements of this specification.

The 68HC11 CPU board shall replace the standard CPU module for the Model 170E controller. It shall use a 68HC11F1 microprocessor instead of a 6802 microprocessor.

The 412HC Program Module shall be a non-functional Program Module that will be used in place of the standard Model 412C Program Module.

The 68HC11 based CPU Module shall use a 68HC11F1 MPU to replace the existing 6802 MPU-based CPU module installed in standard 170E controllers. The MPU shall operate at a crystal-controlled frequency of 9.8 MHz. The MPU chip shall be socket mounted in an AMP PLCC socket #821547-1 series HPT or equal.

The 68HC11 CPU Board shall have four 68B50 Asynchronous Communications Interface Adapters (ACIA).

The 68B50 communication ICs shall be used and shall operate with a crystal frequency of 9.8 MHz. Each ACIA shall have individual jumpers to select 5 different communication baud rates - 1200, 2400, 4800, 9600, 19,200, and 38,400 bps. There shall be no IRQ inhibit jumpers provided; therefore, all ACIAs shall be active. Programs should be written to initialize the 4 communications ACIA chips upon startup. An IRQ status register shall be provided that conforms to the provisions of CALTRANS TEES.

It shall be possible to swap ports 2 and 3 by means of a Port Swap jumper on the 68HC11 CPU Board.

EPROM and RAM shall be resident on the CPU board, and shall be socket mounted. The EPROM socket shall be a 32-pin ZIF force Device. The RAM socket shall be a 28 pin Augat 828 series or equal. The EPROM shall be a type 27C010 or Engineer approved equal.

RAM will be continuous from locations \$0000 to \$6FFF. RAM shall be a ZERO power device exclusively.

The RAM on the 68HC11 CPU Board shall be a zero power device with a Real Time Clock. The Real Time Clock address shall be in the I/O map at locations \$7FF8 to \$7FFF. The following System Address map shall be supported.

**TABLE 825.01.02 (B)**

Address	Function	Size (Bytes)	Bank Mode	Dual Port RAM
0000-6FFF	NVRAM	28K	NA	Disabled
0000-5FFF	NVRAM	24K	NA	Enabled
6000-6FFF	Dual Port RAM	4K	NA	Enabled
7000	Location Switch	1	NA	NA
7001	MCU Registers	1	NA	NA
7002	Port G	1	NA	NA
7003-7009	MCU Registers	7	NA	NA
700A	Feature Switch	1	NA	NA
700B-705F	MCU Registers	85	NA	NA
7060-73FF	Volatile CPU RAM	~1K	NA	NA
7400	DTA Minutes	1	NA	NA

Address	Function	Size (Bytes)	Bank Mode	Dual Port RAM
7401-740A	I/O	10	NA	NA
740B-740E	Not Used	4	NA	NA
740F	DTA Seconds	1	NA	NA
7410-7417	ACIA 1 to 4	8	NA	NA
7418-74FF	Reserved	232	NA	NA
7500-7507	Reserved	8	NA	Disabled
7500-7507	DPRAM Semaphores	8	NA	Enabled
7508-75FE	Reserved	247	NA	NA
75FF (Read)	IRQ Status Port	1	NA	NA
75FF (Write)	RTC Reset	1	NA	NA
7600-7FF7	NVRAM	2K	NA	NA
7FF8-7FFF	NVRAM (Real Time) Clock/Calendar	8	NA	NA
8000-FFFF	PROM	32K <sup>a</sup>	Disabled	NA
8000-FFFF	PROM	32K <sup>a</sup>	Enabled	NA

a Bank Switched

A jumper select shall be provided to switch locations \$6000 to \$6FFF from Internal to External mode for access to the remote Dual Port location. The status of the jumper position shall be read on the IRQ register-bit 5. When an enhanced Program Module is used with this system, it will only have access to addresses \$6000 through 6FFF for dual port operation.

The CPU module shall support 32K x 8 and 128K x 8 EPROM devices. EPROM size shall be jumper selectable.

When using a 128K EPROM, a bank switch shall be enabled with the EPROM memory system. This bank switch shall function by moving to the upper 64K segment of the EPROM. This bank switch jumper controls address line A16. The bank shall be activated by a write to location \$7002 (directly connected to Port G on 68HC11 MPU), which will cause memory to go to the upper 64K of the 128K EPROM. This will enable an extra 32K of EPROM memory via bank switching. The status of A16 will read on the IRQ status register-bit 6.

Feature and location switches shall be provided on the front portion of the 68HC11 CPU board. Switch Actuators shall be accessible from the front of the controller when the controller door is open. It shall be possible to set the Location and Feature DIP switches without removal of the CPU module. Each switch shall be an 8-position front reading dip switch. The Location Switch shall be mounted above the Feature Switch.

The Location and Feature switches shall be decoded as follows: Features switch shall be addressed at \$700A-Port E. Location Switches shall be addressed at \$7000-Port A. A header shall be provided near the front of the module for the SPI and serial interface pins.

It shall be possible to select whether the controller uses RAM on the CPU board or on the Program Module for memory functions in address range \$6000 to \$6FFF. The selection shall be made by making the appropriate jumper setting. If the jumper is set to the internal position, the CPU shall use the NORVRAM on the CPU module for operations in the address range of \$6000 to \$6FFF. If the jumper is set to the external position, the CPU shall use the RAM on the program module for operations involving address range \$6000 to \$6FFF.

Each CPU Board shall be furnished with a Non-Volatile RAM with Real Time Clock.

There shall be 1 LED indicator located on the front of the CPU board, which shall be controlled via a software output of Port G bit 3.

The +12VDC, +5VDC and -12VDC voltages input in the CPU board shall have transorb protection.

It shall be possible to map all memory locations to the 68HC11 CPU board. Manufacturer shall configure the 68HC11 CPU board

to support the following:

- Use 27C010 EPROM on CPU Board
- Map all NOVRAM on CPU Board
- Map \$6000-\$6FFF Memory to CPU Board

Each CPU board shall be furnished with 2 blank 27C010 EPROMs.

The 68HC11 CPU board shall fit and operate correctly in standard 170E controllers.

The 68HC11 CPU board shall be compatible with the 68HC11 versions of local controller software programs used in the District of Columbia. It shall not be necessary to use a Program Module with local controller software programs currently in use in the District of Columbia.

Each Model 170E controller shall be provided with a 412HC nonfunctional PROM module.

The 412HC PROM module shall be similar in appearance and construction to a Model 412C program module, except that it shall have no electronic components.

At a minimum, the 412HC shall consist of an unpopulated printed circuit board, a front panel, and a handle.

The 412HC11 module have the legend "412HC" permanently silk-screened on the outside the module. The legend for the module number shall be a minimum of 10 mm high.

A legend indicating the function of the Location and Feature switches shall be silk screened on the upper left corner of the 412HC module.

**TABLE 825.01.02 (C) LEGEND FOR LOCATION AND FEATURE SWITCH**

<b>Legend</b>	<b>Address</b>
SU-1	7000 Bit 0
SU-2	7000 Bit 1
SU-3	7000 Bit 2
SP-1	7000 Bit 3
SP-2	7000 Bit 4
SP-3	7000 Bit 5
IF-1	7000 Bit 6
IF-2	7000 Bit 7
ADDR 1	7001 Bit 0
ADDR 2	7001 Bit 1
ADDR 4	7001 Bit 2
ADDR 8	7001 Bit 3
DET	7001 Bit 4
ACT	7001 Bit 5
INT-S	7001 Bit 6
INT-M	7001 Bit 7

The 412HC module shall not be equipped with a DB-9 serial connector. The DB-9 connector for port 4 shall be mounted on the front chassis of the Model 170E controller.

All markings must be permanently silk-screened on the 412HC program module. No adhesive labels or dry-transfer may be used.

Provide 2 spare modules for every 10 model 170E –HC11 controllers supplied.

- Input Board
- Output Board
- CPU Board
- Modem
- Utility Display Board
- Power Supply Module

### 825.01.03 MODEL 336-SS CABINETS

**A. GENERAL** - This section defines the Specifications applicable to the Model 336-SS cabinets with base adapters. All cabinets shall comply with the provisions of Specification FHWA-IP-78-16 and CALTRANS TEES, except as modified herein. Cabinet and adapter dimensions are shown in the Department Standard Drawings. 2 types of base adapters will be provided.

#### **B. SPECIFICATIONS**

1. The Model 336-SS cabinet shall be a weatherproof cabinet with dimensions shown in the Standard Drawings. The cabinet top shall be slanted to right side, side that is 90 degrees from front and rear, to prevent standing water.
2. The cabinet and doors shall be fabricated from 0.125-inch minimum thickness sheet aluminum. All exterior seams for cabinet and doors shall be welded. All exterior welds shall be ground smooth. All edges shall be finished to a radius of 0.025-inch minimum.
3. **Fabrication** - Cabinet fabrication shall conform to the requirements of ASTM Designation: B 209 for 5052-H32 aluminum sheets.

Welding on cabinets shall be done by the gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes. Electrodes shall conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy base welding electrodes.

Procedures, welders, and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification", and to the practices recommended in AWS C5.6.

4. **Finish** - The surface of each aluminum cabinet shall be finished to conform to the requirements of Military Specification MIL-A-8625F (Anodic Coatings for Aluminum and Aluminum Alloys) for a Type II, Class I coating, except that the anodic coating shall have a minimum thickness of 0.0007 inch and a minimum coating weight of 27 milligrams per square inch. Prior to applying the anodic coating, the cabinets shall be cleaned and etched as follows:
  - a. **Clean** - Clean by immersion in inhibited alkaline cleaner such as Oakite 61A or Diversey 909, or equivalent, 6 to 8 ounces per gallon, 160°F for five (5) minutes.  
Rinse in cold water.
  - b. **Etch** - Etch in a solution of sodium fluoride, 1 ½ ounces plus sodium hydroxide, 4 to 6 ounces per gallon, at 140° to 150°F for fifteen (15) minutes.  
Rinse in cold water.
  - c. **De-smut** - De-smut in a 50 percent by volume nitric acid solution at room temperature for two (2) minutes.  
Rinse in cold water.
  - d. **Anodic coating** - The anodic coating shall be sealed in a 5 percent aqueous solution of nickel acetate (pH 5.0 to 6.5) for fifteen (15) minutes at 208° to 212°F.
5. **Locks** - The cabinet shall have single front and rear doors, each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall be removable. The operating handle shall be zinc-plated steel with a 7.5 inch overall length and provided with a 5/8 inch Allen-type hex head. The cabinet doorframe shall be double-flanged out on all 4 sides and shall be provided with strikers to hold tension on and form a firm seal between door gasketing and cabinet

doorframe. The flange width shall be a minimum of 1/2 inch. The depth of the double flange shall be a minimum of 1 inch from the outside edge to the cabinet surface. The dimensions of the cabinet door opening shall be as shown in the Standard Drawings. Cabinet locks shall be the solid brass, 6-inch tumbler, rim-type. The locks shall have rectangular, spring-loaded bolts. The bolts shall be 0.375-inch long and 0.75-inch wide by 0.375-inch thick (dimension tolerance is  $\pm 0.125$ -inch). The locks shall be left-hand on the front door and right-hand on the rear door. Keys shall be removable in the locked position only. The lock shall be rigidly mounted. The front portion of the lock shall extend 0.25-inch to 0.375-inch beyond the outside surface of the door. The locks shall be of custom keying to be determined by Contractor in consultation with the Department.

2 keys shall be furnished with each cabinet for the cabinet door lock. A total of 2 removable handles shall be furnished per cabinet. Keys and handles shall not be interchangeable with keys and handles provided with existing cabinets. Keys shall be distinctively shaped as compared with standard number 2 or 3 keys. A ring shall be welded to the end of each door handle that allows placement of the handle on a minimum 3/16 inch tether or key ring. See the Department Standard Drawings for alterations to the locking components to support the electronic cabinet security lock.

The latching mechanism shall be a 3-point draw roller type. Push rods shall be turned edgewise at the outward supports and shall be 0.25-inch by 0.75-inch, minimum. Supports shall be 0.105-inch steel, minimum. Rollers shall have a minimum diameter of 0.375-inch and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch steel, minimum.

6. **Hinges** - The Model 336-SS door's hinging shall be assessed by the Contractor but be comprised of a minimum of 4 butt hinges. Each hinge shall have a fixed pin. Front and rear doors shall be provided with catches to hold the door open at 90 degrees and 180 degrees, plus or minus 10 degrees. The catches shall be capable of holding the door open at 90 degrees in a 60-mph wind at an angle perpendicular to the plane of the door. The front door shall open from the left, and the rear door shall open from the right when facing the doors. Door hinges, pins, and bolts shall be made of stainless steel. The hinges shall be bolted to the cabinet. The hinge pins and bolts shall not be accessible to vandals.
7. **Police Panel** - The police panel door shall be equipped with a lock keyed for a master police key. The police panel shall be mounted on the rear door of the cabinet. Police panel assembly shall extend no further than 1.5 to 2 inches from the back of the rear door. It shall be possible to store the removable cabinet door handle in the police panel.  
2 keys shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1-3/4 inches in length. The lock and the key shall not match those of the existing controller cabinets.
8. A standard Electronic Industries Association (EIA) 19-inch rack cage shall be installed inside the cabinet for mounting the controller unit, pull-out hinged-top drawer, input file, power supply, output file, power distribution assembly, communications assembly and other devices as indicated in the Standard Drawings. The EIA rack portion of the cage shall consist of 2 pairs of full length, continuous, adjustable equipment mounting angles of 0.1345-inch nominal thickness zinc-plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B. The angles shall be supported top and bottom by welded support angles to form a cage.
9. The cabinet shall have ramps on either side level with the bottom edge of the door opening to provide horizontal support for the cage. The cage shall be vertically attached to each side of the cabinet at 4 points, 2 at the top and 2 at the bottom of the rails. Cage and horizontal support mating surfaces shall not be coated in any way to increase resistance of connection to chassis ground.
10. 2 zinc-plated controller unit supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of 3.0 inches. The angles shall be mounted 7.25 inches, minimum, from the top of the EIA rails and shall be adjustable vertically to ensure at least a 7.25-inch vertical opening for mounting the Model 170E Controller Unit.
11. Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inches minimum thickness closed-cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.
12. A pull out hinged-top drawer, having sliding tracks, with lockout and quick disconnect feature shall be provided as shown in the cabinet drawings. The pull-out drawer shall extend a minimum of 355 mm. It shall be possible to lift the hinged top to permit

storage of documents and other small articles in the interior of drawer. The hinged top shall be covered with Formica® or other equivalent smooth, durable, chemical resistant plastic sheet. The minimum interior dimensions of the drawer shall be 25.4 mm high x 330.2 mm deep x 406.4 mm wide. The drawer shall be capable of supporting a weight of 20 kg when fully extended.

13. Bottom of Cabinet Base Adapter shall mate with existing foundation and temporary concrete portable base and top of Cabinet Base Adapter shall mate with cabinet – see and confirm dimensions in the Department Standard Drawings.

- C. CABINET VENTILATION REQUIREMENTS** - Each cabinet shall be equipped with 2 electric fans with ball bearings and a capacity of at least 100 cubic feet of air per minute for each. Each fan shall be independently wired of one another and each shall have separate thermostat control.

Each fan shall be mounted within the cabinet and vented out the top of the cabinet.

Each fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33°C and 65°C with a differential of not more than 6°C between automatic turn on and turn off. The cabinet fan circuits shall be fused at 125 percent of the amperage of the fan motor. The fuse holders shall be easily accessible from the front of the cabinet. It shall not be necessary to reach into the cavity above the 170E controller, or other equipment, in order to access the fuse holders for the fans.

Intakes (including filters) shall be modified from CALTRANS requirements to pass a minimum of 100 cubic feet of air per minute per intake, with intakes on both the front and rear doors. The exhaust area shall accommodate the intake areas.

- D. CABINET LIGHTING AND DOOR OPEN SWITCHING REQUIREMENTS** - Fluorescent lamps shall be installed in the top of the front and rear of the cabinets. Switches shall be installed on the front and rear doors for both lamp control and door open alarms. Opening of either or both doors shall illuminate both lights. Opening of either door shall provide a single ground true input signal to the 170E controller.

Each fluorescent lamp and switch shall be equipped with noise suppression devices. Activation of the fluorescent lamps and associated switches shall not cause any disruption of the 170E controller or any other electrical or electronic device in the cabinet. The Contractor shall install sufficient RFI and surge suppression equipment to assure that operation of the fluorescent lamps shall not disrupt the operation of other equipment in the cabinet.

Fluorescent lamps and associated ballasts shall be rated for high output in cold environments, providing high light output in ambient temperature of -25° C.

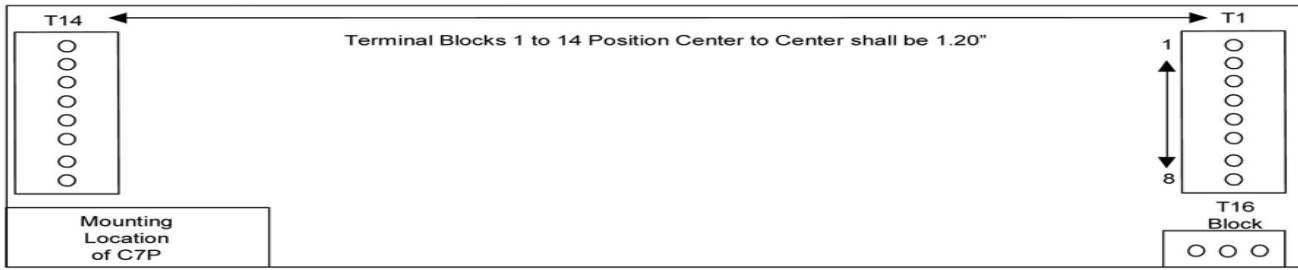
The cabinet lamp circuit shall be fused. The fuse holder shall be easily accessible from the front of the cabinet. It shall not be necessary to reach into the cavity above the 170E controller, or other equipment, in order to access the fuse holder for the cabinet lamps. The fuse holders and switches shall not interfere with the removal of the cabinet rack assembly.

**E. CABINET ASSEMBLIES**

1. **Input File** - Input file shall utilize 5.25 inches of rack height. The input file shall inter-mate with and support 14 input devices as indicated in Figure 825.01.03.

**FIGURE 825.01.03 INPUT FILE LAYOUT**

NOTE: Terminal Blocks T1 to T14 shall be mechanically supported to the chassis of the File and shall be 8 Position 8-32 Screw Barrier Type as called out in the Specifications



T1 to T14 Position Assignment			T16 Position Assignment	
Pos	Pin	Function	Pos	Function
1	SP	Spare	1	AC+ (Hot)
2	F	Ch 1 Output	2	AC- (Neutral)
3	W	Ch 2 Output	3	Equip. Grd
4	D	Ch 1 Input		
5	E	Ch 1 Input		
6	J	Ch 2 Input		
7	K	Ch 2 Input		
8	L	Eq. Grnd		

- The input file shall provide card guides (top and bottom) and a 22-pin, single-readout, edge-connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.
- Pins F and W for each slot shall terminate on the terminal blocks mounted on the rear of the input file and shall connect to the proper controller unit inputs in the connector C7P. Common grounding of output emitters shall be permitted and the Bus brought out to C7P.
- Conductors from connector C1 to the input file shall be terminated at C7S. A dummy plug shall be mounted on the cabinet wall to secure C7S when an input file is not used in the cabinet. Captive screws and sockets shall be provided for securing C7S to the dummy receptacle or C7P located on the input file. C7S pins shall be removable by use of a single pin extractor. Connector C7 shall be a 37 Pin "D" type connector, wired in accordance with Table 825.01.03 (A).

**TABLE 825.01.03 (A) CONNECTOR C7 WIRING**

SOURCE	VIA	DESTINATION
IF-1F	1	C1-56
IF-1W	2	C1-60
IF-2F	3	C1-39
IF-2W	4	C1-43
IF-3F	5	C1-58
IF-3W	6	C1-62
IF-4F	7	C1-41
IF-4W	8	C1-45
IF-5F	9	C1-55
IF-5W	10	C1-59
IF-6F	11	C1-40
IF-6W	12	C1-44
IF-7F	13	C1-57
IF-7W	14	C1-61
IF-8F	15	C1-42



SOURCE	VIA	DESTINATION
IF-8W	16	C1-46
IF-9F	17	C1-67
IF-9W	18	C1-69
IF-10F	19	C1-68
IF-10W	20	C1-70
IF-11F	21	C1-47
IF-11W	22	C1-48
IF-12F	23	C1-49
IF-12W	24	C1-50
IF-13F	25	C1-51
IF-13W	26	C1-52
IF-14F	27	C1-53
IF-14W	28	C1-54
N/C	29	N/C
N/C	30	N/C
N/C	31	N/C
N/C	32	N/C
N/C	33	N/C
IF-1-IF-14 A	34	N/C
IF-1-IF-14 B	35	DC Ground
IF-1-IF-14 C	36	C1-102 Detector Reset
IF-1-IF-14 H&W	37	C1-14 Input DC Ground

The Input File shall be equipped with a connector to supply power to terminal block T16. The connector shall be designated as connector C8P. The connector shall be a Waldom-Molex 3 conductor connector. The male end shall be connected to terminal board T16. A mating female connector shall be installed in the cabinet and shall be wired according to Table 825.01.03 (B) and shall be designated as connector C8S: Where an input file is installed in a cabinet, connector C8P shall be connected to C8S. Where no input file is installed a dummy plug shall be inserted into connector C8S to prevent inadvertent exposure to the conductors in C8S. Each cabinet shall be supplied with a dummy plug that is attached to the cabinet housing via a non-conducting tether.

**TABLE 825.01.03 (B) CONNECTOR C8 WIRING**

POSITION	FUNCTION
1	AC+
2	AC-
3	Ground

Field wire terminal blocks shall be mounted vertically on the back of the assembly. The blocks shall be 8 position barrier types with marker strips, and shall be provided 8/32 x 5/16 inch minimum nickel-plated brass binder head screws and nickel-plated brass inserts.

The edge connectors shall be double-sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

The card guide shall begin  $1.0 \pm 0.5$  inches back from the front face of the file.

The input file shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately above and below the items they are to identify.

With the exception of connectors C8-P and C8-S, input files provided under this Contract shall be electrically and mechanically interchangeable with input files installed in existing cabinets in use with the District.

- F. POWER DISTRIBUTION ASSEMBLY** - A type PDA#2 power distribution assembly shall be furnished and mounted on the EIA 19-inch rack utilizing 7 inches of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails including terminal blocks.

The power distribution assembly shall be provided with marker strips to identify flasher units in the assembly. The marker strip shall be of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately below the flasher units they are to identify.

- 1. Equipment** - The following equipment shall be provided with the power distribution assembly:

- a. 1 Duplex NEMA 5-15R Controller Receptacle
- b. 2 Duplex NEMA 5-15R Equipment Receptacle (one with GFI)
- c. One 1 Pole 50 Amperes minimum, 120 VAC Main Circuit Breaker
- d. 6 Single Pole, 15 Amperes, 120 VAC Signal Bus Circuit Breakers with Auxiliary Switch Feature and Medium Trip Delay Characteristic
- e. One 2 Pole Ganged, 20 Amp, 120 VAC Flash Bus Circuit Breaker
- f. 1 Mercury Contactor - rated minimum 60 Amperes, 120 VAC
- g. 2 Model 204 Flasher Units and Sockets
- h. 1 Model 206 Power Supply Module and Socket
- i. 1 Model 430 Heavy Duty Relay & Socket (Transfer Relay)\*
- j. 1 AUTO/FLASH Control Switch
- k. 1 Flash on Indicator Light
- l. Three 10 Position Terminal Blocks T1, T2 & T4
- m. 4 Position TBK T3

- 2. Circuit Breakers** - The 6 signal circuit breakers shall be wired and routed per the "Circuit Breaker Option One Line Diagram" of the CALTRANS TEES. The auxiliary switch in each breaker shall be open when the circuit breaker contacts are closed. The auxiliary switches on the signal circuit breakers shall be wired in parallel so that the tripping of any load switch breaker shall energize the mercury contactor coils, flash transfer relay coils, and the Flash On indicator. The auxiliary switch contacts shall be rated at 5 Amperes, 120 VAC. The auxiliary switch terminals shall be of the 'fast on' type.

All circuit breakers shall have interrupting capacities in accordance with the current edition of the NFPA National Electrical Code. Notwithstanding the minimum requirements established by the National Electrical Code, all circuit breakers shall have sufficient interrupting capacities to effectively and safely halt the flow of current during any short circuit event.

The Main Circuit Breaker shall be rated for 50 Amperes at 120 VAC. The Equipment receptacles shall be NEMA 5-15R duplex type.

- a. The Front Panel equipment receptacle shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on 6 milliamperes of ground-fault current and shall not occur on less than 4 milliamperes of ground-fault current.

- b. An "Auto/Flash" switch shall be provided which, when placed in "Flash" position (down), shall energize the Mercury Contractor (MC) Coil. When the switch is placed in the "Auto" position (up), the switch packs shall control the signal indications. The switch shall be a single-pole, single-throw toggle switch rated for 20 amperes at 120 volts AC.
- c. A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The Flasher Unit Output shall illuminate the lamp whenever the cabinet is in flash.
- d. The controller unit receptacle shall be a NEMA Duplex Type 5-15R mounted on the back of the cabinet assembly. A second NEMA Duplex Type 5- 15R receptacle shall be provided on the rear of the power assembly. The receptacle shall be labeled 'Equipment' and shall be wired to the load (protected) side ground fault receptacle on the front of the power distribution assembly.
- e. Terminal blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of the same type as specified for signal field wire terminal blocks. 2 spare positions shall be provided. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks. Terminal position assignments shall be as shown on the Plans.
- f. The Flash Relays shall conform to the provisions in Chapter 17, "Heavy Duty Relays, Model 430," of Specification FHWA-IP-78-16 and CALTRANS TEES.
- g. A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contacts remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.
- h. A stand alone fully enclosed NEMA 5-15R duplex receptacle shall be provided for red-light camera power. The receptacle shall be wired to the load side of the Auxiliary Circuit Breaker. The location of the receptacle shall consider convenient access, proximity to other 120VAC terminal blocks and safety, such as mounted to the rack or service panel. The GFI shall not affect red light camera receptacle power. Service Panel space for 2 additional fully enclosed NEMA 5-15R duplex receptacles shall be considered for future ITMS equipment. Cabinet layout drawings shall depict the position of the receptacles. The Power One-Line Diagram shall also depict the inclusion of the receptacles. The receptacles shall be wired to the load side of the Auxiliary Circuit Breaker. The location of the receptacles shall consider convenient access, proximity to other 120VAC terminal blocks and safety. The GFI shall not affect receptacle power. The Contractor shall consider whether an additional Auxiliary Circuit Breaker shall be required in the cabinet.

#### G. OUTPUT FILE WITH HARDWIRED MOTHERBOARD

1. Nylon card guides shall be provided to support the switch packs and the monitor unit.
2. **Output File** - The output file shall utilize 10.5 inches of rack height and shall be capable of containing 12 switch packs, 4 flash transfer relays, and the monitor unit. Four Model 430 flash transfer relays, 1 Enhanced Monitor Unit, 1 isolation relay, and 1 logic relay shall be furnished with each output file.

The output file shall be "hard-wired". With the exception of the red interface board for the conflict monitor, printed circuit boards shall not be used in the construction of the output file.

The output file shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately below the item they are to identify. Field terminal strips on the rear of the output file shall be permanently labeled to show Switch Pack number, Phase number, and Channel (G, Y, R) for each field terminal. In addition, a vertical white marker strip, at least 0.25 inches wide, shall be placed adjacent to each terminal strip.

3. Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the file without the use of tools.

4. Field wire terminal blocks shall be mounted vertically on the back of the assembly. The 3 terminal blocks shall be the 12-position type.
5. The controller unit outputs to the output file shall be connected through Connector C4.
6. The C6P receptacle located on the output file shall be used to inter-mate with the green and yellow output signals of the auxiliary output file. It shall be a 16 pin male circular round connector, AMP Series 1 CPC Standard Sex Square Flange Receptacle. The receptacle on the output file shall be a C6P connector shall be wired to Channel 13 through 18 of the Enhanced Conflict Monitor in accordance with the pin assignments shown in Table 825.01.03 (C).

**TABLE 825.01.03 (C) CONNECTOR C6P WIRING**

SOURCE	CONTACT	DESTINATION (Enhanced Monitor Unit Pin Assignment)
SWPK 13-Pin 7	1	2
SWPK 13-Pin 5	2	8
SWPK 14-Pin 7	3	5
SWPK 14-Pin 5	4	11
SWPK 15-Pin 7	5	C
SWPK 15-Pin 5	6	K
SWPK 16-Pin 7	7	F
SWPK 16-Pin 5	8	N
SWPK 17-Pin 7	9	14
SWPK 17-Pin 5	10	P
SWPK 18-Pin 7	11	17
SWPK 18-Pin 5	12	T
N/C	13	N/C
N/C	14	N/C
N/C	15	N/C
Keying Plug	16	See Note <sup>a</sup>

a A Keying Plug shall be installed in position 16 of the C6P connector from the auxiliary output file.

7. The C6A receptacle located on the output file shall be used to inter-mate with the red output signals of the auxiliary output file. It shall be a 16 pin male circular round connector, AMP Series 1 CPC Standard Sex Square Flange Receptacle. A pin shall be installed in the Pin 16 location of the C6A connector on the output file. There shall be no connection to this pin. The C6A connector shall be wired to Channel 13 through 18 of the Enhanced Conflict Monitor in accordance with the Pin Assignments shown in Table 825.01.03 (D).

**TABLE 825.01.03 (D) CONNECTOR C6A WIRING**

SOURCE	CONTACT	DESTINATION (DC Monitor Unit Pin Assignment)
SWPK 13 Red	1	P20 Ch 13
SWPK 14 Red	2	P20 Ch 14
Locating Pin	3	See Note <sup>a</sup>
SWPK 15 Red	4	P20 Ch 15

SOURCE	CONTACT	DESTINATION (DC Monitor Unit Pin Assignment)
SWPK 16 Red	5	P20 Ch 16
SWPK 17 Red	6	P20 Ch 17
SWPK 18 Red	7	P20 Ch 18
N/C	8	N/C
N/C	9	N/C
N/C	10	N/C
N/C	11	N/C
N/C	12	N/C
N/C	13	N/C
N/C	14	N/C
N/C	15	N/C
N/C	16	See Note <sup>b</sup>

- a A Keying Plug shall be installed in position 3 of the C6A connector from the auxiliary output file.
- b A Blank Pin shall be installed in position 16 of the C6A receptacle on the output file. There shall be no connection to this pin.

8. The red and yellow signals circuits of all switch packs shall be available at a Molex Type 1375 receptacle which shall inter-mate with a Molex Type 1375 plug to allow flash programming. Plug connectors, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment.
9. The monitor connector shall be a rigidly supported printed circuit board edge connector, having 2 rows of 28/56 independent double readout bifurcated contacts on 0.156-inch centers. The connector shall inter-mate with the Enhanced Monitor Unit. The monitor edge connector shall be “hard-wired” to the rest of the output files. Printed circuit boards shall not be used to connect the edge connector of the conflict monitor.
10. It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with the front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.
11. The monitor unit connector shall be wired in accordance with the pin assignment shown on the Plans and the tables in 825.01.03 of these Specifications. Output files supplied under this Contract shall be fully compatible with Enhanced monitors currently in use in the District.
12. The monitor unit compartment including the housed Enhanced Monitor unit shall extend no further than 1.25 inches in front of the 19-inch rack front surface. The switch pack socket connector front surface shall be no more than 8.5 inches in depth from the front surface of the output file.
13. **Red Monitor Program Card** - A red monitor program card shall be mounted on the rear of the output file assembly. It shall connect allow the user to select whether the red signal going to the monitor comes from the load switch red output or from an AC+ source. This allows unused channels to be connected to the AC+ source. It shall be possible to individually program each of the 18 load switch red channels. A removable jumper shall be provided for each channel. The jumper shall have 2 male pins. It shall mate with a 3 pin female receptacle on the red monitor program card that shall allow the user to select AC+ or Load Switch Red Output as the source for the conflict monitor red input. A removable clear acrylic access cover shall be provided to protect personnel from accidental contact with the red monitor program card.

The red monitor program card shall include a relay that disables the red enable line to the conflict monitor when pin C1-101 from the Model 170E controller is energized, indicating software flash. A jumper, similar to those specified in the preceding paragraph shall be provided to enable and disable this feature.

- H. COMMUNICATIONS ASSEMBLY** - The communications assembly shall be furnished and mounted on the EIA 19-inch rack utilizing not more than 5.25 inches (3U) of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails including terminal blocks

Within the controller cabinet, the communications cable shall be separated from the other cabinet cables and terminated on the communications assembly

The communications assembly shall be provided with marker strips to identify wire pair numbers in the assembly. The marker strips shall be of material that can be easily and legibly written on using a pencil or ballpoint pen

The following equipment shall be provided with the communications assembly:

- 1 Model R66MI-50 Termination Block with Grounding Bus attached. Grounding bus shall be terminated at the cabinet ground with No. 8 AWG THHN cable.
- 50 bridging clips
- 1 phone jack (stereo 1/4 inch)
- 12 Model COHP 200 Arrestors or approved equivalent
- 6 Model COHP 350 Arrestors or approved equivalent.
- C2 Connector Harness of minimum 48 inches length, wired neatly and secured to the inside of the cabinet walls or rack, so that enough of the harness is available to connect to the controller and the remainder is out of harm's way. Harness shall not be rolled up at back of Communications Assembly.
- The 66-type block shall have its 6 x 50 - 66-type clips arranged as 2 rows of 50 x 3. One side of the termination block (50 x 3) shall be used to terminate the incoming cable and the other side of the block (50 x 3) shall be used to terminate the outgoing cable. Fifty 2-position bridging clips shall be furnished with each assembly and shall be made of the same material as the 66-type pushdown clips. The bridging clips shall be reusable.
- The Contractor shall provide suitable terminal strips for connection of Master/Sub-Unit harnesses.

- I. FLASH TRANSFER RELAY** - Flash transfer relays shall conform to the provisions in Chapter 17 of Specification FHWA-IP-78-16, "Heavy Duty Relays, Model 430" and CALTRANS TEES.

A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contacts remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.

The coil of the flash transfer relay shall be energized only when the signals are in flashing operation and the police panel "ON/OFF" switch is "ON."

- J. POLICE PANEL** - A police panel shall be mounted behind the police panel door. The panel shall contain 2DPDT toggle switches. 1 switch shall be labeled signals "ON/OFF" and the other shall be labeled "FLASH/AUTOMATIC." The "ON/OFF" switch shall be positioned so that the "ON" position is up. Other components related to the cabinet electronic security lock may be mounted to the police panel

The switches shall have contacts rated for 20 amperes at 120 volts AC

The front and back of the panel shall be enclosed with a rigid plastic covering so that no parts having line voltage are exposed.

- K. SIDE PANEL** - 2 panels shall be provided and mounted on the EIA rack parallel to the cabinet sides.

In viewing from the back door, the left-side panel shall be designated as the "Input-Panel," and the right-side panel shall be designated as the "Service Panel."

1. Service Entry Terminal Block terminals shall be protected by a hinged plastic see-through non-conductive flip cover. A mechanism shall be provided to latch the flip cover in an upright position thereby facilitating wiring to the block.
2. A "Red Light Camera Interface Block" shall be mounted to the Service Panel and labeled as indicated herein. The block shall be a 4 position fuse block, have screw terminal wiring interfaces and hold 3AG fuses with quick-disconnect terminals. The block shall be wired to neutral and ground buses. The block shall accept 2 sets of green and amber sensing circuits required for the camera operation, but these circuits shall be wired by others.

3. The Contractor shall provide additional terminal blocks for current and future device interfaces for such equipment as advanced vehicle detection (VIDS/RTMS), UPS, over-temperature, door alarm preempt running, LCS, C11 connector harness and other controller interfaces, CCTV and communications equipment on both the Input and Service Panels based on equipment information to be provided by the Department. Cabinet layout and wiring drawings shall depict the provisions.

#### L. MISCELLANEOUS

1. A minimum of 7.25 inches of EIA rack height and 18 inches of depth (16 inches behind and 2 inches in front of the mounting ears) shall be provided for the Model 170E Controller Unit.
2. The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a common screwdriver:
  - Pull-out Drawer Assembly
  - Power Distribution Assembly
  - Input File
  - Output File
  - Auxiliary Output File
  - Communications Assembly
3. All fuses, circuit breakers, switches, (except Police Panel Switches) and indicators shall be readily visible and accessible when the front door is open.
4. The cabinet shall be delivered mounted on a 0.75-inch thick plyboard-reinforced shipping pallet. The pallet shall be bolted to the cabinet base. The cabinet shall be enclosed in a slipover cardboard packing shell. The cabinet type, purchase order number, shipping date, and serial number shall be clearly printed on the outside of the cardboard cover. A minimum 2-inch block letters shall be used.
5. All equipment in the cabinet shall be clearly and permanently labeled.
6. Transient suppression shall be provided at the relay bases (across relay coils) and in the fan circuit.

#### M. CONNECTORS

1. Connector C1P shall contain 104 pin contacts and shall inter-mate with connector C1S mounted on the controller unit chassis. Corner guide pins for connector C1P shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inches in length, equipped with a T Handle.
2. Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The plug connector C4P shall be mounted on the output file. Connector blocks for connector C1 pin and socket connectors shall be constructed of diallylphthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.
3. Connector C6P shall contain 16 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. It shall be an AMP Series 1 CPC connector and shall properly intermate with connectors in existing cabinets. The plug connector C6P shall be mounted on the output file and shall mate with connector C6P and harness located on the Auxiliary Output File. Position 3 of the C6P harness and connector from the auxiliary output file shall have a keying plug. The C6P receptacle on the output file and the C6P connector from the auxiliary output file shall be clearly and permanently labeled.
4. Connector C6A shall contain 16 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. It shall be an AMP Series 1 CPC connector and shall properly intermate with connectors in existing cabinets. The plug connector C6P shall be mounted on the output file and shall mate with connector C6A and harness located on the Auxiliary Output File. Position of the C6A receptacle on the output file shall contain a pin, but no connection shall be made to that pin. Position 16 of the C6A harness and connector from the auxiliary output file shall have a keying plug. The C6A receptacle on the output file and the C6A connector from the auxiliary output file shall be clearly and permanently labeled.

- N. CABINET WIRING DIAGRAM** - 2 sets of non-fading cabinet wiring diagrams shall be supplied with each cabinet. The diagrams shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an Elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy-duty side-opening clear vinyl pouch and permanently attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram.

Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the Contracting Officer's Technical Representative (COTR) for review prior to production. Approval by the COTR does not lessen the Contractor's responsibility to meet the Specifications.

- O. AUXILIARY OUTPUT FILE** - The auxiliary output file shall utilize 5.25 inches of rack height and shall be capable of containing 6 switch packs and 2 flash transfer relays. 2 flash transfer relays shall be provided with each auxiliary output file.

1 auxiliary output file shall be supplied with each model 336-SS cabinet. 1 auxiliary output file shall be packed separately and delivered with each model 336-SS cabinet. All necessary harnesses and connectors needed to support operation of the auxiliary output file shall be installed in each model 336-SS cabinet. Where the cabinet is shipped with the auxiliary output file packaged separately (as with 336-SS cabinets), the connectors shall be secured and all exposed terminals and conductors shall be covered with heat shrink insulation tubing.

Nylon card guides shall be provided to support the switch packs.

Switch pack and flash transfer relay sockets shall be readily accessible from the back of the file without the use of tools.

Field terminal blocks shall be mounted vertically on the back of the file.

Controller unit outputs to the auxiliary output file shall be connected through Connector C5.

Connector C5P shall be mounted on the left side of the auxiliary output file back plane located to mate with its associated cabinet harness connector C5S. Connector C5 contact assignments shall be as shown on the Plans.

The red and yellow signal circuits of all switch packs with the exception of load switches 3, 6, 9, 12, 15, & 18, shall be made available at a Molex receptacle/plug connection for flash programming. Each load switch flash programming socket shall have a label that indicates its load switch number (1 to 18). Labeling by phase number is not acceptable.

Connectors C6P and C6A and their associated harness shall be wired to the auxiliary output file back plane and shall be used to inter-mate with the C6P and C6A connectors located on the output file. The harness shall be a minimum of 2 feet in length. Connector contact assignments shall be as shown in Tables 825.01.03 (C) and 825.01.03 (D).

- P. FLASH TRANSFER RELAY** - Flash transfer relays shall conform to the requirements for heavy-duty relays.

A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contact remains closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.

The coil of the flash transfer relay shall be energized only when the signals are in flashing operation.

The flash transfer relay shall transfer switch pack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not prohibit the operation of the controller unit 3.21.5 Field terminals on the rear of the auxiliary output file shall be permanently labeled to show Switch Pack Number, Phase Number, Overlap Letter, and Channel (G/Y/R) for each field terminal. In addition, a white marker strip shall be provided to allow additional identification information to be written next to each terminal. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen.

- Q. CABINET WIRING**

**1. Conductors**

- a. Conductors in the controller cabinet between the service terminals and the signal bus breakers including the chassis ground conductor to Power Distribution Assembly shall be size No. 8 AWG or larger.
- b. All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification: MIL-W-16878/1 Type B or better. The insulation shall have a minimum thickness of



10 mils and shall be nylon-jacketed polyvinyl chloride except that conductor No. 14 and larger may be UL Type THHN, with a minimum of 7 strands. All conductors carrying 110 VAC or higher voltages shall be No. 14 AWG minimum and shall be sized according to the requirements of the current edition of the NFPA National Electrical code.

- c. All conductors shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other side of the conductor.
  - d. All conductors used in controller cabinet wiring shall conform to the following color code requirements:
    - i. The grounded conductors of AC circuits shall be identified by a continuous white color.
    - ii. The equipment grounding conductors shall be identified by a solid green color.
    - iii. The DC logic ground conductors shall be identified by a solid orange color with a colored (except green) stripe.
    - iv. The ungrounded conductors shall be identified by any color not specified above.
- 2. All cabinet wiring harnesses shall be neat, firm, and routed to minimize cross talk and electrical interference. Printed circuit motherboards may be used to eliminate or reduce cabinet wiring.
- 3. Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
- 4. Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removal assembly may be removed without disturbing conductors not associated with that assembly.
- 5. All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material. Insulating material, such as silicon sealant may not be used where it shall interfere with the removal of the component.
- 6. Within the cabinet wiring, the DC logic ground and equipment ground shall be electrically isolated from the AC-grounded conductor and each other by 50 megohms when tested at 250 volts DC, with the power line surge protector disconnected.
- 7. Conductors from connector C7 to the Input File shall be of sufficient length to allow any conductor to be connected to any detector output terminal (positions S, F, W).
- 8. The AC-copper terminal bus shall not be grounded to the cabinet or connected to Logic ground and shall provide a minimum of 10 terminals spread evenly over a 6.5 inches length for connection of field conductors. Nylon screws with a minimum diameter of 0.25-inch shall be used for securing the bus to the service panel. The bus bar shall be made of 0.125-inch copper and tapped for #10-32 machine screws. Set screw compression terminals shall not be provided.
- 9. An equipment grounding (Earth ground) bus shall be provided in each cabinet. The Bus shall be copper and grounded to the cabinet. The bus bar shall be made of 0.125-inch copper and tapped for #10-32 machine screws. Set screw compression terminals shall not be allowed.
- 10. 1 side of the load side of the cabinet power supply shall be connected to the DC logic ground bus using a size No. 14 AWG, or larger, stranded copper wire.
- 11. The DC logic ground bus shall be provided on the input panel as shown on the Plans.
- 12. A size No. 8 AWG, or larger, conductor shall be connected between equipment ground bus and rack rails.
- 13. A size No. 6 Bonding Jumper shall be provided with each cabinet assembly. The jumper shall be of sufficient length to reach from the Chassis Ground Bus to the AC bus. As shipped with the cabinet, the bonding jumper shall have both ends terminated securely on the Chassis Ground Bus.

14. All cabinet wiring, including printed circuit boards, shall be of sufficient capacity to handle the current and power requirements of the circuitry with which the wiring is associated. This includes, but is not limited to, the ability to withstand overcurrents that may occur before tripping operation of the circuit breakers, activation of surge suppressors, and other operation of overcurrent and overvoltage devices that are supplied with the cabinet. In particular, all cabinet wiring shall be able to withstand the effects of normally expected field wiring faults such as bulb failure, bulb filament short circuits, and field wiring short circuits. The Contractor acknowledges that such temporary overcurrents are to be expected in the course of field operations and warrants that cabinet wiring shall not be adversely affected by these occurrences.
15. The Contractor shall warrant that the wiring is of sufficient capacity to withstand all such occurrences as described in 825.01.03.Q.14. In addition to other warranties required elsewhere in this specification, Contractor shall provide a five (5) year warranty covering parts and on-site labor for replacement or repair of any wiring component that fails under normal field service conditions as described in the preceding section. In addition, the Contractor shall provide a five (5) year warranty covering parts and on-site labor to repair and/or replace on any other cabinet component that fails or is damaged as a consequence of the failure of any wiring component to perform in compliance with the requirements of the preceding section.
16. The intent of these requirements is to insure adequate design and construction of cabinet wiring components under normally encountered field service conditions. It is not intended to secure a warrant covering direct lightning strikes or sustained high voltage (greater than 600 volt) short circuits.

**R. TERMINAL BLOCKS** - Terminal blocks shall be provided for terminating all field conductors.

The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type with marker strips and shall be provided with 10/32 x 5/8-inch nickel-plated binder head screws and nickel-plated brass inserts.

The terminal blocks shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 600 volts rms, minimum.

The terminal blocks for the input file and power supply shall be the barrier type with marker strips and shall be provided with 6/32 x 1/2-inch nickel-plated binder head screws and nickel-plated brass inserts.

The terminals of the power line service terminal block shall be labeled "L1" and "AC-," and shall be covered with a hinged clear insulating material to prevent inadvertent contact as described in other sections. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 100 amperes at 600 volts, minimum.

The Contractor shall provide suitable terminal blocks for the terminations considered in all other sections.

Layout and wiring diagrams shall depict terminal blocks.

**S. POWER LINE SURGE PROTECTORS** - 2 types of power line surge protector shall be provided between both line conductors (AC+ and AC-) and equipment ground. The protectors shall be installed at the service terminal block.

1. 1 type of surge protector shall be the 3-Electrode Gas Tube Type and shall have the following ratings:
  - a. *Impulse breakdown* - Less than 1,000 volts in less than one-tenth (0.1) microseconds at 10 kilovolts/microseconds.
  - b. *Standby current* - Less than 1 milliamperere. Striking Voltage: Greater than 212 Volts DC.
  - c. Capable of withstanding 15 pulses of peak current each of which shall rise in eight (8) microseconds and fall in twenty (20) microseconds to 1/2 the peak voltage at three (3) minute intervals. Peak current rating shall be 20,000 Amperes.
2. The other type of surge protector shall be Metal Oxide Varistors (MOV). 1 shall be installed between AC+ and equipment ground and the other between AC- and equipment ground. The varistors shall have the following ratings:
  - a. *Recurrent peak voltage* - 212 volts; Energy rating maximum: 20 joules; Power dissipation: Average 0.85 watts
  - b. *Peak current for pulses* - 2,000 amperes for less than six (6) microseconds

- c. *Standby current* - Less than 1 milliamperere

**T. FACTORY TESTING** - The general procedures and equipment, as described below, used in the evaluation of the controller unit, cabinet and auxiliary equipment are a minimum guide and shall not limit the testing and inspection to insure compliance of the equipment with these Specifications.

These test procedures shall be followed by the Contractor who shall certify that he has conducted inspection and testing in accordance with these Specifications.

1. **Inspection** - A visual and physical inspection shall include mechanical, dimensional and assembly conformance of all parts of these Specifications that can be checked visually or manually with simple measuring devices.
2. **Environmental** - All components shall properly operate within the following limits
  - a. *Ambient temperature* - -37° to 74°C
  - b. *Humidity*: - 5 to 95 percent
3. The relative humidity and ambient temperature values in the following table shall not be exceeded.
  - a. *Shock-test* - per Military Specification: MIL-STD-810D Method 516.1
  - b. *Vibration* - per Military Specification: MIL-STD-810D Method 514.1, equipment class G (Common Carrier).
  - c. Cabinets shall comply with the requirements of UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment".

**TABLE 825.01.03 (E) AMBIENT TEMPERATURE VERSUS RELATIVE HUMIDITY  
AT BAROMETRIC PRESSURES (29.92 IN. HG.)**

AMBIENT TEMPERATURE/ DRY BULB (IN °C)	RELATIVE HUMIDITY (IN PERCENT)	AMBIENT TEMPERATURE/ WET BULB (IN °C)
-37 to 1.1	10	-17.2 to 42.7
1.1 to 46.0	95	42.7
48.8	70	42.7
54.4	50	42.7
60.0	38	42.7
65.4	28	42.7
71.2	21	42.7
74	18	42.7

4. All equipment shall continue normal operation when subjected to the following:
  - a. *Low temperature test* - With the item functioning at a line voltage of 90 VAC the ambient temperature shall be lowered from 20° C to -37° C at a rate of not more than 18° C per hour. The item shall be cycled at -37° C for a minimum of five (5) hours then returned to 20° C at the same rate. The test shall be repeated with the line voltage at 135 VAC.
  - b. *High temperature test* - With the item functioning at a line voltage of 90 VAC the ambient temperature shall be raised from 20° C to 70° C at a rate of not more than 18° C per hour. The item shall be cycled at 70° C for five (5) hours and then returned to 20° C at the same rate. The test shall be repeated with the line voltage at 135 VAC.
5. **Electrical** - All components shall operate properly within the following limits:
  - a. *Applied line voltage* - 90 to 135 VAC

**b. Frequency - 60 ( $\pm 3.0$ ) Hertz**

6. All circuits unless otherwise noted, shall commence operation at or below 90 VAC as the applied voltage is raised from 50 VAC to 90 VAC at a rate of 2 ( $\pm 0.5$ ) volts per second.
  7. All equipment, when housed within its associated cabinet, shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from cabinet shall be tested for compliance with the equipment housed within a DC accepted Model 336-SS cabinet and the cabinet connected to the commercial power lines.
  8. All power line surge protection shall enable the equipment being tested to withstand (nondestructive) and operate normally following the discharge of a 25 microfarad capacitor, charged to plus and minus 2,000 volts, applied directly across the AC line (applied at Cabinet Service Terminal Block) at a rate of once every ten (10) seconds for a maximum of 50 occurrences per test. The unit under test shall be operated at 20° ( $\pm 5^\circ$ ) C and at 120 ( $\pm 12$ ) VAC.
  9. The Model 400 Modem, M170E Auxiliary Board and Model 412C PROM Module shall be housed in a D.C. accepted Model 170E Controller Unit, all provided by others, that in turn is housed in the cabinet during the test described above.
  10. All equipment shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from the cabinet shall be tested for compliance as follows:
    - The equipment shall withstand (nondestructive) and operate normally when 1 discharge pulse of plus or minus 300 volts is synchronously added to the AC power at the Cabinet Service Terminal Block and moved uniformly over the full wave across 360 degrees or stay at any point of Line Cycle once every second. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 ns. The unit under test shall be operated at 20° ( $\pm 5^\circ$ ) C and at 120 ( $\pm 12$ ) VAC.
  11. The Model 400 Modem shall comply with the above conditions when housed in a D.C. accepted Model 170E Controller Unit and tested under the above conditions.
  12. The Model 400 shall also operate correctly when installed in the Central Communications Units being used by the District's central computer.
  13. In no case shall the modems produce a carrier detect signal or transmit received data the central computer when the incoming carrier level is less than -40 dB.
  14. Within the circuit of any device, module or PCB, electrical isolation shall be provided between DC logic ground, equipment ground and the AC grounded conductor. The DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and from each other by 500 megohms, minimum, when tested at the input terminals with 500 VDC.
  15. All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage to the cabinet at a rate of 30 openings and closings per minute for a period of two (2) minutes in duration.
  16. All equipment shall maintain normal operation during and following a period of at least five (5) hours at -37° C and less than 10 percent humidity, when 90 VAC is applied to the input terminals of the cabinet.
  17. Ventilation Testing. Temperature testing shall be conducted on prototypes with full Ventilation subsystem in operation. When maximum internal ambient temperature and humidity are reached, ambient outside temperature shall be noted. At least 1 dozen temperature probes shall be positioned at strategic points around the cabinet innards and monitored. Hot spots and moisture shall be noted. Based on the results of the testing, the Contractor shall re-position equipment as required by the COTR.
- U. TESTING CERTIFICATION** - The Contractor shall supply with each shipment a full test report of the quality control and final test conducted on each item. The test report shall indicate the name of the tester and shall be signed by a responsible manager.

The quality control procedure shall include the following:

1. Acceptance testing of all supplied components.
2. Physical and functional testing of all components.
3. A minimum one hundred (100) hour burn-in of all modules.
4. A minimum twenty-four (24) hour operation of all complete controller unit and cabinet assemblies.

**V. AUXILIARY EQUIPMENT** - The modules and equipment listed in the following paragraphs shall be compatible with the input or output of the Type 170 Controller cabinets specified in 825.01.02.B of these Specifications.

**W. MODEL 204 FLASHER UNIT** - The flasher shall be a solid-state device, producing between 50 and 60 flashes per minute with a 50-percent duty cycle. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting and shall comply with the Model 204 Specification in FHWA-IP-78-16, Chapter 9, and CALTRANS TEES except as noted herein. The output switch shall be capable of switching any current from 0.03 to 20 amperes of tungsten lamp load at 120 volts, 60 Hertz, or 20 amperes at a power factor of 0.85 at 72°.

Flasher units shall be compatible with the District's LED traffic signals.

**X. MODEL 222 TWO-CHANNEL LOOP DETECTOR UNIT** - Loop detector sensor units shall be installed to accommodate up to 8 loop detector inputs. These units will produce output signals to the controller indicating when vehicles pass over and/or remain over the loops embedded in the Roadway. The loop detectors shall be the Model 222 and conform to the provisions of Chapter 4 of Specification FHWA-IP-78-16 and CALTRANS TEES.

**Y. MODEL 242 TWO-CHANNEL D.C. ISOLATORS** - Channel isolators shall be utilized to provide independent isolation between electrical contacts external to the controller for pedestrian pushbuttons and other devices that provide a contact closure as an input. This module shall comply with the provisions of Chapter 7 of Specification FHWA-IP-78-16 and CALTRANS TEES.

**Z. MODEL 200 SWITCH PACKS** - Signal light circuits shall be controlled externally to each controller unit by 3-circuit solid-state switches, which conform to the Specifications for Model 200 Switch Packs as detailed in Chapter 8, Specification FHWA-IP-78-16 and CALTRANS TEES, except as noted herein. Each switch shall have the capability of switching any current from 0.05 to 20.0 amperes of tungsten lamp load at 120 volts 60 Hertz, or 20 amperes at a power factor of 0.85 and a temperature of 70° C.

Switch pack units must also be compatible with the District's LED traffic signals

**AA. MODEL 496 MODEM MODULE** - All modems supplied shall be Model 496 Modem Module.

The modem shall provide 2-wire half-duplex and 4-wire full duplex communications. It shall be switch selectable between half-duplex and full duplex operation. In half duplex, pins X and Y shall be used for Audio In/Out.

The modem shall comply with the following requirements:

1. *Data rate* - 0 to 9600 baud modulation
2. *Modulation* - Phase coherent frequency shift keying (FSK)
3. *Data format* - Asynchronous, serial by bit
4. *Line and Signal Requirements* - Private Metallic Wire, Distance 10 miles minimum
5. *ACIA and Modem Interface* - EIA-232-C standards
6. *Tone Carrier Frequencies (Transmit & Receive)* - 11.2 kHz (MARK) and 17.6 kHz (SPACE) with  $\pm 1$  percent tolerance. The operating band shall be (half power, -3dB) between 9.9 kHz and 18.9 kHz.
7. *Transmitting Output Signal Level* - 0, -2, -4, -6, and -8 dB (at 14.7 kHz) continuous or switch selectable.
8. *Receiver Input Sensitivity* - 0 to -40 dB
9. *Receiver Band-pass Filter* - Shall meet the error rate requirement specified and shall provide 20 dB/Octave, minimum active attenuation for all frequencies outside the operating band.
10. *Clear-to-Send (CTS) Delay* - 12 ( $\pm 2$ ) ms
11. *Receive Line Signal Detect Time* - 8 ( $\pm 2$ ) ms mark frequency
12. *Minimum Carrier Detect Sensitivity* - The modem shall not indicate carrier detect and shall not transmit received data to the controller when received signals are less than -42 ( $\pm 2$ ) dB at modem carrier frequencies (11.2 kHz and 17.6 kHz).
13. *Receive Line Squelch* - 6.5 ( $\pm 1$ ) ms, 0 ms (OUT)
14. *Soft Carrier (7.8 kHz) Turn Off Time* - 10 ( $\pm 2$ ) ms

- 15. *Modem Recovery Time* - Capable of receiving data within 22 ms after completion of transmission.
- 16. *Error Rate* - Shall not exceed 1 bit in 100,000 bits, with a signal-to-noise ratio of 16 dB measured with a flat weight over a 300 to 3000 Hz band.
- 17. *Transmit Noise* - Less than -50 dB across 600 ohm resistive load within the frequency spectrum of 300 to 3000 Hz at the maximum output.
- 18. The modem power requirements are as follows:

Input Voltage	Maximum Current Consumption
+12 VDC	75 milliamperes
-12 VDC	75 milliamperes

Indicators shall be provided on the front of the modem to indicate Carrier Detect, Transmit Data, and Receive Data

The Model 496 modem card shall be supplied with blue card ejectors.

**BB. RADIO INTERFERENCE SUPPRESSOR** - All controller equipment shall be furnished with a radio interference suppressor. The radio interference suppressors shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilohertz to 75 megahertz when used in connection with normal installations. The interference suppressors shall be hermetically sealed in a metal case filled with an insulating compound. Terminals shall be nickel plated, 10- 24 brass studs of sufficient external length to provide space for connecting 2 No. 8 conductors, and shall be so mounted that the terminals cannot be turned in the case, and the termination shall be protected by a removable and replaceable non-conducting transparent cover. Silicon sealant or other similar methods may not be used to provide an insulating cover. Ungrounded terminals shall be properly insulated from each other and shall maintain a surface leakage distance of not less than 1/4- inch between any exposed current conductor and any other metallic part, with an insulation factor of 100-200 megohms dependent on external circuit conditions. Suppressors shall be designed for 125 percent of the total connected load, and in no event less than 25 amperes on 120 volts, 60 Hz, circuits, and shall meet standards of the UL and the EIA.

**CC. CONFLICT MONITOR REQUIREMENTS**

- 1. Monitor shall be provided with a windows based interface program.
- 2. The monitor software shall affix: 'District of Columbia Department of Transportation' in any screen and printout headings.
- 3. The District shall be licensed for unlimited use of the monitor interface software and firmware.  
 The District's licensed use shall be extended to any and all contractors and or consultants authorized and or actively engaged in traffic signal work, and or supplying traffic equipment for the District for as long as they are engaged in such activity with the District. (This licensed use shall only be valid for the DC traffic system).  
 The District shall be entitled to all revisions of this software that is related to initially delivered functionality.
- 4. The District shall be provided with 1 laptop interface cable for every cabinet supplied.
- 5. The District shall be provided with 10 CD copies of the interface software installation files with first shipment of Monitors. The District shall be provided with 100 hard copies of the monitor interface software manual. All installation disks shall include the interface software manual in printable PDF form.
- 6. Monitor shall be programmable via interface program and traditional diode/jumper cards.
- 7. The monitor shall require a flash sense from the cabinet before any programming can be accepted. All parameters not programmable via diode cards shall be enterable via front panel Intersection ID number shall be stored in the monitor.
- 8. Intersection ID change in the monitor shall require re-initialization of all monitor programming to be compatible with all diode's present condition. Programming of monitor shall not be permitted unless ID number is set. All Monitors' programming shall be stored in database form according to currently used controller identification number and name (acisa, or current method).

9. All programming and log history shall be importable and exportable both addressable by individual intersection, and entire database; to CD, or over network for transport between workstations, laptops.
10. Following the import of programming data, the interface program will compare the newly imported values against the laptop's stored values. Before exiting the comparison screen or upon trying to save the newly imported data, the interface software shall ask the operator for permission to overwrite existing programming information if imported information is different from that stored in workstation.
11. All status log history information shall be appended to intersection database, and shall be limited to last 25 events. Retrieved log history information will automatically overwrite the existing log history information.
12. Monitor interface software shall be capable of printing out a 1 for 1 graphical representation of both program cards. This graphical representation shall resemble the exact card layout and shall be scaled to fit on no more than 1 page. All printouts shall include ID number and intersection name. All printable information for individual intersections shall be scaled to 1 page.
13. Monitor interface software shall upload on demand and view; stored diode cuts and locally programmable parameters. Up load screen shall present a save in database option. Choosing of the save in database option shall ask for permission to overwrite current database information upload on demand, current stored activity log stored in monitor. Saving of log history information is limited to the last 25 events.
14. An initial programming screen for an intersection just added to the local laptop shall present a diode card with all diodes present.
15. Laptop Interface software Monitor status screen shall include:
  - a. Intersection name and ID
  - b. Current time and date set in monitor and time and date at time of failure
  - c. Current temperature and temperature at time of failure
  - d. Failure/flash type (conflict, watchdog, etc.), if monitor indicates failure Status of all used channels at time of failure Status of all channels as presently operating
  - e. Current Line voltage and line voltage at time of failure
16. Time and date setting screen shall automatically be presented to operator when laptop communications is established with monitor. A default parameter may be set up to bypass the screen and automatically set the monitor's time and date.
17. All monitors shall be delivered with 2 of each program/jumper cards required to program monitor. The District shall be supplied with 20 spare diode/jumper kits. This kit shall be housed in a compartmented durable plastic box. Each kit shall include 100 replacement Diodes. Each kit shall include 50 pre bent jumpers to fit yellow inhibit and enhancement card.
18. A solid state monitoring device, herein referred to as Enhanced Monitor, shall be installed so that in the event of conflicting signal indications (vehicular or pedestrian, or both), the monitoring device shall cause the signal system to go into flashing operation. The flashing operations shall lock-in and shall release only upon operation of a reset switch. Operation of the monitor shall energize the stop-timing circuit of the controller unit. This device shall comply with the provisions of Chapter 3, Specification FHWA-IP-78-16, except as noted herein. The use of the term "Model 225" is not intended to specify a specific make and model of monitor; rather it is intended to refer to a monitor that meets the requirements contained within these Specifications.

The Enhanced monitor unit shall be capable of monitoring a minimum of 18 field signal output circuits at the field terminals.
19. The monitor shall store and display the conflicting indications existing at the moment of conflict. These indications, 18 indicators, shall be mounted on the front panel. The monitor shall retain this display until reset by a front panel push-button, or upon the loss of power.
20. The monitor module shall be equipped with a programming card. The programming card shall be a printed circuit board 1/16 inch thick and shall plug into the module through a slot in the front panel. A programming card shall be supplied with a full complement of #1N4148 diodes, or equivalent. Each programming card shall contain 153 diodes. The programming card shall be logically labeled and laid out for easy identification of the diodes by switch pack.

21. The wiring of the connector for the conflict monitor programming card shall be in accordance with Table 825.01.03 (F)

**TABLE 825.01.03 (F) CMU PROGRAMMING CARD CONNECTOR WIRING**

<b>PIN</b>	<b>FUNCTION (Circuit Side)</b>	<b>PIN</b>	<b>FUNCTION (Component Side)</b>
1	Channel #2 Green	A	Channel #1 Green
2	Channel #3 Green	B	Channel #2 Green
3	Channel #4 Green	C	Channel #3 Green
4	Channel #5 Green	D	Channel #4 Green
5	Channel #6 Green	E	Channel #5 Green
6	Channel #7 Green	F	Channel #6 Green
7	Channel #8 Green	H	Channel #7 Green
8	Channel #9 Green	J	Channel #8 Green
9	Channel #10 Green	K	Channel #9 Green
10	Channel #11 Green	L	Channel #10 Green
11	Channel #12 Green	M	Channel #11 Green
12	Channel #13 Green	N	Channel #12 Green
13	Channel #14 Green	P	Channel #13 Green
14	Channel #15 Green	R	Channel #14 Green
15	Channel #16 Green	S	Channel #15 Green
16	DC Ground	T	Conflict
17	Channel #17 Green	U	Channel #16 Green
18	Channel #18 Green	V	Channel #17 Green
19	Channel #1 Yellow	W	Channel #9 Yellow
20	Channel #2 Yellow	X	Channel #10 Yellow
21	Channel #3 Yellow	Y	Channel #11 Yellow
22	Channel #4 Yellow	Z	Channel #12 Yellow
23	Channel #5 Yellow	AA	Channel #13 Yellow
24	Channel #6 Yellow	BB	Channel #14 Yellow
---	Locating Key	---	Locating Key
25	Channel #7 Yellow	CC	Channel #15 Yellow
26	Channel #8 Yellow	DD	Channel #16 Yellow
27	No Connection	EE	Channel #17 Yellow
28	Yellow Inhibit Common	FF	Channel #18 Yellow

22. The connector that mates with the programming card shall be keyed between pins 25 and 25 (BB and CC) with an integral, permanent locating key. The locating key shall be part of the connector molding. Separate programming keys that are attached by adhesive or by pressure fit are not acceptable. 1 spare programming card shall be supplied with each monitor. If a monitor uses more than 1 type of programming card, 1 spare of each type shall be supplied.
23. The wiring of the Monitor Unit Connector in the Output File shall be in accordance with Tables 825.01.03 (F) and 825.01.03(G).



**TABLE 825.01.03 (G) MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #1**

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
1	Channel 2 Green	120 VAC	135 VAC	25 VAC	15 MA
2	Channel 13 Green	120 VAC	135 VAC	25 VAC	15 MA
3	Channel 6 Yellow	120 VAC	135 VAC	25 VAC	15 MA
4	Channel 4 Green	120 VAC	135 VAC	25 VAC	15 MA
5	Channel 14 Green	120 VAC	135 VAC	25 VAC	15 MA
6	Channel 8 Yellow	120 VAC	135 VAC	25 VAC	15 MA
7	Channel 5 Green	120 VAC	135 VAC	25 VAC	15 MA
8	Channel 13 Yellow	120 VAC	135 VAC	25 VAC	15 MA
9	Channel 1 Yellow	120 VAC	135 VAC	25 VAC	15 MA
10	Channel 7 Green	120 VAC	135 VAC	25 VAC	15 MA
11	Channel 14 Yellow	120 VAC	135 VAC	25 VAC	15 MA
12	Channel 3 Yellow	120 VAC	135 VAC	25 VAC	15 MA
13	Channel 9 Green	120 VAC	135 VAC	25 VAC	15 MA
14	Channel 17 Green	120 VAC	135 VAC	25 VAC	15 MA
15	Channel 11 Yellow	120 VAC	135 VAC	25 VAC	15 MA
16	Channel 9 Yellow	120 VAC	135 VAC	25 VAC	15 MA
17	Channel 18 Green	120 VAC	135 VAC	25 VAC	15 MA
---	Locating Slot				
18	Channel 12 Yellow	120 VAC	135 VAC	25 VAC	15 MA
19	Channel 17 Red				
20	Chassis Ground				
21	AC – (Neutral)				
22	Watchdog Input	DC Ground			
23	+24 VDC	+24 VDC	+26 VDC	+22 VDC	500 MA
24	Tied to Pin 25				
25	Tied to Pin 24				
26	Not Assigned				
27	Not Assigned				
28	Output SW, Side 1				

**TABLE 825.01.03 (H) MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #2**

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
A	Channel 2 Yellow	120 VAC	135 VAC	25 VAC	15 MA
B	Channel 6 Green	120 VAC	135 VAC	25 VAC	15 MA
C	Channel 15 Green	120 VAC	135 VAC	25 VAC	15 MA
D	Channel 4 Yellow	120 VAC	135 VAC	25 VAC	15 MA
E	Channel 8 Green	120 VAC	135 VAC	25 VAC	15 MA
F	Channel 16 Green	120 VAC	135 VAC	25 VAC	15 MA
H	Channel 5 Yellow	120 VAC	135 VAC	25 VAC	15 MA
J	Channel 1 Green	120 VAC	135 VAC	25 VAC	15 MA
K	Channel 15 Yellow	120 VAC	135 VAC	25 VAC	15 MA
L	Channel 7 Yellow	120 VAC	135 VAC	25 VAC	15 MA
M	Channel 3 Green	120 VAC	135 VAC	25 VAC	15 MA
N	Channel 16 Yellow	120 VAC	135 VAC	25 VAC	15 MA
P	Channel 17 Yellow	120 VAC	135 VAC	25 VAC	15 MA
R	Channel 10 Green	120 VAC	135 VAC	25 VAC	15 MA
S	Channel 11 Green	120 VAC	135 VAC	25 VAC	15 MA
T	Channel 18 Yellow	120 VAC	135 VAC	25 VAC	15 MA
U	Channel 10 Yellow	120 VAC	135 VAC	25 VAC	15 MA
---	Locating Slot				
V	Channel 12 Green	120 VAC	135 VAC	25 VAC	15 MA
W	Channel 18 Red				
X	Not Assigned				
Y	DC Ground		DC Ground		
Z	External Reset	DC Ground			
AA	+24 VDC	+24 VDC	+26 VDC	+22 VDC	500 MA
BB	Stop Time				
CC	Special Function 2	120 VAC / 24 VDC	(Note 1)	(Note 1)	15 MA
DD	Special Function 3	120 VAC / 24 VDC	(Note 1)	(Note 1)	15 MA
EE	Output SW, Side 2				
FF	AC+	120 VAC	135 VAC	95 VAC	

**TABLE 825.01.03 (I) MONITOR UNIT PIN ASSIGNMENTS – SIDE #1**

PIN	FUNCTION	TERMINATION
1	SWPK 2 Green	SP2-7
2	SWPK 13 Green	C6-Pin A
3	SWPK 6 Yellow	SP6-5
4	SWPK 4 Green	SP4-7

<b>PIN</b>	<b>FUNCTION</b>	<b>TERMINATION</b>
5	SWPK 14 Green	C6-Pin C
6	SWPL 8 Yellow	SP8-5
7	SWPK 5 Green	SP5-7
8	SWPK13 Yellow	C6-Pin B
9	SWPK1 Yellow	SP1-5
10	SWPK 7 Green	SP7-7
11	SWPK 14 Yellow	C6- Pin D
12	SWPK 3 Yellow	SP3-5
13	SWPK 9 Green	SP9-7
14	SWPK 17 Green	C6-Pin J
15	SWPK 11 Yellow	SP9-5
16	SWPK 9 Yellow	SP9-5
17	SWPK 18 Green	C6-Pin L
18	SWPK 12 Yellow	SP12-5
19	SWPK 17 Red	
20	Chassis Ground	TB01-9
21	AC – (Neutral)	TB01-10
22	Watchdog Timer	C4-37
23	+24 VDC	TB02-1
24	CMU Interlock	Logic Relay Coil
25	CMU Interlock	Logic Ground
26	Not Assigned	N/c
27	Not Assigned	N/C
28	Output SW, Side #1	AC+ - TB01-11

**TABLE 825.01.03 (J) MONITOR UNIT PIN ASSIGNMENTS – SIDE #2**

<b>PIN</b>	<b>FUNCTION</b>	<b>TERMINATION</b>
A	SWPK 2 Yellow	SP2-5
B	SWPK 6 Green	SP6-7
C	SWPK 15 Green	C6-Pin E
D	SWPK 4 Yellow	SP4-5
E	SWPK 8 Green	SP8-7
F	SWPK 16 Green	C6-Pin G
H	SWPK 5 Yellow	SP5-5
J	SWPK 1 Green	SP1-7
K	SWPK 15 Yellow	C6-Pin F
L	SWPK 7 Yellow	SP7-5

<b>PIN</b>	<b>FUNCTION</b>	<b>TERMINATION</b>
M	SWPK 3 Green	SP3-7
N	SWPK 16 Yellow	C6-Pin H
P	SWPK 17 Yellow	C6-Pin K
R	SWPK 10 Green	SP10-7
S	SWPK 11 Green	SP11-7
T	SWPK 18 Yellow	C6-Pin m
U	SWPK10 Yellow	SP10-5
V	SWPK 12 Green	SP12-7
W	SWPK 18 Red	N/C
X	Not Assigned	N/C
Y	DC Ground	TB02-2
Z	External Reset	TB02-5
AA	+24 VDC	TB02-1
BB	Stop Time	TB02-3
CC	Not Assigned	N/C
DD	Not Assigned	N/C
EE	Output SW, side #2	TB01-12
FF	Ac+ (Hot)	TB01-11

24. Conflict monitors being supplied under this Contract shall operate properly when installed in existing cabinets that are wired to support existing 218 or 225 conflict monitors.

25. All switch pack signals being monitored shall be in conflict with all other switch pack signals being monitored, unless a diode (anode to numerical pins and cathode to alphabetical pins) has been removed. Removal of a diode shall define a non-conflict.

In addition, the yellow signals from all switch packs shall be monitored unless a jumper is placed between the appropriate yellow switch pack pin and a yellow inhibit pin common on the programming card.

The green, yellow and red indications for each switch pack phase shall be brought into the monitor individually. The red inputs for channels 1 to 16 and the red enable signal shall be brought into the monitor via a front panel connector. The connector shall be wired in accordance with Table 825.01.03 (K).

Each switch pack shall be monitored for a 'No Output' condition, where 'No Output' is defined as a condition where all 3 outputs of a given switch pack fail to meet minimum voltage threshold criteria as defined in the CALTRANS TEES. When a no output condition is detected for a switch pack for the duration of time that is specified in section 825.01.03.CC.2 the monitor shall trip and place the cabinet into a latching flash condition. There shall be an indicator that indicates "No Output" or "Red Fail". The monitor shall also indicate, via individual indicators for each of the 18 switch packs, which switch pack caused the No Output event. The monitor shall provide, via some permanently attached hardware such as a switch, the disabling of monitoring for No Output failures by individual channel (switch pack).

**TABLE 825.01.03 (K) CONNECTOR P20 WIRING**

PIN NUMBER	ASSIGNMENT
1	Channel 15 Red
2	Channel 16 Red
3	Channel 14 Red
4	Chassis Ground
5	Channel 13 Red
6	Special Function 1
7	Channel 12 Red
8	RR Preempt
9	Channel 10 Red
10	Channel 11 Red
11	Channel 9 Red
12	Channel 8 Red
13	Channel 7 Red
14	Channel 6 Red
15	Channel 5 Red
16	Channel 4 Red
17	Channel 3 Red
18	Channel 2 Red
19	Channel 1 Red
20	Red Enable

26. The green, yellow, and red indications shall be monitored for multiple output conditions. A multiple output condition shall be defined where the output voltages of more than 1 channel of a given load switch exceeds minimum voltage threshold levels as defined in the CALTRANS TEES for a duration of time as specified in 825.01.03.CC.27. The fault timers shall start immediately upon detection of any 2 or more simultaneous outputs and shall continue timing until only 1 or no output is detected for that switch pack. When a fault condition is detected, the monitor shall illuminate an indicator labeled “Multiple Output”. The monitor shall also indicate, via individual indicators for each of the 18 switch packs, which switch pack caused the Multiple Output fault. The monitor shall provide, via some permanently attached hardware such as a switch, the disabling of monitoring for Multiple Output failures on an individual channel (switch pack).
  
27. The monitor shall monitor output signals applied at the field terminals of each switch pack (green, yellow, red). For the conditions described in 825.01.03.CC.25 and 825.01.03.CC.26, should a fault condition (no output, multiple output) be detected, the unit shall begin timing the duration of this fault condition. If this condition exists for less than seven hundre (700) milliseconds, the unit will not trigger. If the condition last for more than one thousand (1000) milliseconds it will trigger and place the cabinet in a latching flash condition. The unit may or may not trigger if the condition exists for more than seven hundred (700) milliseconds or less than one thousand (1000) milliseconds. For each fault condition, an individual timer shall be maintained for each switch pack. Should more than 1 switch pack experience a fault at one time, or should 1 switch pack experience more than 1 fault condition at one time, each fault timer shall operate independently without being affected by the operation of any other fault detection and timing features. Once a No output or Multiple Output fault has been determined according to the timing requirements in this section, he monitor shall trip and place the cabinet into a latching flash condition.
  
28. The monitor shall detect short or missing yellow cycle.

- 29. When the unit triggers for a fault condition, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control, or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output as indicated above.
- 30. At a minimum, the conflict monitor shall have the following indicators:
  - a. *AC Power* – This indicator shall illuminate when the AC input voltage to the monitor exceeds 103 (± 2) VAC. It shall be extinguished, when the AC input voltage falls below 98 (± 2) VAC.
  - b. *DC Power* – This indicator shall illuminate when the 24VDC input to the monitor exceeds the minimum threshold voltage.
  - c. *Watchdog Error* – This indicator shall illuminate when a watchdog error is detected. *Conflict* – This indicator shall illuminate when the monitor has detected a conflict.
  - d. *PC Ajar* – This indicator shall illuminate when the program board is not installed or not seated properly.
  - e. *No Output or Red Fail* – This indicator shall illuminate when a no output fault has been detected. *Multiple Output or Switch Fail* – This indicator shall illuminate when the monitor has detected a multiple output fault.
  - f. *Yellow Fail* – Shall illuminate when a short or missing yellow cycle is detected.
- 31. The monitor shall include signal output status indicators. There shall be 1 indicator for each channel of each of the 18 switch packs. The indicator for each switch pack shall illuminate when a red, yellow or green output voltage is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status display shall latch and display the output status of each channel at the time the conflict occurred. Should the monitor trip due to a No Output or Multiple Output condition, the signal status indicators shall display the channel(s) that caused the fault and shall latch status display until the monitor is reset.
- 32. After a power outage before which there was a fault, the monitor shall correctly show the previous fault. This will include fault type and channel that was in error.
- 33. The monitor shall provide a means to send fault and channel status to the controller via a serial port.
- 34. The monitor shall have a DB-9 sub-miniature connector that provides an RS-232 interface to the 170E controller. The vendor shall provide an interface cable between the DB-9 connector and the controller’s C20S socket. The interface cable shall be wired in accordance with Table 825.01.03 (L).

**TABLE 825.01.03 (L) CMU WIRING HARNESS**

C 20 PIN	FUNCTION	DB-9 MALE PIN (DCE)	COMMENTS
K	TD	3	
L	RD	2	
N	GND	5	
J	RTS	N/C	Jumper to Pin M
M	CTS	N/C	Jumper from Pin J
D	+5 VDC	N/C	Jumper to Pin H
H	CD	N/C	Jumper from Pin D

- 35. The monitor shall communicate using the following protocol: at 2400bps, Even Parity, 8 Data Bits, 1 Stop Bit. In response to a status request from the controller, the conflict monitor shall transmit the current conflict monitor status. Status communications shall be in accordance with the message format described in Table 825.01.03 (L). The conflict shall not initiate any transmission of data except in response to reception of a valid status request. All responses shall conform to the specified message formats. The communications subroutines shall be interrupt-driven. The monitor shall respond within fifteen (15) milliseconds of

respond of receiving a valid request from the controller. Once the monitor starts transmission of a message to the controller, maximum inter-byte time shall not exceed fifteen (15) milliseconds. Communications with the controller shall operate independently of the conflict monitor – that is communications with the 170E controller shall not be adversely affected by other conflict monitor functions; nor shall communications with 170E controller adversely impact the other operations of the conflict monitor.

36. In response to a status request command, the conflict monitor shall transmit the status information as described in the specified message formats.
37. The conflict monitor shall provide the following status in response to a status request from the 170E controller:
  - a. All fault status (conflict, AC low, 24V, Watchdog, PC Ajar, Red Fail, Switch Fail, Yellow Fail)
  - b. Enable status (Watchdog, Red Enable)
  - c. Channel status (Green, Yellow, Red) Channels 1 to 18
38. The conflict monitor shall contain a real-time clock that maintains the current Year, Month, Day of Month, Day of Week, Hour, Minute, and Second. The real time clock shall maintain the current time information during power outages. It shall continue to maintain accurate time during power outages of at least thirty (30) days in duration. The real time clock shall provide automatic daylight savings time correction.
39. The monitor shall update its real time clock in response to a properly formatted transmission from the 170E controller.
40. The Contractor shall provide 225 Enhanced conflict monitor currently in utilized by the District. The conflict monitor shall conform to all features and protocols currently in use in the District.

## 825.02 ELECTRONIC SECURITY LOCK

- A. **GENERAL** - Cabinet electronic security lock shall be compatible with and shall be a direct replacement in operation and mechanical construction to District Department of Transportation current cabinet electronic security lock.
- B. **FIGURES (SHOWN BELOW)**
  1. **Figure 1** - Electronic Security Lock Subsystem Components
  2. **Figure 2** - Police Panel Electronic Security Lock Subsystem
- C. **DEFINITIONS**
  1. **Access Code** - Any system or method which automatically controls the passage of people and vehicles into or out of an area or Structure
  2. **Annunciated** - An audible and/or visible signaling device
  3. **Access Time** - The period of time during which an access point is unlocked (See Shunt Time)
  4. **Audit Trail** - A listing created which may be created in real time, which may be used to monitor the progress of a person through protected areas.
  5. **Buffer Capacity** - The amount of information a system can store, and may include the users, time of day and specific door.
  6. **Database** - A collection of data used and produced by a computer program. The files created at the host of the access control system forms its database.
  7. **Device Address** - Value set on an access control device to determine its unique identity.
  8. **Electromagnetic** - Pertaining to the combined electric & magnetic fields associated with movements of electrons through conductors.
  9. **Enclosure** - A box or cabinet, usually constructed of metal, that houses system components, such as circuit boards, and other electronic and electrochemical controls and circuitry.

10. **Erasable Programmable Read-Only Memory (EPROM)** - A programmed memory (often a chip) that can not only be read, but can be repeatedly erased under high-intensity ultraviolet light and reprogrammed.
  11. **Fail-Secure** - An electronic lock that requires power to unlock. (Also: fail-locked)
  12. **History** - A log of system activity that can be recalled by utilizing the report command. Most systems offer a feature that notifies the console operator of the amount of available storage for history information preventing information from being written over. The message will usually alert the operator to archive the information onto a removable magnetic board.
  13. **Keypad** - A flat device which has buttons that may be pressed in a sequence to send data to a controller, and which differs (said to be "non-QUERTY") from a typewriter-like computer board.
  14. **Key Lock blocker** - An electromechanical device which is part of the cabinet door locks that cannot physically engage until the key lock is properly engaged.
  15. **Lock Control Unit (LCU)** [Note: the PLC is the main part of LCU] - Micro-computer with inputs and outputs that can be programmed to control and monitor access to the key lock blocker, stores events and communicates with a central data server. Programmable Logic Controller (PLC) is the micro-computer that makes of the LCU. The LCU also includes the thermal fan and power supply for the PLC.
  16. **Momentary Switch** - A switch that, after being activated, automatically returns to its original position; a spring-loaded contact that, when pressed, closes 2 contacts, and when pressure is removed, opens the contact.
  17. **Operator** - A person at a central location that controls the electronic security lock sub-system.
  18. **Reader** - Refers to the "front end" that a user must interact with to allow access. Readers can be keypads, card readers, and proximity readers.
  19. **Time Schedules** - Allows for access based on time of day, date and user. Also allows for holidays, etc.
  20. **Transaction** - A record created that contains pertinent information about an occurrence in the access control and monitoring system.
  21. **User** - An authorized person trying to gain access to field cabinets through the electronic lock sub-system.
- D. CONCEPT OF OPERATION** - All controller cabinets shall be provided with an electronic security lock sub- system local components. The primary purpose of the electronic security lock sub-system is to provide local components that monitor the status of the authorized and unauthorized entry and closure of the controller cabinet. The sub-system shall read from a central location and be able to store local and transmitted central data. Central reading/writing to the LCU shall be accomplished using a central security server/workstation and the DC ITMS Communications sub-system. The central Security Management Software shall be able to support up to 2,500 Electronic Security Sub-systems (LCUs).
- All LCUs shall perform as required from any Traffic Management Center (TMC) or Traffic Operations Center (TOC) that is in primary control of the communications to the LCU. This requirement serves the need for the Integrated Traffic Management System (ITMS) to be able to control the LCU from the appropriate TOC controlling the ITMS system. The ITMS communications system shall provide the channel to address the LCU for this control.
- E. DESCRIPTION OF LOCAL COMPONENTS** - The electronic security lock sub-system shall consist of the following main components:
1. **Lock Control Unit (LCU)** - including Programmable Logic Controller (PLC)
 

This unit shall be mounted in the cabinet and shall perform the following functions:

    - a. Accept user input codes from the local cabinet Security Keypad
    - b. Determine the validity of an entered code and open the door lock
    - c. Electromechanically interface to the mechanical cabinet locks to control entry
    - d. Record and transmit data from various events such as authorized cabinet entry, unauthorized entry or attempted code picking.



- e. Capable of interfacing to the traffic cabinet communications interface through a dedicated serial communications port/channel independent of the signal controller. The serial data port can be configured to accommodate various data or event occurrences from the security sub-system as required by the user.
  - f. LCU includes the PCL, a thermal fan and a power supply.
2. **Keypad (Local User Interface)** - This unit shall be mounted behind a secure police panel door and shall perform the following functions:
- a. Input code entry for cabinet access
  - b. Interface with the Lock Control Unit (LCU)
3. **Backup External Power Supply Terminal (PTS) 12VDC** - This unit shall be mounted behind a secure police panel door and shall perform the following function:
- a. Allow operator to power the electronic security lock sub-system from the police panel using a back- up power supply cable (automobile cigarette lighter adapter) operating with 12VDC voltage supply.
4. **Cabinet Door Locks With Electromechanical Release Control** - This electromechanical release control shall be mounted in its normal cabinet door position and shall perform the following functions:
- a. Cabinet door locks shall include an electromechanical key lock blocker that allows the manual door key to unlock the cabinet door lock after the releasing of the blocking mechanism following receipt of a validated access code at the LCU.
  - b. The electronic security lock sub-system shall check 1) door closure and 2) the position of the sub- system key lock blocker. This information should be adequate to determine proper closure and locking of the cabinet. Note that the subsystem lock blocker cannot physically engage until after the key lock is properly engaged. This means the door is already locked before the blocker can engage. The electronic sub-system shall not record the cabinet closure until both doors have been closed and locked.
5. **Annunciator (Beeper)**. This unit shall be mounted behind the police panel and shall perform the following functions:
- a. When the electronic security lock sub-system releases the blocking mechanism, a distinct audible sound shall be produced that is capable of being heard by the user in the controller cabinet field environment (over the sound of passing vehicles, etc).
  - b. When electronic security lock sub-system is put into the block position (locked) after both cabinet doors are in the closed position, a distinct audible sound different from the release sound shall be produced capable of being heard by the user from a range of 24 inches or less in the controller cabinet field environment (over the sound of passing vehicles, etc.).

## F. FUNCTIONAL REQUIREMENTS

### 1. Lock Dependence And Control Requirements

- a. The electronic security lock sub-system shall be integrated with the physical lock mechanism (called a key lock blocker) to prevent the key lock from properly engaging unless authorized by the electronic sub-system.
- b. The electronic security lock sub-system shall remain in the locked condition (fail-secure) until validation of an authorized access code supports release of the key lock blocker mechanism.
- c. If both the physical door(s) are closed and the key locks for the doors are in the proper locked condition, the electronic security lock sub-system shall engage. The LCU shall not record the cabinet closure until both cabinet doors have been closed and locked.
- d. This sub-system shall provide electronic lock self-diagnostics.
- e. Should the electromechanical key lock blocker fail, it shall not prevent the mechanical lock from being positioned in the proper lock condition.

- f. The electromechanical key lock blocker shall be able to be opened/closed from a central location by an operator via a computer workstation; for any individual LCU, a select group of LCUs or all LCUs.
- g. 1 LCU shall release both key lock blocker mechanisms at the same time so they can be physically opened.
- h. The electronic security lock sub-system shall remain in a locked condition when power is removed from the sub-system, unless externally powered and validation of an authorized access code or released from central location.

**2. Central Security Management Software Requirements** - The software shall have the following functions:

- a. Software shall reside on a security management server located at a central location and be able to communicate (read/write) with all cabinet security lock sub-systems individually and globally.
- b. Central shall read/write all LCUs, up to 2500 cabinet LCUs and these shall transmit back to central.
- c. Central Software shall provide multi-level addressing capability to uniquely communicate with each LCU, based upon the LCUs addressing capability and the serial communications channel provided. Multi-level addressing shall be able to support an addressing scheme that communicates to each LCU using the DC ITMS serial communications channel provided. Each LCU will be provided a Permanent Virtual Circuit (PVC) over the ATM fiber network. Communication shall include reading/writing to memory locations within the LCU for the storage and retrieval of LCU data. For example, an address scheme could combine an LCU Station Address with an IP Port address and a Local LCU Group ID (group of security locks) to identify the delivery address for data to an LCU.
- d. Central shall be able to write data to each LCU to synchronize lock time and store authorized access codes, both individually and on a broadcast basis.
- e. Display alarms shall be able to be prioritized by cabinet and alarm type by central.
- f. Software shall run on in a Microsoft Windows operating system environment or platform compatible with the DC ITMS software environment.
- g. Central shall be able to open/close the Key Lock Blocker for any individual LCU, a select group of LCUs or all LCUs.
- h. Password (configurable) shall be required for operation of this software.
- i. Central shall be able to assign Access Codes to specific users
- j. Central shall maintain a database of Access Codes assigned to users.
- k. Central shall communicate to all field Lock Control Units (LCU) via serial communications located at central location.
- l. Central shall be able to generate status reports of event logs for each LCU.
- m. Reports shall be subject to Engineer's approval and shall include at a minimum:
  - i. Code Administrator name on each report
  - ii. All currently Authorized and Retired codes
  - iii. LCU event log (contains local status logged)
    - Unauthorized Access (Alarm)
    - Unsuccessful Access (Lock Picking) attempts (Alarm)
    - Power Failure (AC) (Alarm) and duration
    - Low Battery (Alarm)
    - Excessive open door status; various time duration thresholds (configurable from central) (Alarm)
  - iv. Date and time stamps for each event log entry
  - v. Lock status open/closed (Alarm)
  - vi. Alphanumeric Intersection Location identification obtained from ACISA number lookup table

- n. Supervisor Control shall be able to perform administration on all related cabinet security databases, reports, access code data, lock time clock and electronic lock control. The Supervisor Control shall be set up with a unique password code, given only to authorized individuals. The Supervisor Code shall be used to release the electronic lock local components in the event that the sub-system has encountered an error.

**3. Code Structure And Storage Requirements** - Code shall have the following characteristics:

- a. Code shall have 8 digit identifier assigned to only 1 person requiring access to the controller cabinet. First 4 digits uniquely identify the person assigned the code, and the second 4 digits is a cabinet access identifier. The cabinet identifier can serve as a common number to all cabinets for a specified period of time. If an 8 digit code shall cause too much memory to be used, a 4 digit code may be considered, subject to the approval of the Engineer.
- b. Valid time period for a specific cabinet access identifier is configurable from central location for all LCUs in the system.
- c. Electronic security lock sub-system shall be able to store valid access codes.
- d. Codes shall be downloaded, edited, and deleted from a central location.

**4. LCU Requirements** - The required features of the LCU shall be compatible with the Central Security Management Software Requirements.

The software/firmware shall perform the following functions with 30 events being recorded and retained in the local memory for polling:

- a. LCU event log shall be provided containing the following local status information:
  - i. Authorized Access Code of field personnel opening cabinet
  - ii. Unauthorized Access
  - iii. Unsuccessful Access Attempts (and Code Sequences)
  - iv. Power Failure (AC) and duration
  - v. Low Battery
  - vi. Excessive open door status (configurable from central)
  - vii. Date and time stamps for logged events
  - viii. Supervisor Access Code Change event
  - ix. Door open/closed, with code, date and time stamp.
  - x. Identity of controller cabinet using 4-digit ACISA number, which shall be supplied by the Contracting Officer's Technical Representative (COTR). ACISA number shall be used at central to look up intersection location name.
  - xi. Verification of lock closure (reset in locked position)
- b. The LCU shall be uniquely addressable from central over ITMS communications network using serial communications protocol.
- c. This sub-system shall include software/firmware that facilitates data to be read from and written to the LCU.
- d. This sub-system shall be capable of immediate notification to central location of all authorized and unauthorized entries.
- e. In the event that communications to central is off-line, the cabinet security lock sub-system shall allow access based on its internal authorized list and shall store an audit trail of at least 30 events.
- f. When communication is restored, the cabinet electronic security lock sub-system shall report, on request, all events to the central security management software database, and shall receive, on request all security sub-system related changes made at the central location.

## 5. LCU Status Indicator Requirements

- a. Transmit and receive indicators for serial communications ports
- b. Power indicator to show LCU is being powered
- c. Program Run indicator to show current software/firmware is running.
- d. Other diagnostic indicators and self-test buttons shall be located internal to the cabinet, available on the LCU.

## 6. Data and Event Requirements

- a. Unique LCU Serial Number for each LCU that is stored in the LCU and addressable from central server
- b. Cabinet ACISA number, identifying unique intersection location for each LCU
- c. Last valid Access Code used, date and time of access
- d. List of recent valid Access Codes used, date and time of access
- e. Current date and time of lock clock upon event
- f. Event status report from lock
- g. Attempted Code Picking Events and Attempted Codes (3 strike lockout for configurable period of time)
- h. Last 30 events
- i. Low Clock and Data Storage Backup Battery Event
- j. AC Power failure

## 7. Diagnostic Requirements - The Electronic Security Lock sub-system shall perform the following diagnostics initiated locally or from central location:

- a. Lock open (Unlock)/Lock closed (Lock)
- b. Communicate with central location
- c. Exercise electronic security lock sub-system annunciator (beeper)

## 8. Maintenance Scenario Requirements

- a. *Scenario 1: Electronic Lock not powered* - An external power supply terminal (PST) shall be provided at each cabinet. External power supply connections are protected and cannot be used to damage internal cabinet components. External power can be supplied through protected external power connections.

The Electronic Security Lock Sub-system shall perform in a normal operating manner once external power to the lock is applied.

- b. *Scenario 2: Electronic Lock malfunctions* - If an Electronic Security Lock Sub-system malfunctions and is not controllable from central or locally at the cabinet, the key lock blocker shall be able to be released by an already established key lock maintenance procedure.

The maintenance procedure to release the security sub-system key lock blocker and key lock shall be accomplished by drilling the mechanical key cylinder. The drilling location for release of the cabinet lock, minimal cabinet intrusion, and effective removal and replacement of the cabinet lock and key lock shall be confirmed by the Engineer.

- c. *Scenario 3: TMC Lockouts* - 3 unsuccessful attempts to access the Electronic Security Lock cause an automatic lockout to last by default fifteen (15) minutes (configurable from central location). Electronic security lock sub-system can be released from central during this period.

## 9. Communications Requirements

- a. 2 built-in serial ports
  - i. Port 1 is RS-232C, fixed at 9600 baud, used for programming the PLC.
  - ii. Port 2 is multi-function RS-232C, RS-422, RS-485 with selective baud rates (300-38,400bps) for central communication
- b. Parity – Odd, Even, None
- c. Start Bits-1
- d. Stop Bits-1
- e. Data Bits-8
- f. Protocol: Asynchronous, Half or Full Duplex (2-way communication)

## 10. Cabinet Installation/Mounting Requirements

- a. This sub-system shall be modular in design to allow for field installation in an existing cabinet
- b. This sub-system shall be mounted internally to the cabinet, except for external components, where noted, using the available cabinet space to the approval of the Engineer. Consideration shall be given first to a LCU rack mount option (See LCU Rack Mount Option below). An interior side panel in the back of the controller cabinet may be considered only upon approval by the Engineer.
- c. Keypad shall be weather proofed, sealed keyboard with a panel seal gasket to protect it. No additional weather proofing or protection shall be required to protect it. All fasteners for removal of keypad shall be internal to the cabinet and shall not be accessible from external to the cabinet or from behind police panel door.
- d. Keypad, Back-up External Power Supply Terminal and Annunciator required for electronic access to the cabinet shall be installed on the police panel, behind the police panel door. The Back-up External Power Supply Terminal and Annunciator may be recommended for integration with the Keypad, if the integration will result in reducing the cost and simplifying the production installation. This integration shall not cause any performance problems and is subject to approval by the Contracting Officer's Technical Representative and the Engineer.
- e. LCU Rack Mount Option - This option specifies the basic size, orientation and location for mounting the LCU within a standard 19-inch controller cabinet equipment rack.

The LCU will be enclosed within a metal box from formed sheet metal. The enclosure shall be approximately 5.25 inches high by 5 inches deep by 12 inches wide. The enclosure shall be mounted on a standard 5.25 inch (3U) by 19 inches rack mount faceplate. The faceplate will be full width (19 inches) but the actual box enclosure on the back shall be approximately 12 inches wide and set off center to the left. This leaves room on the right side for wiring harness connectors.

The unit shall be mounted so any wire routing or cable harness will not obstruct air flow to the LCU, will be able to provide for loops of excess cable/wiring for door opening, and allow for easy storage and removal when necessary.

## 11. Electrical Requirements

- a. *Discrete Output Points (12VDC)* - The security sub-system shall have at least 4 output points available for custom functions. These points can be used to send signals to external devices or to engage relay contacts. The Electronic Security Lock sub-system outputs shall be to points to engage:
  - i. Output 1 - Solenoid Key Lock Blocker
  - ii. Output 2 - Annunciator (Beeper)
  - iii. Outputs 3 and 4 - Spares

- b. *Discrete Input Points (12 VDC Sinking)* - The security sub-system shall have at least 6 input points available for customs functions. These points can be used to send signals to the LCU electronics for use in triggering lock functions. The Electronic Security Lock sub-system inputs shall be to points to engage:
  - i. Input 1 - Keypad inputs
  - ii. Input 2 - Cabinet Door Switches (1 input for front and rear doors)
  - iii. Input 3 - Solenoid Key Lock Blocker
  - iv. Input 4 - Back-up External Power Supply Terminal (PST)
- c. *Contact Closures Outputs (Capable of Handling 24 VDC Signals)* - The electronic security lock subsystem shall provide for 2 relay contacts for switching logic ground of 24 VDC referenced signals. In the absence of other requirements, relay contacts are driven by LCU special functions outputs. These contacts may be used for traffic signal controller interfaces via the C1 or C11 connector.
- d. *Ground True Inputs (referenced to Traffic Signal Controller 23 VDC Supply)* - The electronic security lock sub-system shall accommodate 2 traffic signal controller control signals provided to the LCU as ground true referenced signals. In the absence of other requirements, the LCU shall process these inputs as Special Function Alarms to be communicated to Central. These contacts may be used for traffic signal controller interface via the C1 or C11 connector.
- e. *Electrical Isolation* - The Electronic Security Lock Sub-systems shall not be interrupted or caused to operate abnormally due to Electromagnetic Interference (EMI) or Extraneous Power Signals. The sub- system shall be subjected to the same requirements provisioned in the Cabinet and Controller specification that this specification is attached to.
- f. *Power Failure Recovery* - The electronic lock security sub-system shall recover from power outages transparently to the user, Recovery may be permanent, as in the case of PEPCO grid power restoration, or temporary, as in the case of externally applied power terminal. Under all power outage circumstances, electronic security lock sub-system shall operate as if power had never gone out.

## 12. Power Requirements

- a. 12 VDC shall be supplied by LCU internal power source; 120 VAC converted.
  - i. Output Voltage Range - 6-27 VDC
  - ii. Maximum Output Voltage – 30 VDC
  - iii. Maximum Output Current: - A/point; 6A/common
  - iv. Smallest Recommended Load - 5mAat 5VDC
  - v. Off to On Response Time - < 15ms
  - vi. On to Off Response Time - < 10 ms
- b. *Power Fuses* – include for LCU unit; removable fuse holder mounted for LCU outside enclosure access. Real Time Clock shall be backed up by battery. The battery shall be good for three (3) years of clock operation in the event of a power failure to the cabinet.

**13. Environmental Testing Requirements** - The Electronic Security Lock Sub-system shall be subject to the level of testing specified in the Controller and Cabinet Specification.

**14. Software/Firmware Licensing** - There shall be no software/firmware license fee for each LCU. The firmware for the LCU shall be provided by the supplier and installed at the factory as part of the electronic lock security sub-system.

- G. DOCUMENTATION REQUIREMENTS.** 25 complete sets of operation and maintenance manuals in hard copy format shall be provided. Format and text style shall replicate that described in the controller and cabinet Specifications. In addition, at least 5 copies of CD-ROM electronic manuals shall be delivered.

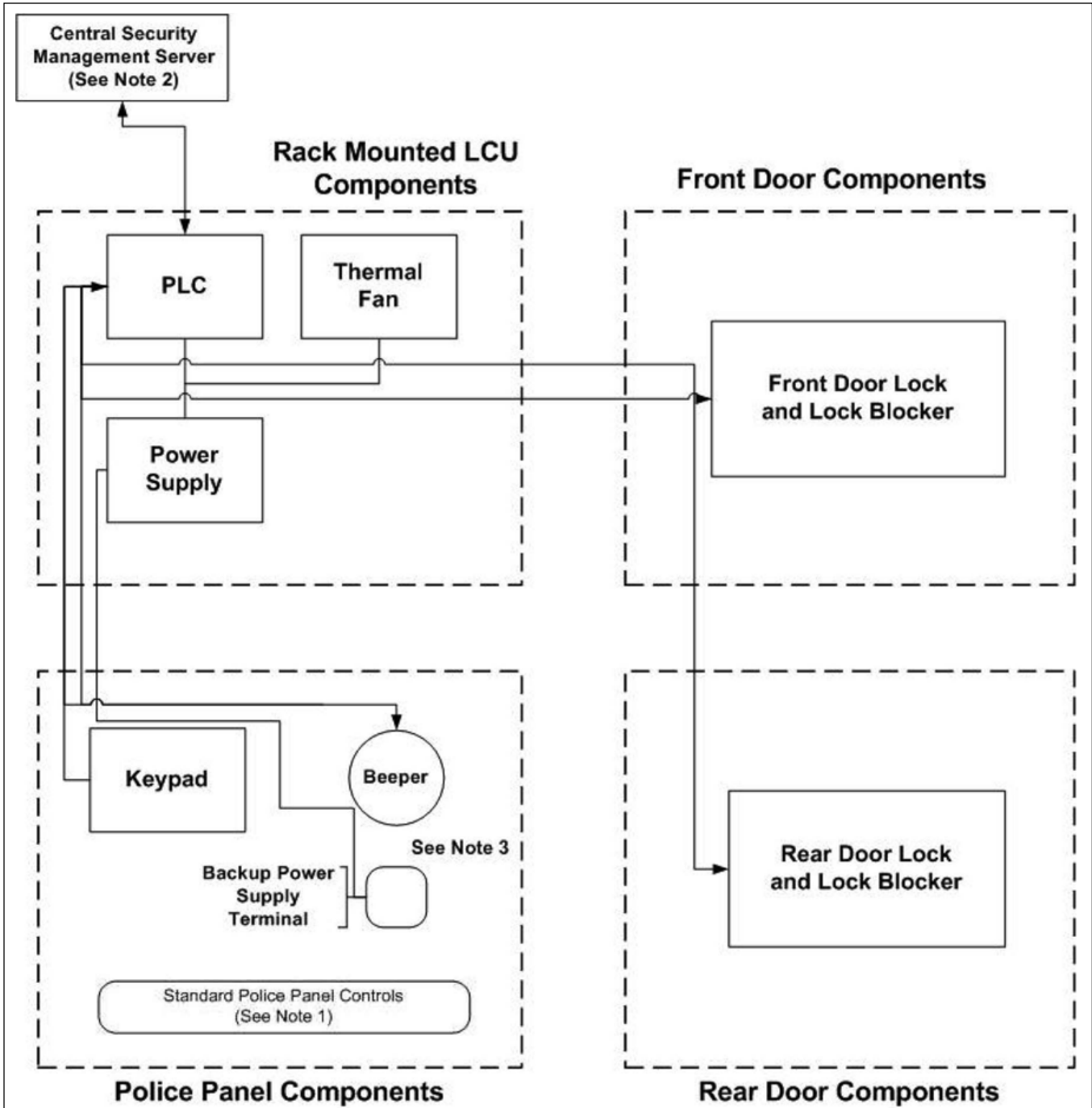
The manuals shall, as a minimum, include the following:

1. Equipment operation
2. Complete installation procedures
3. Complete performance Specifications (functional, electrical, mechanical, and environmental)
4. Complete and accurate troubleshooting, diagnostic and maintenance procedures, including cabinet lock drilling and removal procedures.

Complete source code documentation shall also be provided in hard copy (2 copies) and electronic (2 copies) formats.

- H. TESTING REQUIREMENTS** - Electronic Security Lock Sub-system shall be subjected to the levels of testing for the described Environmental Requirements above. In addition, a self test diagnostics shall be cycled during the cabinet/controller burn-in period to ensure operational performance. Production test to exercise all LCU inputs and outputs logic shall be conducted. All test results shall be recorded and provided to the Contracting Officer's Technical Representative for approval.

FIGURE 1 - ELECTRONIC SECURITY LOCK SUBSYSTEM COMPONENTS



LCU – Lock Control Unit

Opt. – Optional

PLC – Programmable Logic Controller

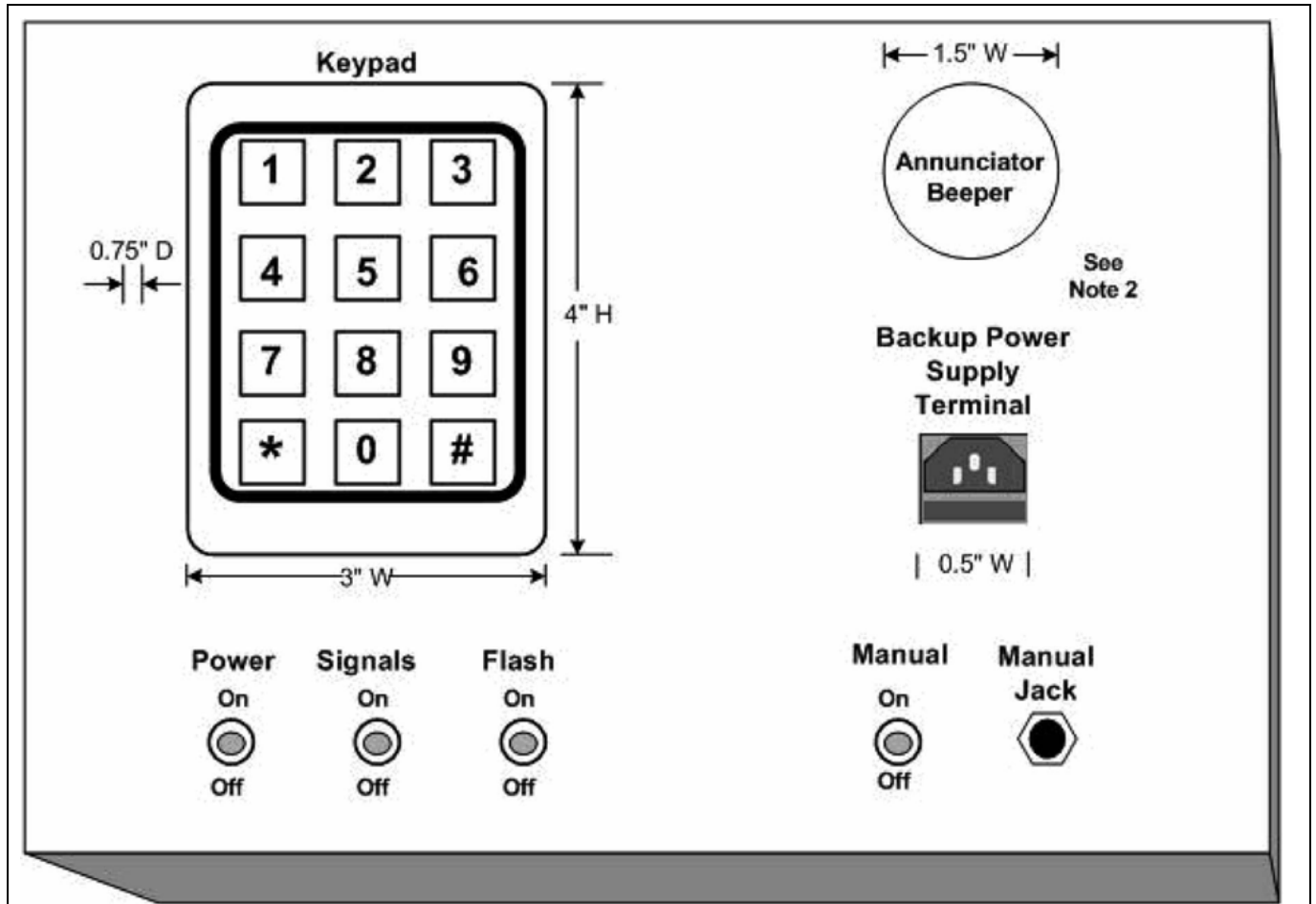
Note 1 – Not part of Lock Sub-system. Shown for completeness.

Note 2 – Central Security Management Server/Workstation connected to its own serial channel that sends/receives data to/from the PLC.

Note 3 – Annunciator (beeper) and Backup Power Supply Terminal (PST) may have the option to be integrated with the Keypad.



FIGURE 2 – POLICE PANEL ELECTRONIC SECURITY LOCK SUBSYSTEM



Notes:

1. All dimensions shown are approximate. Final sizes will be determined by the Subcontractor.
2. Annunciator (beeper) and Backup External Power Supply Terminal may be integrated with the Keypad at the discretion and approval of the COTR/Embankment.

**825.03 336SS TRAFFIC CONTROLLER AUTOMATIC TRANSFER SWITCH**

**A. GENERAL** - All 336SS controller cabinets supplied to DC Department of Transportation, except those cabinets featuring a bolt on UPS (Uninterrupted Power Supply) Cabinet, as specified in 825.05, shall include an Automatic Transfer Switch assembly. Controller cabinets featuring a bolt on UPS cabinet already have provisions for the installation of the Automatic Transfer Switch assembly. The Contractor shall be responsible for providing detailed documentation covering the operation and the mounting installation details to the Department for approval prior to procurement. The automatic Transfer Switch assembly shall include the following::

1. Mating connector for the Department traffic cabinet back-up generator.
2. Mating connector shall be installed in secure interface compartment with locking access door.
3. The Transfer Switch shall automatically transfer to the Input power, which is available with preference given to the standard AC Power Line over the generator power. Upon loss of power line voltage the transfer switch shall disconnect cabinet AC service from the utility power grid and connect to the input from the generator port.
4. The Transfer Switch shall monitor the voltage level of the utility AC Power Line and automatically switch back to utility power when utility power is restored, disconnecting the generator input connection. The voltage sense level shall be adjustable with the pick-up voltage and dropout voltage being individually adjusted.
5. The Transfer Switch shall not allow the generator input port to be connected to the electrical utility power grid. Short line permutations shall not affect the operation of the Transfer Switch. The Transfer Switch design shall prevent chattering of the relays as the power goes up and down.
6. The Transfer Switch shall mount on the 19-inch rails of the cabinet and connect to the TBS terminal lock for the AC Line Power. The front panel shall be hinged so that the unit can be swung out of the way to allow access to cabinet components and wiring behind the Transfer Switch.
7. The generator connector shall mount to a metal box, which can be mounted on either sidewall of the cabinet. A door, similar to the police door, shall provide access to the generator connector.
8. The generator connector and cable shall be capable of handling 50 Amps.
9. The automatic Transfer switch shall be covered by a manufacturer’s thirty-six (36) month warranty.

**B. SPECIFICATIONS**

**TABLE 825.03 SPECIFICATIONS**

Power-Handling Capability	50 Amps at 120 VAC
Turn-on Voltage	90-140 VAC (Set to 103VAC)
Turn-off Voltage	90-140 VAC (Set to 98 VAC)
Turn-on Delay AC Line	3-60 Seconds (Set to 5 seconds)
Turn-on Delay Generator	3-60 Seconds (Set to 15 Seconds)
Size	17.95 inches W x 6.25 inches H x 2.5 inches D
Indicators	NORMAL (AC Line Power) GENERATOR (Generator Power)
Environmental	-37° to + 74° C 5 to 95% humidity non-condensing
Connector	Amp Circular Plastic Connector #213889 with #213841 Pins (3) Pin 1.....AC+ Pin 2.....AC Pin Pin 3.....Equip. Ground

**825.04 336SS TRAFFIC CONTROLLER CABINET UPS UNIT**

**A. GENERAL** - All 336SS controller cabinet assemblies shall include an uninterrupted power supply (UPS) unit with the following Specifications:

1. UPS unit shall be rack-mountable to the DC Department of Transportation 336SS Traffic Control Cabinet
2. UPS unit shall occupy a maximum of 2 -rack units
3. UPS unit shall be supplied with four 12V/7Ah internal batteries, which are maintenance-free and user-replaceable. UPS unit shall provide surge suppression up to 1796 Joule rating, and the device is fully SNMP/HTTP manageable with the addition of an external card. It is also equipped with 2 serial communications ports that allow for the control of 2 PCs or servers.
4. UPS unit shall include the full SNMP/HTTP manageable option.
5. UPS unit shall carry a three (3) year unlimited warranty.
6. UPS unit shall produce Pure Sine Wave operation with built-in EMI, RFI.
7. UPS unit shall incorporate full AVR-Boost/Buck-Boost/Buck topology.
8. UPS units shall include compatible management software which allows users to view detailed information about their electrical power and the vitals of the UPS including:
  - a. *Configurable system notifications*
  - b. *Automatic self-tests*
  - c. *Adjustable high/low voltage warnings*
  - d. *Event/data logging*
  - e. *Scheduled shut downs*
9. UPS unit shall be field-hardened
10. UPS unit shall include LED status lights that indicate Power-On, Wiring faults, AVR and Battery level.
11. Audible Alarms- audible tones shall identify when the unit is running off battery power, unit overloads and low battery.
12. UPS unit shall include Re-settable Circuit Breaker-Convenient unit reset switch in case of overload.
13. UPS unit shall be manufactured under ISO-9000 standards, and products shall be certified by the FCC, cUI and UL.

**B. TECHNICAL SPECIFICATIONS****1. Technical Information**

- a. *Product Type Plug/Connector Type* - Pure Sinewave UPS NEMA 5-15P
- b. *Receptacles* - 6 A x NEM 5-15R-Back-up/Surge-protected
- c. *Switching Time* - 4 ms
- d. *Dataline Protection* - 1 x RJ45 (1-in/1-out)
- e. *Automatic Voltage Regulation* - Yes

**2. Power Description**

- a. *Load Capacity* - 1500VA/ 1000W
- b. *Input Voltage* – 110 VAC
- c. *Input Voltage Range* – 85 VAC to 150 VAC Single-phase
- d. *Output Voltage* - 120 VAC Single-phase

- e. *Frequency*
  - i. 47 to 63 Hz Input
  - ii. 47 to 53 Hz Output
  - iii. 57 to 63 Hz Output
- f. *Voltage Handling* - 5 percent
- g. *Waveform Type* - Sine Wave
- h. *Surge Energy Rating* - 1780J
- i. *Filtering* - EMI/RFI
- j. *Circuit Breaker* - 1 x 15A

### 3. Management

- a. *Network Manageability* - SNMP Manageable Optional via RMCARD 100
- b. *Overload Protection*
  - i. On Utility - Circuit Breaker
  - ii. On Battery - Internal Current Limiting
- c. *Audible Alarms*
  - i. Low Battery
  - ii. On Battery
  - iii. Overload
- d. *Bypass Switch* - Not Provided

### 4. Controls/Indicators

- a. *Status Indicators*
  - i. Power On
  - ii. Battery In Use
  - iii. AVR
  - iv. Load Level
  - v. Battery Level

### 5. Interfaces/Ports

- a. *Interfaces/Ports* - 2 x Serial/USB (Combo) DB9

### 6. Battery Information

- a. *Batteries* 4 x 12V/7Ah Maintenance Free Sealed Lead-acid User-replaceable Hot-swappable
- b. *Backup/Run Time*
  - i. Five (5) Minute(s) 1000W Full-load
  - ii. Fifteen (15) Minute(s) 500W Half-Load
  - iii. Server & Router (750W) – Ten (10) minutes
- c. *Battery Life* – Three (3) Year(s) to six (6) Year(s)
- d. *Battery Recharge Time* – Eight (8) Hour (s)

**7. Environmental Conditions**

- a. *Temperature*
  - i. 32° F (0° C) to 95° F (35° C) Operating
  - ii. 5° F (-15° C) to 113° F (45° C) Non-operating
- b. *Humidity*
  - i. 0 to 95 percent Non-condensing Operating Humidity
  - ii. 0 to 95 percent Non-condensing Non-operating
- c. *Altitude*
  - i. 0 ft to 10,000 ft Operating
  - ii. 0 ft to 50,000 ft Non-operating

**8. Physical Characteristics**

- a. *Color* - Black
- b. *Form Factor* - 2U Tower/Rack Mountable
- c. *Power Cord/Cable* - 10 ft
- d. *Dimensions* - 3.5 inches Height x 17.25 inches Width x 15.75 inches Depth
- e. *Shipping Dimensions* - 18.5 inches Height X 20 inches Width x 10.25 inches Depth – Display Case
- f. *Weight* - 56 lbs
- g. *Shipping Weight* - 64 lbs – Display Box

**9. Miscellaneous**

- a. *Package Contents*
  - i. UPS Unit User Manual Rack Mount Kit
  - ii. Power Management Software
  - iii. Warranty Card
  - iv. Serial Cable
  - v. Phone Cable
  - vi. Serial-to-USB Adapter
- b. *Certifications & Standards* - FCC Class B certified cUL UL 1778

**825.05 BOLT ON UPS CABINET ASSEMBLY WITH INVERTER CHARGER AND BATTERY BANK**

- A. **GENERAL** - This specification establishes the minimum requirements for a complete emergency battery backup system for use with Light Emitting Diode (LED) Traffic Signal Modules. The Battery Backup System (BBS) shall include, but not be limited to the following: Inverter/Charger, batteries, combination power transfer relay and manual bypass switch and all necessary hardware and interconnect wiring. The BBS shall provide reliable emergency power to a traffic signal system (Vehicle and Pedestrian Traffic) in the event of a power failure or interruption.

The BBS shall be capable of providing power for full run-time operation for an “LED-only” intersection (all colors: red, yellow, green and pedestrian heads), an intersection with only yellow and/or pedestrian incandescent bulbs or flashing mode operation for an intersection using Red LED’s.

1. The Contractor shall supply UPS systems that meet the following performance Specifications - UPS system shall be the Department version of The Dimensions brand model 24M11-WBE bolt on unit, offered by Sensata Technologies, or approved equal. UPS shall include the Department approved version of: Dimensions brand independent power panel and transfer switch.

## B. OPERATION

1. **Compatibility** - BBS shall be compatible with The District Department of Transportation's 336S and 336 Super stretch traffic controller cabinet, Model 170E Controllers, Model 2070 Controllers and cabinet components for full time operation.
2. **Run-Time** - The BBS shall provide a minimum six (6) hours of full run-time operation for an "LED-only" intersection (minimum 700W/1000VA active output capacity, with 80 percent minimum inverter efficiency).
3. **Output Capacity** - The BBS shall be able to provide a minimum of 1100W at +25°C, continuous active output capacity, with 80 percent minimum inverter efficiency while running in Backup Mode (on batteries). The BBS shall be able to provide 850W at +74°C, continuous active output capacity.
4. **Output Voltage** - When utilizing battery power, the BBS output voltage shall be between 110 VAC and 125 VAC, pure sine wave output,  $\leq 3$  percent THD, 60Hz  $\pm 0.05$ Hz.
5. **DC System Voltage** - The BBS DC system voltage shall be 24 VDC.
6. **Transfer Time** - The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries shall be forty (40) milliseconds. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.
7. **Operating Temperature** - Operating temperature for the inverter/charger, and power transfer relay and manual bypass switch shall be -40°C to +74°C.
8. **AC Feedback** - BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service.
9. **Surge Protection** - The BBS shall have lightning surge protection compliant with IEEE/ANSI C.62.41.
10. **Power and Control Connections** - The BBS shall be easily replaced by having easily removable AC input and output cables. The DC input connection shall be a 1 piece Anderson type connector. The external transfer relay control and battery temperature compensation cables shall be a quick release connector. The AC, DC, external transfer relay, and battery temperature compensation cables shall be removable without the use of a screwdriver.
11. **AC Connection** - The AC input and output shall be separate panel mounted plug / receptacles that allow no possibility of accidental exposure to dangerous voltages (male receptacle for AC Input and female receptacle for AC Output). The receptacles shall utilize some form of locking mechanism or hold down clamps in order to prevent accidental disconnects.
12. **DC Connection** - The DC connection shall be a recessed 1 piece Red Anderson style receptacle.
13. **Relay / Temperature Probe Connection** - The external power transfer relay control and battery temperature sense inputs shall be heavy duty panel mounted connectors. The temperature probe must have a lug for attaching the sensor to the battery.
14. **General Connections** - All connections shall provide mechanically and electrically secure connections without the use of a screwdriver. The only exception will be the 18-position Relay Terminal Block which shall require a small screwdriver for holding down the relay wires.
15. **Unit Failure** - In the event of inverter/charger failure, battery failure or complete battery discharge, the power transfer relay shall revert to the NC (and de-energized) state, where utility line power is connected to the cabinet.
16. **Overload** - The Battery Backup System must be able to shutdown to protect against internal damage in the event of an overload at it's output.

## C. FUNCTIONALITY, DISPLAYS, AND CONTROLS

1. **Standby Type System** - There shall be 2, user adjustable transfer point set types if the user wanted to use the BBS as a "Standby" type system instead of the default "Buck/Boost or Line Interactive" type system. The user will be able to select either

“Normal” or “Generator” transfer points. The user will be able to set the low and the high cutoff transfer points which are adjustable between 89 and 135 AC volts. The BBS will automatically apply the 5 volt difference for the return transfer points.

If the BBS is configured to use these adjustable transfer points, the BBS shall bypass the utility line power whenever the utility line voltage is outside of the set transfer points ( $\pm 2$ VAC).

In cases of low (below the set low cutoff point) or absent utility line power, when the utility line power has been restored at or above  $5 \text{ VAC} \pm 2 \text{ VAC}$  of the set low cutoff point for more than thirty (30) seconds (or the user configured line qualify time), the BBS shall transfer from battery backed inverter mode back to utility line mode.

In cases of high (above the set high cutoff point) utility line power, when the utility line power has been restored at or below  $5 \text{ VAC} \pm 2 \text{ VAC}$  of the set high cutoff point for more than thirty (30) seconds (or the user configured line qualify time), the BBS shall transfer from battery backed inverter mode back to utility line mode.

2. **Buck/Boost or Line Interactive Type System** - The BBS shall be line interactive by default, and have a Buck/Boost function or mode of operation. The Buck/Boost shall have a range of 80-160 VAC. There are not to be any user configurable transfer point settings for the Buck/Boost function. With Buck/Boost selected as the sense type, the output to the signal system will be regulated to voltages between 102-130 VAC.
3. **Buck Boost Counters and Run Time** - There will be a Buck and Boost event counter and run time meter accessible through the LCD and Ethernet. Buck and Boost events will be recorded separately from each other. The counter and run time meter will show the cumulated information since the last reset.
4. **Line Qualify Time** - The BBS will have an adjustable line qualify time. The range will be from one (1) to sixty (60) seconds, in one (1) second increments. The factory default setting will be thirty (30) seconds.
5. **LCD Display** - The BBS shall have a 4 line by 20 character backlit LCD display. The main screen shall indicate information regarding; transfer points, transfer point type, time of day status, utility input voltage, charger on/off status, battery percent of charge, battery voltage, BBS Mode, a scrolling line of text (which automatically lists any faults, alarms and relay status information), inverter event counter and run time meter. The run time meter shall indicate run time in hours and minutes. The display shall be temperature compensated and have a user selectable contrast adjustment by pressing “Enter” at the main screen.
6. **Keypad** - The BBS shall have a 4-way navigational keypad so that the user can navigate the menu system by using “↑”, “↓”, “←”, “→”, “Enter”, and “Esc” keys. There shall also be an “Inv” key to turn the inverter on or off.
7. **Status LED’s**
  - a. *Green LED “Output”* – This is to be on any time the BBS is providing output for wither backup, buck, or boost modes.
  - b. *Red LED “Fault”* – This is to be on any time there are any faults in the system.
  - c. *Yellow LED “Alarm”* – This is to be on anytime there are alarms on the system.
8. **Charger** - The BBS shall have an integral charger. The charger shall be a 4 step charger (zero-volt start, bulk, accept, and float). The charger shall have the capability of providing the charge current required by the battery up to 20 amps DC.
9. The user shall be able to select either “gel” or “AGM” type batteries. The default setting is for AGM.
10. The BBS shall use a temperature-compensated battery charging system. The charging system shall compensate over a range of 2.5 – 4.0 mV/ °C per cell.
11. The temperature sensor shall be external to the inverter/charger unit. The temperature sensor shall come with 2 meters (6 feet 6 inches) of wire and have a lug at the end for termination to the negative post of a battery for the best temperature measurement.
12. Batteries shall not be recharged when battery temperature exceeds  $50 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$ .
13. Recharge time for the battery, from “protective low-cutoff” to 80 percent or more of full battery charge capacity, shall not exceed ten (10) hours.
14. **Backup Counter And Run Time** - The BBS shall include a front-panel event counter display to indicate the number of times the BBS was in Backup, Buck, and Boost modes; and a front-panel hour meter to display the total number of hours and/or minutes the unit has operated in those modes since last reset. The run time shall be displayed in HHH:MM format. All meters shall be re-settable. The information displayed shall be cumulative since last reset.

- 15. Event Log** - There shall be an event log that is 256 lines in length. Data shall be recorded in a FIFO format so that the oldest record is purged as the newest is entered. The event log shall date and time stamp all events. Each event that is recorded will also show the operating mode of the BBS before the event (Standby, Backup, Buck, and Boost).
- 16. Dry Relay Contacts** - The BBS shall provide the user with 6 programmable dry relay contacts. These dry relay contacts shall be rated for 3 amps at 125 VAC. Each relay can be programmed to trigger by more than 1 condition simultaneously. If any relay is energized, it will show up on the main screen of the LCD, Ethernet web browser, and the RS-232 menu. The programming options are as follows:
- **ON BATTERY**
  - **LOW BATTERY**
  - **TIMER**
  - **TIME OF DAY**
  - **ALARM**
  - **FAULT**
  - **BBS FAILURE**
  - **OFF**

The relay contact terminal blocks shall conform to On-Shore Technology, type ED2200/22, or Phoenix Contact type FRONT 2,5, 5-H/SA 5, or WECO type 180A-111, or equivalent. The spacing between each terminal shall be 0.197-inch (5mm), with the hold-down screw and wire entrance both on the same face, facing forward and in the horizontal axis.

- 17. Timer Relay Contacts** - The BBS shall have a timer that will energize the dry contact relays (that are configured for "Timer") after the user configured time has elapsed. This timer is started when the BBS is in Backup mode. The user can configure the timer from zero (0) to four hundred and eighty (480) minutes, in one (1) minute increments. The factory default setting is at one hundred and twenty (120) minutes.
- 18. Low Battery Relay Contacts** - The BBS shall have an adjustable low battery relay setting. This setting shall be adjustable so that the user can set the point at which the low battery relay energizes. This setting applies to any dry contact relay that is configured for "Low Battery". This setting is adjustable from 0 to 100 percent of remaining usable battery capacity in 5 percent increments. This setting must be in percent. The factory default setting is 40 percent.
- 19. Battery Voltage Test Points** - The BBS shall include a LCD display to indicate battery voltage and standard meter probe input jacks (+) and (-) to read the battery voltage externally.
- 20. Circuit Breakers** - The BBS shall be equipped with Input and Output AC circuit breakers. The BBS shall also have a DC input circuit breaker.
- 21. Time of Day Program** - The BBS shall be equipped with a Time Of Day (TOD) program. The user can set the beginning and the end time of the TOD program. The user can also "Enable" and "Disable" the program. Operation is such that if the program is enabled and the BBS goes to Backup mode, the TOD program will energize any dry contact relays that are programmed for TOD. If the BBS is still in Backup mode and the TOD program has expired, any relay that was energized by the TOD program will de-energize when the TOD program expires.
- 22. Keypad Password Protection** - The BBS Configuration and System menus (on LCD) shall be password protected with a 6 digit alphanumeric password. The password feature can be disabled by the user in the System menu. This feature by default is disabled.
- 23. Web Browser Password Protection** - The web browser shall be password protected and require a user ID and a password. This feature by default is disabled.
- 24. Bypass Switch** - The manual bypass switch module and power transfer relay shall be rated at 240VAC/30 amps.
- D. COMMUNICATIONS** - The UPS must be the capability to provide Ethernet and IP addressing communications for inclusion in systems with the capability for remote monitoring and programming. This capability must be provided internal to the unit. As an interim solution; UPS system must also be capable of serial communications via the Department existing 170 controllers through available spare hardware port.



UPS supplier must comply with communications protocols currently used by the Department QUICNET© system.

1. **User Configuration, System, and Status Menus** - All BBS Configuration, System, and Status menus shall be accessible and programmable from the RS-232 port and from the Ethernet port. Additionally, all log files shall be available through these ports.
2. **RS-232** - The BBS shall have RS-232 communications. The communications port shall be an EIA-232 (DB9-Female) connector.

The data transmission rate shall be user adjustable between 300 and 115200 baud.

3. **Ethernet** - The BBS shall have an Ethernet port as standard. The Ethernet port shall be an RJ45, EIA 568B pin out type connector. The data rate shall be 100 mbps.

The BBS shall have an embedded web server.

The Ethernet port shall have user configurable IP, subnet mask, and gateway.

The firmware and web pages for the BBS shall be upgradeable through the Ethernet port using a Java applet. The applet shall have:

- User input box for the IP address of the system that is to be upgraded.
- “Connect” button to initiate communication to the BBS which reports current Model Number, Serial Number, MAC Address, System DC Voltage, and Firmware & Web page version levels.
- “Update” button that when clicked automatically updates the BBS firmware and web pages on the BBS without the user having to select files for uploading.
- 2 progress bars that show that the web pages file and firmware file are being uploaded. At the end of the update the applet shall state to the user “All Operations Complete.”

4. **Web Pages** - Shall have a header area that shows location, date, time, firmware version, BBS Mode, quick status updates of alarms –faults –and relay status. This header is to be on every web page.

Shall have a Configuration page that allows for configuration of; sense type, transfer points (normal and generator), line qualify time, Time of Day program, self test, low battery relay in percent, timer relay, and dry relay contacts

Shall have a Status page that shows the current settings of; sense type, transfer points, line qualify time, Time of Day program, self test, and dry relay contacts

Shall have a System page to configure; location, date, time, password, user ID, IP address, sub-net mask, and gateway address

Shall have an email page to configure which events trigger an email. It also shall allow input of up to 6 email addresses

Shall have a 256 line event log (FIFO). The event log shall be able to be printed from the web browser. The event log shall be able to be saved as an htm file. The event log shall also be able to be copied and pasted into an excel spreadsheet.

- E. **POWER** - The AC power interface must be an independent panel design meeting the following minimum requirements.

The Independent Panel Design must be used primarily for existing cabinets being retrofitted with UPS systems. This panel must be mounted in close proximity to the existing power interface and must provide the following: a 50A 120VAC single phase electrical service interface must be required at the direction of the Engineer to support relocation of incoming utility service wiring to the new panel power-in terminal strip with a properly rated circuit breaker to control the utility power state, a surge suppressor to protect the UPS, the wiring to the Manual Bypass Switch must be integrated into this panel for incoming AC Power such that all wires are accessible within this panel on identified terminal stripes that will allow for the maintenance of the equipment using only standard hand tools. The output AC power from the Manual Bypass Switch shall be terminated on the original incoming utility power service terminals. The panel shall be covered with plexi-glass or other approved material to minimize the risk of electrical hazards.

- F. **STATUS/ALARMS** - The Status/Alarms outputs of the UPS must be interfaced into the traffic controller through appropriately defined status inputs to report the conditions required above. Logic Common from the traffic controller must be provided to the common side of the status/alarm terminations and the status/alarm output must be returned to the controller.

UPS assembly must include appropriate terminations and relays to facilitate connection of existing PHOTO ENFORCEMENT

## EQUIPMENT.

Photo enforcement equipment must be connected in a manner that will not provide power from the UPS system when UPS system is in operation and in standby mode (photo enforcement equipment must be connected to always draw from PEPCO feed, and must not operate when intersection is on battery power).

**G. PROCEDURES** - When installing UPS at an existing traffic signal controller cabinet location, the Contractor shall notify the Agency Engineer a minimum of five (5) days prior to beginning Work. The traffic signal must not be disconnected from utility unless a representative of the Department representative is present and then only during the time of day and day of week designated by the Department representative.

**H. WARRANTY** - The UPS, in its entirety, must be warranted for two (2) years from the date of installation against defective material and workmanship. Batteries warranty must be a minimum of three (3) years and must not be prorated during the warranty period.

The Contractor shall provide 3 blue and white prints of the control circuit diagram. The blue and white prints shall be produced from the original diagram and must be clear and legible. The Contractor shall install 2 copies of the circuit diagram inside the traffic signal controller cabinet or in the UPS cabinet in the ready accessible water resistant enclosure and must furnish 1 additional copy to the Engineer. The Contractor shall provide 1 set of the following to the Engineer: equipment list, operation and maintenance manuals, board level schematic diagram and wiring diagrams of the UPS and battery data sheets.

**I. DOCUMENTATION** - An additional copy of the UPS software on CD or Jump drive must be provided to the Engineer at no additional cost.

**J. INSTALLATION**

**1. Procedures** - The Contractor shall deliver each UPS cabinet to the targeted intersection as a pre-configured, tested package; ready to be bolted onto the existing controller cabinet.

Contractor shall follow all the Department construction standards and permitting regulations.

UPS assembly must be delivered to location fully charged and load tested.

Contractor shall schedule a pre-installation field visit to each targeted location. The pre-installation visit shall include a designated representative from the Department. The pre-installation visit shall determine the actual side of the controller cabinet that the UPS cabinet will be attached.

Contractor shall take digital photograph of the targeted cabinet, and shall illustrate on the photograph, the actual mounting location of the UPS assembly.

The Department shall approve or disapprove the proposed mounting location based on the PDF submittal.

UPS system must be connected to allow any existing generator ports to provide charging voltage to the battery banks during long term outages.

**2.** UPS system must be tested under full intersection load prior to PEPCO power being restored and while intersection is still under manual police control to insure proper operation.

Wiring for the UPS within the traffic signal controller cabinet and within the UPS cabinet (when required) must be sized in accordance with the NEC and must conform to the requirements the Agency Specifications. Wiring panels and terminal blocks must be neatly finished and clearly and permanently marked. Conductors must be neatly arranged and bundled in groups with cable ties. The bundled conductors shall not obstruct access to other circuits and terminals in the cabinet. A listing, indicating terminal numbers with a description of their use, shall be attached to the cabinet door and overlaid with a clear, plastic covering. Edges of the plastic overlay shall be sealed with a clear waterproofing compound. Unless cable is passing through the cabinet uninterrupted, incoming and outgoing conductors must have each wire connected to terminal post positions.

The UPS cabinet assembly shall be side mounted on existing traffic controller cabinet.

Cabinet for UPS must be weatherproof and constructed of welded sheet anodized aluminum, 0.125-inch minimum. Cabinet finish must include graffiti resistant coating. Cabinet mounting attachments must be durable, corrosion resistant, compatible

with the aluminum of the cabinet or isolated from it and of heavy-duty construction. Cabinets shall be no larger than 40 inches in height, 15 inches in width, and 10 inches in depth.

3. **Doors** - Cabinet doors shall provide full access to the cabinet interior and must have gaskets to ensure weatherproofing. The door must be equipped with the Agency's standard tumbler lock. 2 keys for each cabinet shall be provided to the Engineer. Hinges must be stainless steel and continuous. Doors must have a doorstop arrangement that will allow it to be firmly positioned at 90 and 135 degrees,  $\pm 10$  degrees. The locking system for cabinets must be a 3-point draw roller system. Rollers must be fabricated from nylon with a diameter of at least 8/10 inch. The door opening shall be double flanged on all 4 sides.

The door must have a screened and louvered vent design to prevent rain entry, with a standard size furnace vent filter. The filter tray shall be sized to house and secure the filter in place. The screen shall be constructed from at least 0.031-inch aluminum with 1/8-inch diameter openings positioned on 3/16 inch staggered centers. The screen must be placed on the inlet side of the filter and held in place by the filter or silicone adhesive.

- K. **QUALITY ASSURANCE** - Each BBS shall be manufactured by an ISO 9001:2008 certified company in accordance with a manufacturer Quality Assurance (QA) program.

QA process and test results documentation shall be kept on file for a minimum period of seven (7) years.

Each system shall be visually inspected for any exterior physical damage or assembly anomalies. Any defects shall be cause for rejection.

- L. **WARRANTY** - Manufacturers shall provide a five (5) year warranty. The first three (3) years will be with the Advanced Replacement Program. Under the Advanced Replacement Program, the manufacturer will send out a replacement unit within 2 business days of the call notifying them of an issue. The manufacturer will send out either a new unit or a re-manufactured unit that is fully tested and is up to the latest revision. The manufacturer is responsible for all shipping charges to the customer. The last two (2) years of the warranty will be factory-repair warranty for parts and labor on the BBS. Batteries shall be warranted for full replacement for two (2) years from date of purchase. The warranty shall be included in the total bid price of the BBS

## 825.06 WOOD POLES

### A. WOOD POLE TYPE 35 FEET CLASS 4 CREOSOTE

1. **Description** - These Specifications cover structural timber and lumber, miscellaneous wood products and preservative treatments for wood poles used as part of the specification.
2. **Detail Requirements** - Structural timber and lumber shall conform to the requirements of AASHTO M 168. The species and the grade of the structural lumber shall be as shown on the Plans. The Engineer may approve the substitution of another species of equal or greater strength selected from the "Allowable Unit Stresses for Structural Lumber – Visually Graded" of AASHTO's Standard Specifications for Highway Bridges or the supplement to the National Design Specification for Stress-Grade Lumber and Its Fastenings of the National Forest Products Association.

Except as otherwise specified, the species and grade of structural lumber, timber, and posts for the following applications shall be as follows:

Signalization and Electrical Service shall conform to ANSI Class 5.1.

Sawn material, both rough and dressed, shall be certified by the mill as to grade and shall be grade marked in accordance with the grading rules and basic provisions of the American Lumber Standards (PS-20-70) by the Department. If dressed, the grade mark shall be applied after dressing.

- B. **PRESERVATIVES** - Timber preservatives shall be used according to their suitability for the condition of exposure to which they will be subjected, and they shall not be used interchangeably. Treatments shall conform to the following limitations:

1. Waterborne preservatives shall be used for timber where a clean surface is desirable. The moisture content of the wood material shall not be more than 19 percent at the time of treatment.
2. Pentachlorophenol may be used for timber that is not to be painted.

3. Preservatives shall conform to the requirements of AASHTO M 133 except that I.C.3. Coal tar creosote solution will not be permitted.
4. Pressure treatment shall conform to the requirements of AWP C2 except for piles, which shall conform to the requirements of AWP U1. Gage readings will be the criteria for acceptance except in cases involving referee testing, in which the assay method will be the determining computation.

### C. GUIDELINES

1. **Precautions** - It is requires that this information be available to persons using Inorganic Arsenical Pressure-Treated Wood (CCA), Pentachlorophenol Pressure-Treated Wood, and Creosote Pressure-Treated Wood.

2. **Generic Precautions For All Three Types** - Do not use treated wood under circumstances where the preservative may come in contact with food or animal feed like food containers.

Do not use treated wood for cutting-boards or countertops.

Only treated wood that is visibly clean and free of surface residue should be used for patios, decks, and walkways.

Do not use treated wood for construction of those portions of beehives which may come into contact with the honey.

Treated wood should not be used where it may come in direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke or ashes. Treated wood from commercial or industrial use (e.g. construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. Wear a dust mask when sawing or machining treated wood. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations or airborne sawdust from treated wood.

Wear eye goggles to protect eyes from flying particles when power-sawing and machining treated wood.

Wash exposed areas thoroughly after working with treated wood and before eating, drinking or using tobacco products.

If preservatives or sawdust accumulate on clothing, launder before re-use. Wash work clothes separately from other household clothing.

3. **Additional Precautions For Creosote Pressure Treated Wood** - Wood treated with creosote should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture); unless an effective sealer has been applied.

Creosote-treated wood should not be used in residential interiors. Creosote-treated wood may be used in interiors of industrial building components which are in ground contact and are subject to decay or insect infestation. For such uses, 2 coats of an appropriate sealer must be applied. Sealers may be applies at the installation Site.

Do not use creosote-treated wood for farrowing or brooding facilities.

Do not use creosote-treated wood where it may come into direct or indirect contact with drinking water for domestic animals or livestock, except for uses involving accidental contact such as docks and bridges.

Avoid frequent or prolonged skin contact with creosote-treated wood; when handling treated wood, wear long-sleeved shirts and long pants and use gloves that are impervious to the chemicals (for example, gloves that are vinyl-coated).

Coal tar pitch and coal tar pitch emulsion are effective sealers for creosote-treated wood block flooring. Urethane, epoxy, and shellac are acceptable sealers for all creosote-treated wood.

**825.07 CCTV CAMERA AND ASSOCIATED EQUIPMENT SPECIFICATION**

- A. GENERAL** - After receiving the Engineer's approval of the catalog cuts, the Contractor shall procure the CCTV camera, encoder and DSL modem for the cabinet, decoder and DSL modem for the TMC, mast arms and all other associated equipment as determined to be necessary according to the Department Standard Drawings, this special provision and as directed by the Department personnel.
- B. MATERIALS** - The following is a list of materials that are needed for the installation of CCTV Cameras:

**TABLE 825.07 MATERIALS**

Quantity	Item	Notes
1 each	Honeywell ACUIX 35X Outdoor Pendant with clear lower dome and 8 inch pigtail with 14 pin connector factory installed, including ACUIX Pigtail Assembly, smoked Cover	Camera must operate with existing Department Philips/Bosch protocol
1 each	PMA18BS Pole Mount Adapter	
1 each	DWM19S Wall Mount	
1 each	Remote Vision System panel mount camera interface power supply with surge protection on power data and video. 120 VAC Input, 24VAC camera power and heater/blower. Video output for local test monitor. Includes Phillips to Honeywell standard protocol conversion. Dimensions: 9" x 7" x 5" (HWD). Includes NEMA4X fiberglass enclosure (or approved equal)	
1 each	25 foot Honeywell Composite Cable, for ACUIX model camera	
2 each	ML624 Actelis Ethernet Access Device (EDA)	
2 each	ML688 Actelis Copper Drop/Add (EDA)	
1 each	Siquira Model C-60 encoder, with DC power adapter, and mating AC power cord	
1 each	Siquira Model S-60 decoder, with DC power adapter, and mating AC power cord	
	RG-6 flooded coax cable (West Penn Wire # 6325 or equiv.)	see Project drawings for appropriate length
3-pair	19 gauge solid distribution cable (Type IMSA 60-6 or RUS Spec. PE-54 BWFG)	see Project drawings for appropriate length
	IMSA 19-1, 7 conductor, 14 gauge, stranded cable	
2 each	1½ inches cast iron hub plate (Pelco SE4124 or equivalent)	
2 each	Rubber grommet (sized to fit hole drilled into pole for cable protection)	
1 each	1½ inches x 9 inches steel nipple	
1 each	1½ inches x 2 inches steel nipple	
1 each	1½ inches bushing	
2 each	1½ inches lock nut	
2 each	5/16-24 x 1/4 inches stainless steel set screw	
4 each	#10-32 x 1/2 inches stainless steel screw (supplied with power supply)	
1 each	1½ inches malleable iron LB threaded conduit body (drilled and tapped for 5/16-24 set screws)	
1 each	1½ inches malleable iron LR or LL threaded conduit body (drilled and tapped for 5/16-24 set screws)	
2 each	neoprene gasket	

Quantity	Item	Notes
1 each	galvanized conduit body cover (1½ inches)	
	30 feet, ¾ inches stainless steel metal strap banding (Band-It C206 or equivalent)	
6 each	¾ inches stainless steel metal strap banding buckles (Band-It C256 or equivalent)	
2 each	universal channel clamp (Band-It SX0220 or equivalent)	
2 each	medium extrusion 8½ inches long (Band-It SX0073 or equivalent)	
1 each	Kellum Grip (Hubbell part # 02201037 or equiv.)	
2 each	3M 4460-D shield connector	
1 each	BNC connector (West Penn Wire # CN-BM73-2 or equiv.)	
2 each	BNC connector (West Penn Wire # CN-BM73-5 or equiv.)	
1 each	RJ-11 jack (Suttle # 625A2-4-50)	
1 each	RJ-45 jack (Suttle # 625A28NK50)	
1 each	McCain Accessory Power Tap	
1 each	Tripp-Lite Power Strip (Model #PDU1215)	
1 each	RJ-11 telephone cord (comes with Modem)	
2 each	3 feet Category 5 straight patchcord	
1 each	5/16-18x1½ inches bolt	
1 each	5/16x1¼ inches fender washer	
1 each	5/16 K-Lock nut	
4'-12'	3/32 Stainless Steel Safety Cable (length determined at installation)	
2 each	splicing sleeves for safety cable	
1 each	Hubbell HBL5965VY plug for camera cable	

Miscellaneous Hardware should include:

1. 10-32x1 inch screws
2. Spade connectors
3. Butt connectors
4. Silicone sealant
5. Battleship gray spray paint

Contractor shall install all required Cables to pole and mount equipment according to the Department CCTV standards and as directed by the Department ITS personnel.

Communications pairs shall be assigned by the Department

Brand names specified in this document may be replaced by an approved equal.

## 825.08 ACCESSIBLE PEDESTRIAN SIGNAL (APS) UNITS

- A. **DESCRIPTION** - Furnish and install accessible pedestrian signal (APS) units conforming to the following technical Specifications
- B. **MATERIALS** - Furnish materials in accordance with the following:
  1. Provide a 2-piece cast aluminum housing unit consisting of a base housing and a removable cover. Ensure the internal components provide a pushbutton with all the electrical and mechanical parts required for operation. Supply housing or an adapter (saddle) that conforms to the pole shape, fitting flush to ensure a rigid installation. Supply adapters of the same material

and construction as the housing. Close unused openings with a weather-tight closure painted to match the housing. Provide a minimum 0.5 inch hole with an insulating bushing through the back of the housing.

2. Ensure the manufacturer's name or trademark is located on the housing. The APS pushbutton shall be a solid state switch rated for at least 1 million operations.
3. Ensure APS complies with US Access Board's "Draft Guidelines for Accessible Public Rights of Way" (PROWAG) Section R306. In addition, ensure that the APS complies with and provides operation consistent with the MUTCD.
4. Supply an APS (pushbutton station) that includes a pedestrian sign, a pushbutton, vibrotactile arrow and an audible speaker contained in 1 unit and with the following features:
  - a. Vibrating tactile arrow with high visual contrast.
  - b. Pushbutton locator tone with a duration of 0.15 seconds or less, repeating at one (1) second intervals. The pushbutton locator tones must deactivate when the traffic control signal is operating in a flashing mode.
  - c. The locator tones must be intensity responsive to ambient sound and be audible (a maximum of 5 dBA louder than ambient sound) up to 6 to 12 feet from the pushbutton or to the building line whichever is less. Speech walk message for the WALKING PERSON (symbolizing WALK) indication.
  - d. *Speech pushbutton information message* - Unless Plans require otherwise, provide each pushbutton station with a 9-inch X 15-inch sign. Use sheet aluminum with minimum thickness of 0.080-inches for information signs for push buttons.
  - e. *Audible tone walk indications* – consisting of ticks repeating at 8 to 10 times per second at multiple frequencies with a dominant component at 880 Hz  $\pm$  20 percent. It must provide an audible walk indication during the walk interval only. The audible walk indication must be from the beginning of the associated pedestrian walk phase and must have the same duration as the pedestrian walk signal except it must be possible to limit the accessible walk indication to the first seven (7) seconds of the walk interval when the pedestrian signal rests in walk. When the accessible walk indication is limited during rest in walk a button press during the walk interval must recall the walk interval provided the crossing time remaining is greater than the pedestrian change interval.
  - f. Automatic volume adjustment in response to ambient traffic sound level provided up to a maximum volume of 100 dBA. Tone or voice volume measured at 3 feet from the pushbutton station shall be 2 dB minimum and 5 dB maximum above ambient noise level and shall be responsive to ambient noise level changes.
  - g. The pushbutton must be Americans with Disabilities Act compliant and activate both the walk interval and accessible pedestrian signal.
  - h. Actuation indicator-tone and light.
  - i. Extended button press which can be used to request a louder WALK signal and locator tone for subsequent clearance interval.
  - j. Weather-resistant speaker protected by a vandal resistant screen.
  - k. Capable of operating at, as a minimum, up to 1000 ft (AWG #12) cable run from signal cabinet
  - l. Pushbutton station and Central control unit shall be rated for the following temperature range:
    - i. Pushbutton station - -30°F to +155°F.
    - ii. Central Control Unit - -30°F to +165°F
  - m. The Accessible Pedestrian Signal (APS) units shall be operationally compatible with Type 170E and controllers/ cabinet assemblies currently used by the Department. APS units shall be operationally compatible with the BiTran 215 Pre-timed software, the BiTran 215 Actuated software, and the BiTran 233 Actuated software. In the case of conflicts between Specifications, the latest Department Specifications will control. Unless specified otherwise in the Plans, supply a central control unit (CCU) for the pushbutton stations that resides in the Traffic Signal Controller Cabinet. Provide a CCU capable of controlling up to 4 pedestrian phases and 12 Pushbutton stations. Ensure that all inputs and outputs on the CCU have Transient Voltage Protection.

- n. APS shall be capable of being operated in both the pre-timed and actuated modes. In the actuated mode, pushing the APS button will call the associated WALK phase and will give verbal instructions to the pedestrians. In the pre-timed or recall mode, pushing the APS button will activate the onset of verbal instructions to the pedestrians when the associated WALK interval is displayed as part of the traffic signal cycle. While the locator tone shall be active at all times, verbal pedestrian crossing instructions shall only be heard upon actuation of the APS button.
    - i. If Plans specify that the APS will require no additional space or wiring in the cabinet, provide 1 control unit per push button station capable of mounting in the pedestrian signal housing.
    - ii. If a special device or software is required to configure the APS operation, provide a minimum of 1 device or copy of software per signal cabinet along with any required connectors, unless required otherwise by the Plans.
    - iii. Provide any wiring harnesses, connectors, interface cables, terminal blocks, etc. required for connecting the pushbutton station or CCU to the traffic signal controller assembly and making the Pushbutton stations operational.
- C. CONSTRUCTION** - Unless specified otherwise, wire the APS to the nearest splicing point or terminal strip using stranded No. 12 AWG XHHW wire with 600-volt insulation. Do not use terminal connections or splice wire leads except in the hand holes located in the signal pole shaft, in the signal pole base, or at locations approved by the Engineer. All allowed splices must be watertight. Attach wires to terminal posts with solderless terminals. Attach terminals to the wires with a ratchet-type compression crimping tool properly sized to the wire. Remove any burrs or rough edges on any holes drilled for wire entry to APS pushbuttons. Ensure pushbutton stations are mounted at the proper height and orientation. Provide a neat workmanship in the installation of any wiring harnesses, control units, wiring panels, push button stations. Follow manufacturer's recommendations regarding installation and weatherproofing.
- D. DOCUMENTATION REQUIREMENTS** - Each APS shall be provided with the following documentation:
- Complete and accurate installation wiring guide.
  - Contact name, address, and telephone number for the representative, manufacturer, or distributor for warranty repair.
  - If requested supply schematics for all electronics. 1 schematic diagram shall be provided for pushbutton stations, panels, central control units or control units, along with any necessary installation instructions.
- E. Warranty** - The APS unit shall be warranted against any failure due to workmanship, material defects or intensity within the first sixty (60) months of field operation. APS unit shall operate as required above after sixty (60) months of continuous use over the temperature range of -30°F to +165°F in a traffic signal operation. The Contractor shall provide a written manufacturer warranty against defects in materials and workmanship for APS unit for a period of sixty (60) months after installation. Replacement of APS units shall be provided within five (5) days after receipt of failed module(s) at no cost to the Department, except the cost of shipping the failed modules.

## 825.09 LIGHT EMITTING DIODE (LED) VEHICLE SIGNAL MODULES

- A. GENERAL** - Light emitting diode (LED) traffic signal modules shall meet the requirements of this section and as shown in the Contract Documents.
- B. LIGHT EMITTING DIODE (LED) TRAFFIC SIGNAL MODULES** - The acceptable design and operating requirements for 12 inch (300 mm) Light Emitting Diode (LED) vehicle signal modules are listed in this section
- C. DESCRIPTION**
  - 1. This specification covers "red ball", "yellow ball", "green ball", "red arrow", "yellow arrow" and "green arrow" LED modules to be used in place of the incandescent lamp, reflector, socket, gasket and lens assembly of the vehicle signal sections. Each LED module shall consist of an assembly that utilizes LEDs as the light source in lieu of an incandescent lamp for use in vehicle signal sections.
  - 2. All vehicle signal LED modules shall be engineered to fit into all ITE compliant conventional vehicle signal housings. They shall fit in the conventional polycarbonate vehicle signal head housing, as used in the District of Columbia, and as described in detail in an accompanying technical specification.



3. The LEDs utilized in the modules shall be AllnGap technology for red and yellow indications or InGaN for green indications. The LED's shall be the ultrabright type rated for 100,000 hours of continuous operation form -40° C to +74° C.
4. Each LED module shall be rated for a minimum useful life of forty-eight (48) months. All LED modules shall meet all parameters of this specification during this period.
5. Each individual LED module shall be wired such that a catastrophic loss or the failure of 1 LED will result in the loss of not more than 5 percent of the signal module light output.
6. Each "red ball" and "green ball" module shall be in full compliance of all provisions of the current version of Institute of Transportation Engineers Interim LED Purchase Specification, Vehicle Traffic Control Signal Heads.

**D. ELECTRICAL REQUIREMENTS**

1. **Power Consumption** - The maximum power consumption requirements measured in watts for each module are as follows:

**TABLE 825.09 (A)**

MODULE	25° CELSIUS	74° CELSIUS
Red Ball	11.0W	17.0W
Yellow Ball	22.0W	25.0W
Green Ball	15.0W	15.0W
Red Arrow	9.0W	12.0W
Yellow Arrow	10.0W	12.0W
Green Arrow	11.0W	11.0W

All LED Modules except the yellow ball shall be U.S. EPA Energy Star compliant at 25 degrees Celsius. Power consumption of these LED Modules shall not exceed that maximum allowed by the EPA.

2. **Operating Voltage** - Each module shall operate from a 60HZ±3HZ AC line over a voltage ranging from 95 volts to 135 volts. Fluctuations of line voltage shall have no visible effect upon the luminous intensity of the indications. The operating voltage of the modules shall be 120 Volts AC. All operating parameters shall be measured at this voltage. LED circuitry shall prevent perceptible flicker to the unaided eye over the 95 to 135 voltage range.
3. The LED module shall have a power factor of 0.90 or greater at a nominal rated voltage at 25 degrees Celsius after sixty (60) minutes of operation.
4. Total harmonic distortion (current and voltage) induced into an AC power line by an LED signal shall not exceed 20 percent at the rated voltage at 25 degrees Celsius.
5. The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients as stated in Section 2.1.6 of the NEMA Standard TS-2 current version.
6. Each LED module and associated on-board circuitry shall be in compliance with Federal Communications Commission (FCC) noise regulations and must meet FCC Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
7. All wiring and terminal blocks must meet the requirements of Section 13.02 of the ITE Publication: Equipment and Material Standards, Chapter 2, Vehicle Traffic Control Signal Heads.
8. Each LED module shall be operationally compatible with controller assemblies and peripheral equipment including sold state load switches; flashers, and conflict monitors currently used in the District of Columbia. Current controller Specifications are available for review at the specific request of the Contractor or vendor.

When a current of 20 mA AC or less is applied to the unit, the voltage read across the 2 leads shall be 15 VAC or less.

9. Each LED module shall feature control circuitry to prevent current flow through the LED module in the off state to avoid any false indication as may be perceived by the human eye during the daylight and evening hours.
10. 2 secured, color coded, 600 V, 16 AWG minimum jacketed wires conforming to the National Electrical Code, rated for service at + 105 degrees Celsius, are to be provided for electrical connections for each LED signal module. Transient voltage suppression rated at 1500 watts for one (1) millisecond and fusing with a maximum rating of 2 amps shall be provided to minimize the effect and repair cost of an extreme over-voltage situation of other failure mode.

#### E. ENVIRONMENTAL REQUIREMENTS

**TABLE 825.09 (B)**

MODULE	25 degrees Celsius	74 degrees Celsius
Green Ball	15.0W	15.0W
Red Arrow	9.0W	12.0W
Yellow Arrow	10.0W	12.0W
Green Arrow	11.0W	11.0W

All LED Modules except the yellow ball shall be U.S. EPA Energy Star compliant at 25 degrees Celsius. Power consumption of these LED Modules shall not exceed that maximum allowed by the EPA.

1. Each LED module shall be rated for use in operating temperatures in the range of -40° C (-40° F) to +74° C (+165° F). Each LED module shall meet all Specifications throughout this temperature range.
2. Each LED module shall be protected against dust and moisture intrusion in conformance with NEMA Moisture Resistant Standard 250-1991 for Type 4 enclosures to protect all internal components.

#### F. COMPONENTS

1. Each LED module shall be a single, self-contained sealed unit, not requiring on-site assembly for installation into an existing traffic signal housing.
2. The power supply for the LED module shall be integral to the unit.
3. The circuit board and the power supply shall be contained inside the module.
4. Each LED module shall incorporate a printed circuit board containing all required LED's and circuit components. The LED's shall be mounted and soldered to the printed circuit board.
5. Each LED module shall feature two 39-inch long 20 AWG wire leads with strain relief and spade terminals for connection to the terminal block of the signal head. 1 of the conductors shall contain white insulation to signify neutral. The color of the other conductor shall be different and shall be used to differentiate between the red ball, yellow ball, green ball, red arrow, yellow arrow and green arrow LED module. Conductor colors shall be unique and different for those used for pedestrian signal indications also.
6. Each LED module shall feature a rigid housing for protection in shipping, handling, and installation, and a 1-piece neoprene gasket. Screw-in type products are expressly prohibited for LED modules.
7. The assembly and manufacturing process for the LED signal assembly shall be designed to ensure that all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.
8. Each LED module shall be watertight when properly installed in a traffic signal housing. Each LED module shall utilize the same mounting hardware used to secure the incandescent lens and gasket assembly, and shall only require a screwdriver or a standard installation tool to complete the mounting.

9. Each LED module shall weigh less than 5 pounds.
10. Each LED module shall be designed to be installed in the doorframe of a standard traffic signal housing. Each LED module shall be capable of being sealed in the doorframe with a 1 piece EPDM (ethylene, propylene rubber) gasket.
11. Each LED module shall be weatherproof after installation and connection.

#### **G. MATERIALS**

1. Materials used for the lens and signal module shall conform to the appropriate ASTM Specifications for the materials.
2. Enclosures containing either the power supply or electronic components of the signal module shall be made of UL94VO flame retardant materials. The module lens does not need to conform with this requirement.
3. The lens of the LED module shall be integral to the unit, shall be convex with a smooth outer surface and shall be made ultraviolet stabilized plastic material.
4. Each LED module lens shall be capable of withstanding ultraviolet (direct sunlight) exposure for a minimum period of five (5) years without exhibiting evidence of deterioration.
5. A surface coating or chemical surface treatment shall be applied to each outer polymetric lens to provide front surface abrasion resistance.
6. Each LED module shall incorporate an inner Frensel lens sealed to the lamp housing to collimate the light emitted by the LED engine. The outer lens shall focus the collimated light to meet ITE intensity and distribution standards.
7. Each LED module shall almost perfectly approximate to the motorist the appearance of a 12 inch standard incandescent signal. The surface of the LED module shall appear to the motorist to be nearly totally uniform in illumination, and have a wide viewing angle making it suitable for installation on wide boulevards.
8. The external lens surface for all LED modules shall be smooth with no raised surfaces so as to minimize the collection of dirt, debris, and other particulate contaminants, which may impact luminous intensity, and to facilitate periodic cleaning. External lens facets are prohibited.
9. The lens for the red ball and the red arrow shall be tinted red or may use transparent film materials with similar characteristics to enhance on/off contrasts.
10. The lens for the yellow ball and the yellow arrow shall be tinted yellow or may use transparent film materials with similar characteristics to enhance on/off contrasts.
11. The lens for the green ball and the green arrow shall be clear. No tinting or transparent film materials shall be used.
12. The use of tinting or other materials to enhance on/off contrasts shall not affect chromaticity and shall be uniform across the face of the lens.

#### **H. MODULE IDENTIFICATION**

1. Each LED Module shall have the manufacturers name, trademark, model number, serial number, date of manufacture (month and year) and lot number as identification permanently marked on the back of the module. This identification is required, and is in addition to any other identification that may be required in Contract Special Provisions by the District of Columbia.
2. Rated voltage and rated power in Watts and Volt-Amperes shall also be permanently marked on the back of each LED module.
3. Each LED module shall have prominent and permanent markings for correct indexing and orientation within a signal head housing. The markings shall consist of an up arrow, or the word "UP" or "TOP" to ensure that the LED module is inserted into the signal head housing with the correct orientation.
4. Conductors connecting the LED module to the signal head housing terminal block shall be color coded to differentiate between the red ball, red arrow, yellow ball, yellow arrow, green ball, and green arrow LED module.
5. Each LED module shall have a symbol of the type of module (circular ball or arrow) in the color of the module. The symbol shall be 1 inch in diameter, and the color shall be written in 1/2 inch letters next to the symbol.

## I. PHOTOMETRIC REQUIREMENTS

1. The minimum initial and maintained minimum intensities for red ball, yellow ball, and green ball LED modules measured in candela (cd) at 25 degrees Celsius shall be as follows:

**TABLE 825.09 (C) PHOTOMETRIC REQUIREMENTS**

Angle(v,h)	MINIMUM INITIAL INTENSITIES			MAINTAINED MINIMUM INTENSITIES		
	Red	Yellow	Green	Red	Yellow	Green
2.5, ± 2.5	399	798	798	339	678	678
2.5, ± 7.5	295	589	589	251	501	501
2.5, ± 12.5	166	333	333	141	283	283
2.5, ± 17.5	90	181	181	77	154	154
7.5, ± 2.5	266	532	532	226	452	452
7.5, ± 7.5	238	475	475	202	404	404
7.5, ± 12.5	171	342	342	145	291	291
7.5, ± 17.5	105	209	209	89	178	178
7.5, ± 22.5	45	90	90	38	77	77
7.5, ± 27.5	19	38	38	16	32	32
12.5, ± 2.5	59	119	119	50	101	101
12.5, ± 7.5	57	114	114	48	97	97
12.5, ± 12.5	52	105	105	44	89	89
12.5, ± 17.5	40	81	81	34	69	69
12.5, ± 22.5	26	52	52	22	44	44
12.5, ± 27.5	19	38	38	16	32	32
17.5, ± 2.5	26	52	52	22	44	44
17.5, ± 7.5	26	52	52	22	44	44
17.5, ± 12.5	26	52	52	22	44	44
17.5, ± 17.5	26	52	52	22	44	44
17.5, ± 22.5	24	48	48	20	41	41
17.5, ± 27.5	19	38	38	16	32	32

2. The minimum initial and minimum maintained intensities for red arrow, yellow arrow, and green arrow LED modules measured in candelas per square meter (cd/m<sup>2</sup>) shall be as follows:

**TABLE 825.09 (D)**

MODULE	MINIMUM INITIAL INTENSITIES	MINIMUM MAINTAINED INTENSITIES
Red Arrow	5,500	5,500
Yellow Arrow	11,000	11,000
Green Arrow	11,000	11,000

3. The red ball, red arrow, green ball, and green arrow LED module shall meet or exceed the illuminations values as shown in 825.09(I)(1) and 825.09(I)(2) throughout the useful life based upon normal use in traffic signal operations over the operating temperature.

4. The yellow ball and yellow arrow LED module shall meet or exceed the illumination values as shown in 825.09.(I)(1) and 825.09(I)(2) throughout the useful life bases upon normal use in a traffic signal operations at 25 degrees Celsius.

Within five (5) minutes of turn-on, the initial luminous intensity of yellow ball LED modules shall meet that of ITE compliant green ball LED modules at 25 degrees Celsius, 120 Volts AC. Yellow ball LED modules shall be compliant with CALTRANS Specifications. CALTRANS Laboratory compliance certificates shall be furnished prior to product acceptance.

5. The intensity of red ball and green ball LED modules shall not vary by more than 10 percent over the allowable voltage range.
6. Red ball and green ball LED modules shall meet the most recent publication VTCSH-LED adopted by reference into FHWA's MUTCD, or the most current standards and measurements criteria for LED modules. Test data to verify compliance of these LED modules with this standard, including all tests listed in Section 6.4 of the standard, shall be provided by a NEMA approved testing facility.

In addition, red ball and green ball LED modules shall be compliant with CALTRANS Specifications. CALTRANS Laboratory compliance certificates shall be furnished prior to product acceptance.

7. Red ball, red arrow, yellow ball, and yellow arrow LED modules shall utilize AllnGaP technology exclusively, either AS (Absorbing Substrate) or TS (Transparent Substrate), and shall not exhibit degradation of more than 30 percent of the initial light intensity following accelerated life testing (operating at 85 degrees C and 85 percent humidity for 1,000 hours). AlGaAs technology shall not be acceptable.

8. Green ball and green arrow LED modules shall utilize Indium Gallium Nitride (InGaN) technology. Green ball and green arrow LED modules shall not be illuminated when the applied voltage is less than or equal to 35 Volts A.C. Illumination of green ball and green arrow LED modules shall be in compliance with the current version of ITE VTCSH when the applied voltage is between 80 and 135 Volts AC.

9. The measured chromatically coordinates of the LED modules shall conform to the following chromatically requirements:

RED - Y: Not greater than 0.308 or less than 0.998-x.

YELLOW - Y: Not less than 0.411, not less than 0.995-x, not less than 0.452

GREEN - Y: Not less than 0.506 – 0.519x, nor less than 0.150 + 1.068x, not more than 0.730 – x.

- a. Chromaticity requirements shall pertain to both ball and arrow LED modules.
  - b. Chromaticity requirements shall be satisfied throughout the useful life of the LED modules over the operating temperature range.
10. Red arrow, yellow arrow, and green arrow LED modules shall contain not less than 2 rows of LED's forming the shape of the arrow.
    - a. Each LED arrow module shall meet the Specifications stated in section 9.01 of the ITE Publication Equipment and Materials standards, Chapter 2 (Vehicle Traffic Control Signal Heads) for arrow indications.
    - b. LED's shall be spread and arranged evenly across the illuminated portion of the arrow area.

#### J. QUALITY ASSURANCE

1. The modules shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include 2 types of quality assurance: (1) design quality assurance, and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the modules built to meet this specification, and a documented process of how problems are to be resolved.
2. QA process and test results documentation shall be kept on file for a minimum period of seven (7) years.

3. LED signal module designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

#### 4. Design Qualification Testing

- a. Design qualification testing shall be performed by the manufacturer or an independent testing Laboratory hired by the manufacturer on new LED module designs, and when a major design change has been implemented on an existing design.
- b. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the LED module, results in a different circuit configuration of the power supply, or changes the layout of other individual LED's in the module.
- c. A quantity of 2 units for each design shall be submitted for Design Qualification Testing.
  - i. Test units shall be submitted to the District of Columbia after the manufacturer's testing is complete.
  - ii. The manufacturer's testing data shall be submitted with test units for District of Columbia verification of Design Qualification Testing Data.
- d. **Burn In**
  - i. The sample modules shall be energized for a minimum of twenty-four (24) hours at 100 percent on-timed duty cycle, at a temperature of +74 degrees C (+165 degrees F) before performing any design qualification testing.
  - ii. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, shall be a cause for rejection.
- e. For Design Qualification Testing, all Specifications will be measured including, but not limited to:
  - i. Rated Initial Luminous Intensity. Measured over the operating temperature range
  - ii. Chromaticity (Color). Measured over the operating temperature range.
  - iii. Electrical. All specified parameters shall be measured and used for quality comparison of production quality assurance on production modules (rated power, etc.)
  - iv. Equipment Compatibility. Modules shall be tested for compatibility with the controller unit, conflict monitor, and load switch. Each signal module shall be connected to the output of a standard load switch connected to an AC Voltage supply between the values of 95 and 135 VAC with the input to the load switch in the "off" position. The AC Voltage developed across each LED signal module so connected shall not exceed 10 Vrms as the input AC voltage is varied from 95 Vrms to 135 Vrms.
  - v. Mechanical vibration testing shall be as per MIL-STD-833, Test Method 2007, using 3 four (4) minute cycles along each x, y, and z axis, at a force of 2.5 Gs with a frequency sweep from 2HZ to 120 HZ. The loosening of the lens, of any internal components, or other physical damage shall be cause for rejection.
  - vi. Temperature cycling shall be performed as per MIL-STD-883, Test Method 1010. The temperature range shall be per "Environmental Requirements". A minimum of 20 cycles shall be performed with a thirty (30) minute transfer time between temperature extremes and a thirty (30) minute dwell time at each temperature. Module(s) being tested shall be energized and functioning throughout the duration of the test. Failure of a module to function properly, or any evidence of cracking of the module lens or housing after temperature cycling shall be cause for rejection.
  - vii. Moisture resistance testing shall be performed on all modules mounted in a standard polycarbonate vehicle signal housing as specified for use in the District of Columbia per NEMA Standard 250-1991 for Type 4 enclosures. Any evidence of internal moisture in the module after testing shall be cause for rejection.

#### 5. Production Quality Control Testing

- a. The following Production Quality Assurance tests shall be performed on each new LED module prior to shipment. Failure to meet the requirements of any of these tests shall be cause for rejection. Test results shall be retained by the manufacturer for seven (7) years (except for yellow LED modules).

- b. The burn-in period shall consist of each signal module being energized at the rated voltage for a thirty (30) minute stabilization period before the measurement is made.
  - c. Each LED module shall be tested for rated initial intensity after burn-in.
    - i. A single point of measurement, with a correlation to the intensity requirements of section 1.04 of the VTCSH for circular modules, may be used.
    - ii. The ambient temperature for this measurement shall be +25 degrees C (+77 degrees F).
    - iii. Each LED module failing to meet the minimum luminous intensity requirements specified in section 8.1 of VTCSHs shall be cause for rejection.
  - d. Each module shall be tested for the required power factor after burn-in.
  - e. Each module shall be measured for current flow in amperes after burn-in. The measured current values shall be compared against rated values resulting from design qualification measurements under "Design Qualification Testing". The current flow shall not exceed the rated value.
  - f. Each module shall be visibly inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of the lens to ensure there are no scratches (abrasions), cracks, chips, discoloration, or other defects. Any such defect shall be cause for rejection.
6. The manufacturer shall be required to undertake Design Qualification and Production Quality Control testing as specified in 825.09.J.4 and 825.09.J.5 and report all results to the District of Columbia through the Contractor. The procurement and installation of LED modules prior to the receipt and acceptance of test results by the District of Columbia is done at the Contractor's risk.

#### K. WARRANTY

- 1. The manufacturer shall provide a written warranty against defects in materials and workmanship for a minimum period of sixty (60) days.
- 2. The warranty period shall begin on the date the LED module is energized and placed into service at the intersection, or ninety (90) Calendar Days after delivery of the LED module to the District of Columbia, whichever occurs first.
- 3. Replacement LED modules shall be provided on a 1 for 1 basis promptly after receipt of LED modules that have failed .after being placed into service and before the expiration of the sixty (60) month period. Replacement shall occur at no cost to the District of Columbia prior to random sample testing.
- 4. All warranty documentation shall be submitted to the District of Columbia prior to random sample testing..
- 5. Red ball and green ball LED modules shall be warranted to be in compliance with the ITE VTCSH, (and any subsequent revisions or addenda to said document) Specifications for luminous intensity for a period of five (5) years, consistent with the provisions of 825.09.K.2.

#### 825.10 CONVENTIONAL POLYCARBONATE VEHICLE SIGNAL HEAD

- A. **GENERAL** - The minimum acceptable design and operating requirements for 12 inch conventional vehicle signal heads are listed in this section. Each signal head section shall be capable of being joined together to form a vehicle signal head featuring 2 to 5 sections. Each section shall be capable of accepting a 12 inch LED (Light Emitting Diode) module insert with legends to control vehicle traffic.
- B. **SIGNAL HEAD HOUSING**
  - 1. The signal heads shall meet or exceed the requirements set forth in the latest standard of the Institute of Transportation Engineers (ITE).
  - 2. The signal heads shall be constructed from ultraviolet stabilized virgin polycarbonate resin.
  - 3. The signal heads shall have a minimum thickness of 0.100 inches.

4. Unless otherwise specified, the color of the signal head shall be battleship black, MVCL 14187, GE LEXAN Number 70402. This color shall be impregnated throughout the body of the signal head. Federal black may be required in certain specified applications.
5. Each signal head section shall be capable of being joined together to form a vehicle signal head featuring 2 to 5 sections arrayed as defined in the MUTCD. Each signal section shall feature an opening on the top and bottom of the section capable of accommodating at least three 0.75 inch diameter cables.
6. Each signal head section shall feature stainless steel hardware, where appropriate.
7. A terminal block with capacity to accommodate a minimum of 8 wires shall be provided in the middle section of the signal head assembly. The terminal block shall be capable of securing conductors at least 12 AWG in diameter.
8. Each section of the signal head shall be manufactured and reinforced to withstand winds up to 80 miles per hour without showing any deflection in the vertical plane or obvious structural failure.
9. The signal heads will be equipped with plastic serrated locking rings to enable field installation and connection with metallic upper and lower mounting hardware.
10. Each signal head section shall feature a mechanism for attaching the slotted mounting tabs from the tunnel visor.
11. Each signal head section shall feature cored holes for back plate mounting.
12. **Pre-Fabrication Submittal** - Prior approval from the District of Columbia is required before signal housing is fabricated. Color chips shall be submitted at least one (1) week prior to the start of the manufacturing process.
13. **Warranty** - The manufacturer shall warrant the housing to be free from defects in material and workmanship for a period of two (2) years from the date of shipment. Any failure of the device within this period will be repaired by the manufacturer at no cost to the District of Columbia.
14. **Performance Testing** - The District of Columbia reserves the right to receive on demand a test report from an independent laboratory certifying that the equipment supplied meets all technical Specifications at no cost to the District of Columbia.
15. **Rejection** - The District of Columbia reserves the right to reject an entire shipment if 10 percent or more of the devices prove to be defective within thirty (30) days of receipt.

#### C. SIGNAL HEAD VISOR

1. A Signal head visor shall provided for each signal section
2. Each visor shall enclose the entire face of the signal section except the bottom. A tunnel visor shall be provided.
3. Each visor shall be constructed from ultraviolet, stabilized virgin polycarbonate resin.
4. Unless otherwise specified, the exterior color of the visor shall be battleship black, as described in 825.10(B)(4) the inside of the visor shall be dull black. A federal black exterior color may be required in certain specified applications.
5. Each visor shall feature slotted mounting tables for easy attachment to the signal head housing. Stainless steel screws shall be used to affix the visor to the signal head housing.
6. The tunnel visor for each vehicle signal head section shall be a minimum of 10 inches long.
7. Each vehicle signal section ordered shall contain 2 tunnel visors; 1 to be attached to the housing and the other to be packaged separately with all mounting hardware.

#### 825.11 CONVENTIONAL POLYCARBONATE PEDESTRIAN SIGNAL HEAD

- A. **GENERAL** - The minimum acceptable design and operating requirements for pedestrian signal heads are listed in this section. The pedestrian signal head shall feature 2 sections mounted 1 above the other. Each section shall be capable of accepting a 12 inch LED (Light Emitting Diode) module insert with legends to control pedestrian traffic.



**B. SIGNAL HEAD HOUSING**

1. As a minimum, the signal heads shall meet or exceed the requirements set forth in the latest standard of the Institute of Transportation Engineers (ITE).
2. The signal heads shall be constructed from ultraviolet stabilized virgin polycarbonate resin.
3. The signal heads shall have a minimum thickness of 0.100 inches.
4. The signal head shall feature 2 sections mounted 1 above the other with an opening between the 2 sections capable of accommodating at least three 0.75 diameter cables.
5. Unless otherwise specified, the color of the signal head shall be the battleship black, MVC 1417, GE LEXAN Number 70402. This color shall be impregnated throughout the body of the signal head. Federal black may be required in certain specified applications.
6. The signal head shall be nominal 12 inch square for both the upper and the lower sections. The upper section will feature the "RAISED HAND" LED insert and the bottom section will feature the "WALKING PERSON" LED insert.
7. The upper section of the signal head will feature a terminal block with capacity to accommodate internal and external wires to ensure proper operation. The terminal block shall be capable of securing conductors at least 12 AWG in diameter.
8. The signal head shall feature stainless steel hardware, where appropriate.
9. The signal head will be equipped with plastic serrated locking rings to enable field installation and connection with metallic upper and lower mounting hardware.
10. Each signal head section shall feature a mechanism for attaching the slotted mounting tabs from the tunnel visor.
11. Each signal head section shall be manufactured and reinforced to withstand winds up to 80 miles per hour without showing any deflection in the vertical plane or obvious structural failure.
12. **Pre-Fabrication** - Submittal: Prior approval from the District of Columbia is required before signal housings are fabricated. Color chips shall be submitted at least one (1) week prior to the start of the manufacturing process.
13. **Warranty** - The manufacturer shall warrant the housing to be free from defects in material and workmanship for a period of two (2) years from the date of shipment. Any failure of the device within this period will be repaired by the manufacturer at no cost to the District of Columbia.
14. **Performance Testing** - The District of Columbia reserves the right to receive on demand a test report from an independent laboratory certifying that the equipment supplied meets all technical Specifications at no cost to the District of Columbia.
15. **Rejection** - The District of Columbia reserves the right to reject an entire shipment if 10 percent or more of the devices prove to be defective within thirty (30) days of receipt.
16. The vehicle signal head shall be capable of being mounted on a span wire, on a pole, on a post top, or on a mast arm.

**C. SIGNAL HEAD VISORS**

1. A signal head visor shall be provided for each section.
2. Each visor shall enclose the entire face of the signal section except the bottom. A tunnel visor shall be provided.
3. Each visor shall be constructed from ultraviolet stabilized virgin polycarbonate resin.
4. Unless otherwise specified, the exterior color of the visor shall be battleship black, as described in 825.10.B.4 the inside of the visor shall be dull black. A federal black exterior may be required in certain specified applications.
5. Each visor shall feature slotted mounting tabs for easy attachment to the signal head housing. Stainless steel screws shall be used to affix the visor to the signal head housing.
6. The tunnel visor for each vehicle signal head section shall be a minimum of 10 inches long.
7. Each pedestrian signal section ordered shall contain 2 tunnel visors; 1 to be attached to the housing and the other to be packaged separately with all mounting hardware.

**825.12 VEHICLE SIGNAL BACK PLATE**

**A. GENERAL** - The minimum acceptable design and functional requirements for back plates for vehicle signal heads are listed in this section. Back plates complying with these Specifications shall be available for 3 Section, 4 Section, and 5 Section 12 inch traffic signal heads in arrays approved by and shown in the MUTCD.

**B. MATERIAL**

1. The back plate shall be manufactured from polycarbonate materials. Specifically, the back plate shall be produced from virgin ABS containing 60 percent styrene, 20 percent rubber and 20 percent acrylic. It shall contain ultraviolet inhibitors and stabilizers for protection against ultraviolet degradation.
2. The back plate shall have a minimum thickness of 0.125 inches and must meet a falling dart impact test of 16ft/lb.
3. The back plate shall meet or exceed Underwriters Laboratories UL94 Test H.B.
4. The back plate shall have a minimum tensile stress of 5300 psi at 73 degrees Fahrenheit.
5. The back plate shall be fabricated for cold weather applications. It shall have a hair cell finish on 1 side and a smooth finish on the other side.
6. The back plate shall be colored dull black. This color shall be impregnated throughout the entire back plate so as to prevent varying shades and tones.

**C. FABRICATION**

1. The back plate shall be 1 piece, vacuum formed with a hair cell finish on the front side. All surfaces shall be flat and straight without blisters, buckling or warping.
2. All outside and inside edges shall be formed with a 0.50 to 0.625 inch flange (inside dimension) turned away from the front surface. Flanges shall be straight, uniform and have a consistent flange dimension throughout.
3. The back plate shall be designated to fit each manufacturer's vehicle signal head, and it shall be contoured to the signal head to eliminate gaps between the back plate and the signal housing and to allow for attachment to the signal head.
4. There shall be a minimum 5 inch border beyond both sides, the top bottom of the signal head. Each exterior corner shall be constructed with a 3 inch radius.
5. The finished back plate shall be pre-drilled to fit the vehicle signal head for which it is designated, or it shall contain drill starts for field drilling.
6. Each back plate shall be designated to properly fit manufacturer's vehicle signal heads.

**D. HARDWARE**

1. Each back plate shall include all necessary nuts, bolts and washers for assembling the back plate and attaching it to the signal head.
2. All hardware shall be stainless steel with a permanent dull black finish.
3. When mounted on bases provided on the signal head, self tapping screws and applicable washers shall be provided. When mounting the back plate by drilling through the signal head housing, the proper quantity of the following shall be provided: #8-32 x 0.75 inch pan head screw, 0.625 inch x 1 inch elongated washer, and #8 Hex, locknut with nylon insert.

**825.13 MAST ARM MOUNT SIGNAL BRACKET**

The purpose of this specification is to provide the minimum acceptable design and operating requirements for brackets used to mount conventional and optically programmable traffic signal heads to mast arms. The brackets shall be capable of supporting all vertical vehicle signal head configurations permitted by the Manual on Uniform Traffic Control Devices (MUTCD), and they shall be adaptable to fit all mast arms currently in use within the District of Columbia.

**A. GENERAL**

1. The bracket will consist of upper and lower arms, a vertical support tube, mast arm clamp screws, and all necessary hardware including bolts, washers, nuts, gaskets, etc. to allow for assembly of the signal head to the bracket and the bracket to the mast arm.
2. The bracket shall attach to the signal in a clamping manner holding the signal both top and bottom in order to ensure maximum rigidity. A standard bracket shall accommodate vehicle signal heads from all major signal head manufacturers.
3. The bracket shall be capable of accommodating all vertical traffic signal configurations permitted for 12 inch vehicle signal heads by MUTCD. This shall include 3 Section 12 inch signals, 4 Section 12 inch signals, and 5 Section 12 inch signals. All signals are stacked in a vertical plane with 1 section mounted directly above the other except the 5 Section 12 inch signal which features 2 adjacent columns of 2 sections mounted 1 above the other with 1 section mounted directly above the other 2 so that the total assembly is 3 sections tall and 2 sections wide so that the center of the top section coincides with the line vertically dividing the 2 columns.
4. The bracket shall be completely adjustable and capable of being adjusted at least in the following 4 manners: (1) vertically to adjust the height of the signal head above the Roadway, (2) rotational around the bracket axis, (3) rotational around the mast arm, and (4) rotational right and left from the vertical plane.
5. The bracket shall feature Type 201 stainless steel band to fasten the bracket to the supporting arm or Structure. The bracket shall be easily adjustable to fit all sizes of round, octagonal, octoflute, elliptical or other similar cross section mast arm shapes without special tools or equipment.
6. All electrical wiring shall be completely concealed within the bracket. The vertical support shall be a gusseted "C" shaped extruded aluminum tube to accommodate the signal cable regardless of vertical positioning of the tube.

**B. MATERIALS AND DESIGN**

1. The upper and lower arms shall be cast from 319 aluminum or equivalent. The lower arm bracket shall be internally threaded to accommodate the threaded vertical support tube. The lower arm shall be furnished with ABS plastic covers which will slide up and snap into position without the use of fasteners or tools. Upper and lower arms shall have 72 tooth serrations cast into the arm to assure a positive lock with the signal housing and shall be secured about their rotational axis with stainless steel set screws. Both the upper and the lower arms shall have a tri-bolt arrangement for attachment to the signal head housing. The opening in the lower arm shall accommodate a minimum 1-7 Conductor 14 AWG traffic signal cable conforming to IMSA Specification 19-1 with accommodations for the minimum cable bending radius.
2. The vertical support tube shall be a double gusseted tube extruded from 6063-T6 aluminum alloy and have a cross section in the shape of the letter C. The minimum exterior diameter of the tube shall be 1.50 inches and the wall thickness shall be adequate to structurally accommodate all vehicular signal heads currently in use in the District of Columbia. The interior of the tube shall be of sufficient capacity to accommodate 1-7 Conductor 14 AWG traffic signal cable conforming to IMSA Specification 19-1 with accommodations made to account for minimum cable bending radius. Each tube shall be complete with a vinyl closure strip and shall be threaded on 1 end to accommodate the lower arm assembly.
3. The mast arm clamp assembly shall feature male and female halves. Both halves shall be cast from 356-T6 aluminum alloy or equivalent. The male clamp half shall be secured with the female clamp half, utilizing a spring steel retainer ring. This assembly shall provide an unobstructed center of 2-3/8 inch minimum internal diameter, allowing for 360 degree rotation of the clamp assembly. There shall be no internal cross bracing assembly obstructing the center opening.
4. The mast arm clamp assembly shall be equipped with 2 stainless steel bands, 5/8 inch wide, 0.045 inch thick, and 29 inches long. The stainless steel bands shall have a minimum tensile strength of 100,000 psi. A set screw secured buckle shall be utilized in securing the band.
5. A clamp screw shall be used to attach the stainless steel bands to the clamp kit. The clamp screw shall be 7/16 inch – 14 x 3 inch 1 piece drop forged from C-1045 carbon steel or 410 stainless steel with a minimum tensile strength of 80 KSI. The clamp screw shall be formed with a slot sized to accept a 5/8 inch stainless steel band.
6. Each bracket shall include all necessary hardware to accomplish a complete, secure installation. All necessary bolts, washers, nuts, gaskets, etc. shall be provided to allow the assembly of the signal to the bracket and the bracket to the mast arm.

**C. FINISH**

1. All aluminum parts shall have an Alodine 1200 or equivalent finish.
2. All steel parts shall have a yellow zinc di-chromate finish.

**825.14 LIGHT EMITTING DIODE (LED) COUNTDOWN PEDESTRIAN SIGNAL MODULES**

The purpose of this specification is to describe the minimum acceptable design and operating requirements for 12 inch (300 mm) Light Emitting Diode (LED) pedestrian signal modules intended for use where countdown displays are required. The specific items included in this specification include the 12 inch overlay lunar white walking person and the Portland orange raised hand LED module, and the 12 inch Portland orange countdown LED module.

**A. GENERAL DESCRIPTION**

1. This specification covers 2 separate LED modules. The first type features the Portland orange raised hand overlaid on the lunar white walking person arrayed in a module. The second type features the Portland orange countdown display.
2. Each module is to be used in place of the incandescent lamp, reflector, socket, gasket, and lens assembly of the standard 12-inch (300 mm) pedestrian signal head section. Each LED module shall consist of an assembly that utilizes LED's as the light source in lieu of an incandescent lamp for use in pedestrian signal head sections.
3. Pedestrian LED modules shall be engineered to snugly fit in all ITE compliant conventional pedestrian signal housings. The LED module shall be deemed non compliant and ineligible for use in the District of Columbia if the physical properties of either the LED module of the pedestrian signal head housing must be altered in any way to achieve a snug fit. The pedestrian overlay and countdown LED modules shall fit in the conventional polycarbonate pedestrian signal head housing currently in use in the District of Columbia, and described in detail in Specification 825.11. Unless otherwise noted, pedestrian signal heads are 12 inches square.
4. Each LED module shall utilize the appropriate technology to achieve the required color and shall be the ultra bright type rated for 100,000 hours of continuous operation at a temperature range of minus 40 degrees C to plus 74 degrees C.
5. Each LED module shall be rated for a minimum useful life of sixty (60) months. All of the LED modules shall meet the parameters of this specification during this period.
6. Each individual LED module shall be wired such that a catastrophic loss or failure of 1 LED will result in the loss of not more than 5 percent of the signal module light output.
7. The WALKING PERSON and the RAISED HAND symbols shall conform to all applicable requirements of the Manual on Uniform Traffic Control Devices (MUTCD).
8. The WALKING PERSON and the RAISED HAND shall be overlaid in a special configuration which centers both within the module and provides clear and distinct illumination when either symbol is in use. One and only one symbol is to be illuminated at any one time.
9. The WALKING PERSON and the RAISED HAND overlay module shall feature internal circuitry and wiring which prevents both displays from being illuminated at the same time.
10. The countdown LED module shall conform to the following minimum requirements:
  - a. The countdown numbers shall feature 2 separate digits. 2 rows of LED's shall be provided to form each digit.
  - b. Countdown logic circuitry uses AC power to derive traffic signal timing data from the intersection traffic signal controller. The timer shall be microprocessor based.
  - c. The unit shall feature a mechanism such as a multi-position dip switch to enable the user to select specific modes for countdown functions. The unit shall be capable of displaying descending countdown numbers during the WALK and the pedestrian clearance interval or during the pedestrian clearance interval only. The operator shall be capable of selecting the preferred operation manually by using this mechanism.
  - d. The unit shall feature a test switch which displays "8" for two (2) seconds before going blank.

- e. The unit shall automatically adjust to the programmed intervals of the traffic signal controller. During transition between timing Plans, the unit shall be dark for no more than 2 signal cycles while the unit adjusts to the new traffic signal timing patterns. The WALKING PERSON and the RAISED HAND displays in the adjacent LED module shall continue to operate in accordance with the approved traffic signal sequence of operation during this transition period.
  - f. The countdown unit shall be capable of displaying numbers ranging from 00 to 99. Each number shall be 7 inches tall.
11. The WALKING PERSON, the RAISED HAND, and the COUNTDOWN displays shall be designed to be clearly visible and legible under any lighting conditions from a distance of 200 feet anywhere within a 15 degree cone of vision centered about the optical axis.

**B. ELECTRICAL REQUIREMENTS**

**1. Power Consumption**

- a. The maximum power consumption requirements measured in watts for each module are as follows:

**TABLE 825.14**

MODULE	25° CELSIUS	74° CELSIUS
RAISED HAND	10.0 WATTS	12.0 WATTS
WALKING PERSON	12.0 WATTS	15.0 WATTS
COUNTDOWN	12.0 WATTS	15.0 WATTS

**2. Operating Voltage**

- a. Each module shall operate from a 60 MH (± 3 HZ) AC line over a voltage ranging from 95 Volts to 135 Volts. Fluctuations of line voltage shall have no visible effect upon the luminous intensity of the indications.
  - b. The operating voltage of the modules shall be 120 Volts AC. All operating parameters shall be measured at this voltage.
  - c. LED circuitry shall prevent perceptible flicker to the unaided eye over the 95 to 135 Volt range.
3. The LED signal module shall have a power factor of 0.90 or greater at a nominal rated voltage at 25 degrees C after sixty (60) minutes of operation.
4. Total harmonic distortion (current and voltage) induced into the AC power line by an LED signal shall not exceed 20 percent at the rated voltage at 25 degrees C.
5. The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients as stated in the most recent version of the NEMA Standard TS-2.
6. Each LED module and associated on-board circuitry shall be in compliance with the Federal Communications Commission (FCC) noise regulations and must meet FCC Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
7. The LED modules shall be U.S. EPA-Energy Star compliant. Power consumption of these LED modules shall not exceed the maximum allowed by the EPA.
8. All wiring and terminal blocks must meet the requirements of section 13.02 of the ITE Publication "Equipment and Material Standards", Chapter 2 (Vehicle and Traffic Control Signal Heads).
9. Each LED module shall be operationally compatible with traffic signal controller assemblies and peripheral equipment including solid state load switches, flashers and conflict monitors currently used in the District of Columbia. Current controller Specifications are available for view in 825.01.

When a current of 20 mA AC or less is applied to the unit, the voltage read across the 2 leads shall be 15 VAC or less.

- 10. Each LED module shall feature control circuitry to prevent current flow through the LED module in the off state to avoid any false indication as may be perceived by the human eye during daylight and evening hours.

**C. ENVIRONMENTAL REQUIREMENTS**

1. Each LED module shall be rated for use in operating temperatures in the range of -40 degrees C (-40 degrees F) to +74 degrees C (+165 degrees F). Each LED module shall meet all Specifications throughout this temperature range.
2. Each LED module shall be protected against dust and moisture intrusion in conformance with NEMA Moisture Resistant Standard 250-1991 for Type 4 enclosures to protect all internal components.

**D. CONSTRUCTION REQUIREMENTS**

1. Each LED module shall be a single, self-contained device, not requiring on-site assembly for installation into an existing pedestrian signal housing.
2. The power supply for each LED shall be integral to the unit.
3. The circuit board and the power supply shall be contained inside the module.
4. Each LED module shall incorporate a printed circuit board containing all required LED's and circuit components. The LED's shall be mounted and soldered to the printed circuit board.
5. Each LED module shall feature two 39-inch long 20 AWG minimum wire lead with strain relief and spade terminals for connection to the terminal block of the pedestrian signal head. 1 of the conductors shall contain white insulation to signify neutral. The color of the other conductor shall be different and shall be used to differentiate between the RAISED HAND and the WALKING PERSON LED modules. The 2 conductors shall be 600 Volt, 20 AWG minimum jacketed wires conforming to the requirements of the latest edition of the National Electrical Code, rated for service at +105 degrees C.
6. Each LED module shall feature a rigid housing for protection in shipping, handling, and installation, and a 1-piece neoprene gasket. Screw-in products are expressly prohibited for LED modules in conventional polycarbonate pedestrian signal heads.
7. The assembly and the manufacturing process for the LED signal assembly shall be designed to ensure that all internal components are adequately supported to withstand mechanical shock and vibration from high winds and from other sources.
8. Each LED module shall be watertight when properly installed in a pedestrian signal head housing. Each LED module shall utilize the same mounting hardware used to secure the incandescent lens and gasket assembly, and shall only require a screwdriver or a standard installation tool to complete the mounting.
9. Each LED module shall weigh less than 5 pounds.

**E. MATERIALS**

1. Materials used for the lens and signal module shall conform to the appropriate ASTM specification for the materials.
2. Enclosures containing either the power supply or the electronic components of the signal module shall be made of UL94V0 flame retardant materials. The LED module lens does not need to comply with this requirement.
3. The lens for the RAISED HAND LED module and the WALKING PERSON LED module shall be clear, not tinted, and with a textured surface to reduce glare.
4. Each LED module lens shall be UV stabilized plastic capable of withstanding the impact of ultraviolet direct sunlight for a minimum period of five (5) years without exhibiting evidence of deterioration.
5. The external lens shall be smooth with no raised features so as to minimize the likelihood of the collection of dirt, debris, and other particulate contaminants which may impact luminous intensity, and to facilitate periodic cleaning. External lens facets are prohibited.

**F. MODULE IDENTIFICATION**

1. Each LED module shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month and year) and lot number as identification permanently marked on the back of the module. This identification is required, and is in addition to any other identification that may be required in Contract Special Provisions by the District of Columbia.
2. Rated voltage and rated power in Watts and Volt Amperes shall also be permanently marked on the back of each LED module.

3. Each LED module shall have prominent and permanent markings for correct indexing and orientation within a pedestrian signal head housing. The markings shall consist of an up arrow, or the words “UP” or “TOP” to ensure that the LED module is inserted into the signal head housing with the correct orientation.
4. As detailed in 825.14(D)(5) of this specification, conductors connecting the LED module to the pedestrian signal head housing terminal block shall be color coded to differentiate between the RAISED HAND, the WALKING PERSON, and the COUNTDOWN LED modules.

#### **G. PHOTOMETRIC REQUIREMENTS**

1. Each RAISED HAND LED module shall provide an average luminous intensity of 3,750 candela per square meter throughout the useful life and over the operating temperature range.
2. Each WALKING PERSON LED module shall provide an average luminous intensity of 5,300 candela per square meter throughout the useful life and over the operating temperature range.
3. Each COUNTDOWN LED module shall provide an average luminous intensity of 5,300 candela per square meter throughout the useful life and over the operating temperature range.
4. The uniformity ratio of an illuminated symbol shall not exceed 4 to 1 between the highest luminance area and the lowest luminance area in the LED module.
5. The color output of each LED module shall conform to the requirements of section 5.3 in the ITE Publication “Equipment and Material Standards”, Chapter 3, (Pedestrian Traffic Control Signal Indications).
  - a. The RAISED HAND within the overlay LED module and the COUNTDOWN LED module shall be Portland orange conforming to; Not greater than 0.390, not less than 0.331, nor less than 0.997-x.
  - b. The WALKING PERSON within the overlay LED module shall be lunar white conforming to: X: Not less than 0.290 nor greater than 0.330; Y: Not less than  $1.5x - 0.175$ , or greater than  $1.5x - 0.130$ .
6. Both the RAISED HAND and the WALKING PERSON LED modules shall be filled with LED’s to give the appearance that the entire image is illuminated when energized. Outlined images will not be permitted.
7. The height of the RAISED HAND and the WALKING PERSON images on the module shall not be less than 250 mm and the width of each image shall not be less than 165 mm. Each image shall be centered horizontally and vertically on the LED module.

#### **H. QUALITY ASSURANCE**

1. The modules shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include 2 types of quality assurance: (1) design quality assurance, and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the modules built to meet this specification, and a documented process of how problems are to be resolved.
2. QA process and test results documentation shall be kept on file for a minimum period of seven (7) years.
3. LED signal module designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.
4. **Design Qualification Testing**
  - a. Design qualification testing shall be performed by the manufacturer or an independent testing laboratory hired by the manufacturer on new LED module designs, and when a major design change has been implemented on an existing design.
  - b. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the LED module, results in a different circuit configuration of the power supply, or changes the layout of other individual LED’s in the module.
  - c. A quantity of 2 units for each design shall be submitted for Design Qualification Testing.
    - i. Test units shall be submitted to the District of Columbia after the manufacturer’s testing is complete.

- ii. The manufacturer's testing data shall be submitted with test units for District of Columbia verification of Design Qualification Testing data.
- d. *Burn In*
- i. The sample modules shall be energized for a minimum of twenty-four (24) hours at 100 percent on-timed duty cycle, at a temperature of +74 degrees C (+165 degrees F) before performing any design qualification testing.
  - ii. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, shall be a cause for rejection.
- e. *For Design Qualification Testing* - all Specifications will be measured including, but not limited to:
- i. Rated Initial Luminous Intensity. Measured over the operating temperature range
  - ii. Chromaticity (Color). Measured over the operating temperature range
  - iii. Electrical. All specified parameters shall be measured and used for quality comparison of production quality assurance on production modules (rated power, etc.)
  - iv. Equipment Compatibility. Modules shall be tested for compatibility with the controller unit, conflict monitor, and load switch. Each signal module shall be connected to the output of a standard load switch connected to an AC Voltage supply between the values of 95 and 135 VAC with the input to the load switch in the "off" position. The AC Voltage developed across each LED signal module so connected shall not exceed 10 Vrms as the input AC voltage is varied from 95 Vrms to 135 Vrms.
  - v. Mechanical vibration testing shall be as per MIL-STD-833, Test Method 2007, using 3 four (4) minute cycles along each x, y, and z axis, at a force of 2.5 Gs with a frequency sweep from 2HZ to 120 HZ. The loosening of the lens, of any internal components, or other physical damage shall be cause for rejection.
  - vi. Temperature cycling shall be performed as per MIL-STD-883, Test Method 1010. The temperature range shall be per "Environmental Requirements". A minimum of 20 cycles shall be performed with a thirty (30) minute transfer time between temperature extremes and a thirty (30) minute dwell time at each temperature. Module(s) being tested shall be energized and functioning throughout the duration of the test. Failure of a module to function properly, or any evidence of cracking of the module lens or housing after temperature cycling, shall be cause for rejection.
  - vii. Moisture resistance testing shall be performed on all modules mounted in a standard polycarbonate vehicle signal housing as specified for use in the District of Columbia per NEMA Standard 250-1991 for Type 4 enclosures. Any evidence of internal moisture in the module after testing shall be cause for rejection.

## 5. Production Quality Control Testing

- a. The following Production Quality Assurance tests shall be performed on each new LED module prior to shipment. Failure to meet the requirements of any of these tests shall be cause for rejection. Test results shall be retained by the manufacturer for seven (7) years.
- b. The burn-in period shall consist of each signal module being energized at the rated voltage for a thirty (30) minute stabilization period before the measurement is made.
- c. Each LED module shall be tested for rated initial intensity after burn-in.
  - i. A single point of measurement, with a correlation to the intensity requirements of section 1.04 of the VTCSH for circular modules, may be used.
  - ii. The ambient temperature for this measurement shall be +25 degrees C (+77 degrees F).
  - iii. Each LED module failing to meet the minimum luminous intensity requirements of 3570 od/m<sup>2</sup> for the raised hand symbol and 5300 od/m<sup>2</sup> for the walking person symbol shall be cause for rejection.
- d. Each module shall be tested for the required power factor after burn-in.
- e. Each module shall be measured for current flow in amperes after burn-in. The measured current values shall be compared against rated values resulting from design qualification measurements under "Design Qualification Testing". The current flow shall not exceed the rated value.



- f. Each module shall be visibly inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of the lens to ensure there are no scratches (abrasions), cracks, chips, discoloration, or other defects. Any such defect shall be cause for rejection.
- 6. The manufacturer shall be required to undertake Design Qualification and Production Quality Control testing as specified in 825.14(H)(4) and 825.14(H)(5) of these Specifications and report all results to the District of Columbia through the Contractor. The procurement and installation of LED modules prior to the receipt and acceptance of test results by the District of Columbia is done at the Contractor's risk.

## I. OPERATIONAL REQUIREMENTS

1. The countdown timer will be designed to either count down to zero the accumulated sum of the pedestrian "WALK" and the "CLEARANCE" (flashing don't walk) times or count down to zero only the "CLEARANCE" time. The countdown display shall always be dark during the steady don't walk indication. The mode of operation shall be selected through an easily accessible multi-position dip switch. All units procured for this Contract shall be delivered configured to count down to zero from the pedestrian clearance time.
2. The module, when connected to the appropriate pedestrian signal switch pack outputs, shall have an automatic learn mode in order to learn and store the pedestrian times in its memory, and to self-adjust for subsequent changes in pedestrian timing. The individual "WALK" and "CLEARANCE" times shall be stored in 2 separate counters.
  - a. Following power restoration to the unit after a power outage of greater than two (2) seconds, the unit will remain dark for 1 for 1 pedestrian cycle to learn, to acquire the current pedestrian timing parameters, to replace any values that were stored in memory prior to the power outage with the newly acquired times, and to display the newly acquired times on the next pedestrian cycle.
  - b. The unit shall detect changes in pedestrian timing during normal operation, and act upon them as described below:
    - i. The countdown timer will automatically re-program itself should it detect any increase in pedestrian timing. The increased timing shall be displayed on the subsequent pedestrian cycle.
    - ii. The countdown timer will ignore any shortened pedestrian cycle that produces a shortened pedestrian clearance time equal to or less than two (2) seconds.
    - iii. The countdown timer will detect any reductions in pedestrian timing detected (such as those occurring during a traffic pre-emption cycle) and display on the subsequent pedestrian cycle the timing stored in its memory prior to the shortened pedestrian cycle.
    - iv. The countdown timer will re-program itself should it detect 2 consecutive identical shortened pedestrian cycles and display this timing on the next pedestrian cycle.
3. The unit shall be designed to suspend any timing and go dark when, for any reason, the switch pack output displays a steady don't walk indication during the time of a pedestrian "WALK" or "CLEARANCE" period and if the module has not yet arrived at the zero count in the cycle.
4. The countdown timer shall be capable of timing consecutive, complete pedestrian cycles outputted by the traffic signal controller.
5. The unit shall be designed to operate during and following a pre-emption cycle as described in this section.
  - a. The countdown timer shall recognize if the "WALK" or "CLEARANCE" times have been truncated or shortened
    - i. During some pre-emption events, the "WALK" indication, if displayed, would be truncated by the traffic signal controller and then proceed immediately to time the full pedestrian "CLEARANCE" cycle. Should this condition be detected, the timer module shall detect the termination of the "WALK" and the beginning of the pedestrian "CLEARANCE" and begin timing the clearance stored in its memory toward zero.
    - ii. During other pre-emption events, the "WALK" indication, if displayed, would be truncated by the traffic signal controller and then proceed immediately to time a shortened pedestrian "CLEARANCE" cycle. Should this condition

be detected, the timer module shall detect the termination of the "WALK" and the beginning of the pedestrian "CLEARANCE" and begin timing the clearance time stored in its memory toward zero. Once the switch pack output displays a steady "DON'T WALK" indication during the timing of this pedestrian "CLEARANCE" and if the module has not arrived at the zero count in the cycle, the timer will be designed to go dark.

- iii. In pre-emption cases which immediately eliminate both the "WALK" and the "CLEARANCE" outputs, the pedestrian indication will immediately cycle to a steady "DON'T WALK" display. In such instances, the countdown timer shall recognize the steady "DON'T WALK" indication and the timer will be designed to go dark.
  - b. At the cycle immediately following the pre-empted cycle, the countdown timer shall display the correct timing parameters as initially programmed and not be affected by the reduced time. If the reduced time is less than two (2) seconds, the countdown timer shall ignore this and continue to display the correct time, as initially programmed.
6. The countdown timer shall be designed to retain the pedestrian timing stored in the memory for all power outages of less than one (1) second, and to continue timing this pedestrian timing. Memory may or may not be retained for power outages between one (1) and two (2) seconds duration. The unit will resume operation as described in 825.14(I)(2)a for power outages greater than two (2) seconds in duration.

#### **J. WARRANTY**

- 1. The manufacturer shall provide a written warranty against defects in materials and workmanship for a minimum period of sixty (60) months after acceptance of the modules.
- 2. Replacement countdown and overlay LED modules shall be provided on a 1 for 1 basis promptly after receipt of LED modules that have failed at no cost to the District of Columbia.
- 3. All warranty documentation shall be submitted to the District of Columbia prior to the random sampling testing.
- 4. The warranty period shall begin on the date the LED module is energized and placed into service at an intersection, or ninety (90) days after delivery of the module to the District of Columbia, whichever comes first.

#### **825.15 PEDESTRIAN PUSH BUTTONS**

- A. The purpose of this specification is to define the minimum acceptable requirements for pedestrian push buttons in the District of Columbia.
- B. The housing of the pedestrian push button shall be constructed from cast aluminum, and the housing shall be painted battleship gray of federal black to match the pole upon which it is mounted. The pedestrian push button mounted on a wood pole shall be painted battleship gray.
- C. The unit shall be designed for installation on fluted traffic signal and street light poles in use in the District of Columbia.
- D. The unit shall feature a micro-switch designed for at least 1 million operations.
- E. The micro-switch closure shall occur when a plunger type assembly is pushed.
- F. The plunger shall be stainless steel or polished aluminum.
- G. The unit shall be designed to ground an input into the controller and will not carry any live electrical current.
- H. The pedestrian push button shall feature a large, mushroom shaped plunger that satisfies the minimum requirements of the Americans With Disabilities Act (ADA).
- I. The pedestrian push button must withstand severe impacts without deforming and cannot be made to stick in the "on" position.
- J. Pedestrian push buttons must be pressure activated requiring no more than 1 to 3 pounds of force. Visual LED light confirmation of actuation shall be required.

- K. The unit shall be designed without a sign enclosure.

## 825.16 RADAR BASED STOP BAR DETECTION DEVICES

- A. **GENERAL** - This item shall govern the purchase of aboveground radar presence detector (RPD).

An RPD detects vehicles by transmitting electromagnetic radar signals through the air. The signals bounce off vehicles in their paths and part of the signal is returned to the RPD. The returned signals are then processed to determine traffic parameters.

RPDs are not affected by normal weather and environmental conditions such as rain, wind, snow, dust, etc. They also do not require cleaning and can maintain performance over a wide range of ambient temperatures.

RPDs provide a non-intrusive means of detecting traffic. This property not only makes them safer to install but also more cost effective than sensors that require roadway modifications or placement.

- B. **SENSOR OUTPUTS** - The RPD shall present real-time presence data in 10 lanes.

The RPD shall support a minimum of 16 zones.

The RPD shall support a minimum of 16 channels.

The RPD shall support user-selectable zone to channel mapping.

The RPD shall use AND logic to trigger channels when all selected zones are active.

The RPD shall use OR logic to combine multiple zones to a channel output, and shall have channel output extend and delay functionality.

The RPD algorithms shall mitigate detections from wrong way or cross traffic.

The RPD system shall have fail-safe mode capabilities for contact closure outputs if communication is lost.

- C. **DETECTABLE AREA**

1. **Detection Range** -The RPD shall be able to detect and report presence in lanes with boundaries as close as 6 ft. (1.8 m) from the base of the pole on which the RPD is mounted.

The RPD shall be able to detect and report presence in lanes located within the 140 ft. (42.7 m) arc from the base of the pole on which the RPD is mounted.

2. **Field of View** - The RPD shall be able to detect and report presence for vehicles within a 90 degree field of view.

3. **Lane Configuration** - The RPD shall be able to detect and report presence in up to 10 lanes.

The RPD shall be able to detect and report presence in curved lanes and areas with islands and medians.

- D. **SYSTEM HARDWARE** - For each approach to be detected, 1 RPD corner radar shall be used.

1. **Preassembled Backplate** - Each RPD shall have a traffic cabinet preassembled backplate with the following:

- a. AC/DC power conversion
- b. Surge protection
- c. Terminal blocks for cable landing
- d. Communication connection points

The preassembled backplate for the RPD shall be a cabinet side mount or rack mount.6 www

2. **Contact Closure Input File Cards** - The RPD shall use contact closure input file cards with 2 or 4 channel capabilities.

The contact closure input file cards for the RPD shall be compatible with industry standard detector racks.

**E. MAINTENANCE** - The RPD shall not require cleaning or adjustment to maintain performance.

The RPD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement.

Once the RPD is calibrated, it shall not require recalibration to maintain performance unless the Roadway configuration changes.

The mean time between failures shall be ten (10) years, which is estimated based on manufacturing techniques.

**F. PHYSICAL PROPERTIES** - The RPD shall not exceed 4.2 lbs. (1.9 kg) in weight.

The RPD shall not exceed 13.2 in. by 10.6 in. by 3.3 in. (33.5 cm x 26.9 cm x 8.4 cm) in its physical dimensions.

All external parts of the RPD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.

**1. Enclosure** - The RPD shall be enclosed in a Lexan EXL polycarbonate.

The enclosure shall be classified "f1" outdoor weatherability in accordance with UL 746C.

The RPD shall be classified as watertight according to the NEMA 250 standard.

The RPD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- a. External icing (NEMA 250 clause 5.6)
- b. Hose-down (NEMA 250 clause 5.7)
- c. 4X corrosion protection (NEMA 250 clause 5.10)
- d. Gasket (NEMA 250 clause 5.14)

The RPD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

The RPD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

**G. ELECTRICAL** - The RPD shall consume less than 10 W.

The RPD shall operate with a DC input between 9 VDC and 28 VDC.

The RPD shall have onboard surge protection.

**H. COMMUNICATION PORTS** - The RPD shall have 2 communication ports, and both ports shall communicate independently and simultaneously.

2 independent communication ports allow 1 port to be used for configuration, verification and traffic monitoring without interrupting communications on the dedicated data port.

The RPD shall support the upload of new firmware into the RPD's non-volatile memory over either communication port.

The RPD shall support the user configuration of the following:

Response delay

Push port

The communication ports shall support a 9600 bps baud rate.

**I. RADAR DESIGN** - The RPD shall be designed with a matrix of 16 radars.

The matrix of 16 radars enables the sensor to provide detection over a large area and to discriminate lanes.

**1. Frequency Stability** - The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

This specification ensures that, during operation, the RPD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality. Analog and microwave components within an RPD have characteristics that change with temperature variations and age. If the output transmit signal is not referenced to a stable frequency source, then the RPD is likely to experience unacceptable frequency variations which may cause it to transmit out of its FCC allocated band and thus will be non-compliant with FCC regulations.

The RPD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

Temperature-based compensation techniques have been shown to be insufficient to ensure transmit frequency stability. One reason this type of technique is not sufficient is that it does not compensate for frequency variations due to component aging.

The bandwidth of the transmit signal of the RPD shall not vary by more than 1 percent under all specified operating conditions and over the expected life of the RPD.

The bandwidth of an RPD directly affects the measured range of a vehicle. A change in bandwidth causes a direct error in the measured range, i.e., a 5 percent change in bandwidth would cause a range error of 10 ft. (3 m) for a vehicle at 200 ft. (61 m). If the bandwidth changes by more than one percent due to seasonal temperature variations and component aging, then the RPD will need to be frequently reconfigured to maintain the specified accuracy.

**2. Antenna Design** - The RPD antennas shall be designed on printed circuit boards.

Printed circuit board antennas eliminate the need for RF connectors and cabling that result in decreased reliability. Printed circuit antennas are less prone to physical damage due to their extremely low mass.

The vertical beam width of the RPD at the 6 dB points of the 2-way pattern shall be 65 degrees or greater.

The antennas shall cover a 90 degree horizontal field of view.

The sidelobes in the RPD 2-way antenna pattern shall be -40 dB or less.

Low sidelobes ensure that the performance from the antenna beam widths is fully achieved.

**3. Resolution** - The RPD shall transmit a signal with a bandwidth of at least 245 MHz.

The bandwidth of the transmit signal translates directly into radar resolution, which contributes directly to detection performance. For example, an RPD that transmits at a low bandwidth will have low radar resolution, which could cause it to count a single vehicle as 2 vehicles in adjacent lanes. As another example of the adverse effects of low radar resolution, the response from a sign or other radar target in the Roadway may spill over into the lanes of travel and desensitize the radar. In order to achieve the specified detection accuracy in a variety of conditions, the unwindowed radar resolution cannot be larger than 2 ft. (0.6 m) at the half-power level, which requires a bandwidth of 240 MHz. The high radar resolution reduces the problem of vehicle responses getting drowned out by brighter vehicles in adjacent lanes and improves performance for moving and stopped vehicles near roadway targets.

**4. RF Channels** - The RPD shall provide at least 8 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

**5. Verification** - The RPD shall have a self-test that is used to verify correct hardware functionality.

The RPD shall have a diagnostics mode to verify correct system functionality.

## J. CONFIGURATION

**1. Auto-configuration** - The RPD shall have a method for automatically defining traffic lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RPD and shall not require an external PC or other processor.

The auto-configuration process shall work under normal intersection operation and may require several cycles to complete.

- 2. Manual Configuration** - The auto-configuration method shall not prohibit the ability of the user to manually adjust the RPD configuration.

The RPD shall support the configuring of lanes, stop bars and detection zones in 1-foot (0.3-m) increments.

When lanes have variable widths or have variable spacing (e.g. gore between lanes), precise resolution is necessary.

- 3. Windows® Mobile-based Software** - The RPD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation.

A visual representation of traffic patterns allows an installer to quickly associate specific detections with corresponding vehicles, and it facilitates verification of RPD performance.

The RPD shall include the ability to do counting and pulsed channels.

The graphical interface shall operate on Windows Mobile, Windows XP, Windows Vista and Windows 7 in the .NET framework.

The software shall support the following functionality:

- a. Operate over a TCP/IP connection
- b. Give the operator the ability to save/back up the RPD configuration to a file or load/restore the RPD configuration from a file
- c. Allow the backed-up sensor configurations to be viewed and edited
- d. Provide zone and channel actuation display
- e. Provide a virtual connection option so that the software can be used without connecting to an actual sensor
- f. Local or remote sensor firmware upgradability

- K. OPERATING CONDITIONS** - The RPD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.

RPD operation shall continue in rain up to 1 inch (2.5 cm) per hour.

The RPD shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F (-40°C to 74°C).

The RPD shall be capable of continuous operation over a relative humidity range of 5 percent to 95 percent (non-condensing).

## L. TESTING

- 1. FCC** - Each RPD shall be certified by the Federal Communications Commission (FCC) under CFR 47, part 15, section 15.249 as an intentional radiator.

The FCC certification shall be displayed on an external label on each RPD according to the rules set forth by the FCC.

The RPD shall comply with FCC regulations under all specified operating conditions and over the expected life of the RPD.

- 2. NEMA TS 2-2003 Testing** - The RPD shall comply with the applicable standards stated in the most recent version of NEMA TS 3-2009. Third party test results shall be made available for each of the following tests:

- a. Shock pulses of 10 g, 11 ms half sine wave
- b. Vibration of 0.5 g up to 30 Hz
- c. 300 V positive/negative pulses applied at 1 pulse per second at minimum and maximum DC supply voltage
- d. Cold temperature storage at -49°F (-45°C) for twenty-four (24) hours
- e. High temperature storage at 185°F (85°C) for twenty-four (24) hours

- f. Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
- g. Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- h. High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- i. High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

**M. MANUFACTURING** - The RPD shall be manufactured and assembled in the USA.

The internal electronics of the RPD shall utilize automation for surface mount assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

The RPD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of forty-eight (48) hours duration or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased RPD by serial number, upon request.

**N. SUPPORT** - The RPD manufacturer shall provide both training and technical support services.

- 1. Training** - The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the RPD to ensure accurate RPD performance.

The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.

Classroom lab training shall involve presentations outlining and defining the RPD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual RPD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- a. Knowledgeable trainer or trainers thoroughly familiar with the RPD and its processes
- b. Presentation materials, including visual aids, printed manuals and other handout materials for each student
- c. Computer files, including video and raw data, to facilitate the virtual configuration of the RPD
- d. Laptop computers or Windows CE handheld devices with the necessary software, and all necessary cables, connectors, etc.
- e. All other equipment necessary to facilitate the virtual configuration of the RPD

Field training shall provide each trainee with the hands-on opportunity to install and configure the RPD at roadside.

Training shall be such that each trainee will mount and align the RPD correctly.

- 2. Technical Assistance** - Manufacturer-provided technical support shall be available according to contractual agreements, and a technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RPD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of RPDs should such services be required.

**O. DOCUMENTATION** - RPD documentation shall include an instructional training guide and a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.

The RPD manufacturer shall supply the following documentation and test results at the time of the bid submittal:

- FCC CFR 47 certification (frequency compliance)

IED 6100-4-5 class 4 test report (surge)

- P. WARRANTY** - The RPD shall be warranted free from material and workmanship defects for a period of two (2) years from date of shipment.

The advertised detection accuracy of the company's sensors is based on both external and internal testing, as outlined in each product's specification document. Although our sensors are very accurate by industry standards, like all other sensor manufacturers we cannot guarantee perfection or assure that no errors will ever occur in any particular applications of our technology. Therefore, beyond the express Limited Warranty that accompanies each sensor sold by the company, we offer no additional representations, warranties, guarantees or remedies to our customers. It is recommended that purchasers and integrators evaluate the accuracy of each sensor to determine the acceptable margin of error for each application within their particular system(s).

## 825.17 RADAR PRESENCE DETECTOR INSTALLATION

- A. GENERAL** - This item shall govern the installation of an aboveground radar presence detector (RPD).

RPDs can provide accurate, consistent, and reliable presence detections provided they are installed properly. The requirements in this specification are intended to ensure proper RPD installation.

### B. MOUNTING AND INSTALLATION

- 1. Mounting Assembly** - The RPD shall be mounted directly onto a mounting assembly fastened to a mast arm, pole or other solid structure.

The RPD mounting assembly shall provide the necessary degrees of rotation to ensure proper installation.

The RPD mounting assembly shall be constructed of weather-resistant materials and shall be able to support a 20-lb. (9.1kg) load.

- 2. Mounting Location** - The RPD shall be mounted at a height that is within the manufacturer's recommended mounting heights.

The RPD shall be mounted at an offset from the first lane that is consistent with the RPD's minimum offset.

The RPD shall be mounted so that at least 20 feet along the farthest lane to be monitored is within the field view of the RPD.

The RPD shall be mounted with its cable connector down and shall be tilted so that the RPD is aimed at the center of the lanes to be monitored. Typically, the RPD is tilted off of vertical by 20–30 degrees.

The RPD shall be mounted on a vertical signal pole or on the horizontal mast arm.

The RPD shall be mounted so that its field of view is not occluded by poles, signs or other structures.

RPDs that are mounted within 20 feet (6.1 m) of each other or that are monitoring the same intersection shall be configured to operate on different RF channels regardless of the pointing direction of the RPDs.

It is recommended that the manufacturer be consulted to verify final RPD placement if the RPD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored Roadway.

- 3. Cabling** - The cable end connector shall meet the MIL-C- 26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells.

The cable shall be the Orion Wire Combo-2204-2002-PVCGY or an equivalent cable that conforms to the following Specifications:

- a. The RS-485 conductors shall be a twisted pair.
- b. The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 40 pF/ft at 1 kHz.



- c. The RS-485 conductors shall have nominal conductor DC resistance of less than 16.7 ohms/1000 ft. (304.8 m) at 68°F (20°C).
- d. The power conductors shall be 1 twisted pair with nominal conductor DC resistance of less than 11.5 ohms/1000 ft. (304.8 m) at 68°F (20°C).
- e. Each wire bundle or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

The cable shall be terminated only on the 2 farthest ends of the cable.

The cable length shall not exceed 2000 ft (609.6 m) for the operational baud rate of RS-485 communications (9.6 Kbps).

If 12 VDC is being supplied for the RPD then the cable length shall not exceed 110 ft. (33.5 m).

If 24 VDC is being supplied for the RPD then the cable length shall not exceed 600 ft. (182.9 m).

Both communication and power conductors can be bundled together in the same cable as long as the abovementioned conditions are met.

- 4. **In Cabinet Interface Equipment** - The RPD shall be installed using a Preassembled Traffic Cabinet Backplate or an equivalent that provides input power surge suppression, sensor cable surge suppression, AC to DC power conversion (if necessary), and terminal blocks. The surge protection devices shall meet or exceed the EN 61000-4-5 Class 4 Specifications.
- 5. **Power Supply** - If needed, the RPD shall be installed using a Din Rail mounted AC to DC power converter that meets the following Specifications:

The power converter shall be power rated at 48 W for temperatures less than 140°F (60°C) with a 5% power decrease for each degree increase up to 158°F (70°C).

The power converter shall operate in the temperature range of to -29.2°F to 165.2°F (-34°C to 74°C).

The power converter shall operate in the humidity range of 5% to 95% at 77°F (25°C) non-condensing.

The power converter shall accept an input voltage of 85 to 264 VAC or 120 to 370 VDC.

The power converter shall operate at an input frequency of 47 Hz to 63 Hz.

The power converter shall produce an output voltage of 24 VDC ±4%.

The power converter shall withstand a voltage across its input and output of 2 kV. The power converter shall withstand a voltage across its input and ground of 1.5 kV.

The power converter shall conform to safety standards UL 60950 and EN 60950.

The power converter shall conform to EMC standards EN 55022 Class B and EN 61000-3-2, 3.

In brown-out conditions (i.e. < 85 VAC input), the output voltage of the power converter shall be less than 1 VDC.

The terminal blocks shall be color-coded insulation displacement terminal blocks.

The terminal blocks shall be prewired to the other in-cabinet equipment so that no wiring other than cable terminations, connecting input power and connecting input file cards shall be required during installation.

- 6. **Input File Cards** - The input file cards that meet the following Specifications shall be used.

The input file cards shall be compatible Department's 336SS cabinet.

The input file card shall translate data packets from the RPD into contact closure outputs.

The input file card shall support presence detection.

The input file card shall receive data packets over an RS-485 bus at a baud rate of 9600 bps.

The input file card shall auto-baud and auto-detect an RPD over wired and wireless communication channels that have a maximum latency of 500 ms.

**825.18 MICROWAVE VEHICLE DETECTOR**

**A. PURPOSE** - The purpose of this specification is to describe the minimum acceptable requirements for microwave vehicle detectors.

**B. GENERAL TECHNICAL REQUIREMENTS**

1. The unit shall be capable of detecting a motion of every type of vehicle permitted to operate in the public Roadway.
2. The unit shall be capable of detecting motion in 1 direction, and ignoring motion in the opposite direction from that being detected.
3. The range of detection shall be from 3 feet to 100 feet.
4. The cone of the detector shall be based upon a 16 degree field of view. For example, at a distance of 60 feet from the detector, the field of the detection should be 18.5 feet wide..
5. The detector shall be equipped with 2 field adjustment controls; 1 control shall be for range, and the other control shall be for time delay extension.
6. The extension timer shall be capable of extending the detector output for at least one-half (0.5) seconds to seven-and-a-half (7.5) seconds. The extension shall begin with the termination of the detected vehicle output and shall continue for the duration of the selected extension time interval.
7. No individual component of this detector shall be of such design, fabrication, nomenclature, or other identification as to preclude the purchase of said component from any wholesale electronic distributor.
8. 1 isolation module with 12 VAC output shall be supplied with each microwave vehicle detector unit in order to ensure operation of this detection device with the Type 170 Microprocessor Based Traffic Signal controller.

**C. MECHANICAL CONSTRUCTION**

1. Each detector shall be encased in a finished, fabricated aluminum case with a square, high impact plastic opening in the front of the unit's antenna. The size of this opening shall not exceed 4 inches by 4 inches.
2. Each detector housing shall be water resistant. Water resistance shall be attained without the use of substances such as silicon gels, w. Which deteriorate in the presence of ultraviolet rays.
3. The size of the detector shall be: HEIGHT – 4.5 inches, WIDTH – 4.5 inches, DEPTH – 7.5 inches.
4. A mounting bracket shall be supplied with each detector unit. The bracket shall come complete with all hardware needed to affix the detector unit to the bracket, and the bracket to the pole or mast arm. It shall be possible to securely affix the bracket to all types of street light and traffic signal poles currently in use in the District of Columbia.
5. 2 types of mounting brackets shall be available; 1 for the overhead mounting of the device, and 1 for side of the pole mounting. These may be interchangeable. The user will specify individually the type of mounting bracket required.

**D. ENVIRONMENTAL REQUIREMENTS** - The detector shall be capable of continuous operation over a temperature range of -35 degrees F to +165 degrees F.

**E. FUNCTIONAL REQUIREMENTS**

1. The microwave detector unit must have a Federal Communications Commission (F.C.C.) certification.
2. The detector shall operate at the frequency of 10.525 Ghz, as permitted under F.C.C. Rules, Part 15.
3. The detector unit shall contain an electro-mechanical, 2 AMP SPDT Relay to send a signal from the detector to the intersection traffic signal controller.
4. The detector shall be self-contained, except for the power source, which will operate at both 10 VAC to 24 VAC and 12 VDC. See 825.19 for the technical specification for the isolation module with 12 VAC output for interface requirements between the microwave vehicle detector and the Type 170 Microprocessor based traffic signal controller.

5. The detector unit shall employ a circuit for power failure to put the relay into a closed position (recall), during a power failure. Upon resumption of electrical service to the detector unit, the relay shall be activated to return the unit to proper actuation of the vehicles.
6. The detector unit shall have a monitoring circuit for the transceiver (Gunn diodes) that will failsafe the relay to a closed (recall) position.
7. Tuning shall be automatic, except for the range adjustment. Diodes shall be allowed a five (5) minute warm-up period. There shall be no tuning controls of any kind requiring an operator.
8. The detector unit shall function either on an overhead mast arm mount, or mounted to the side of the pole. The detector shall operate at a height in the range of 12 feet to 22 feet above the Roadway grade.
9. The detector unit shall contain on the printed circuit board an LED light for activation, and an LED light signifying component failure.

#### F. MANUFACTURERS' REQUIREMENTS

1. The manufacturer shall test all microwave detector units before they are shipped, and attest, in writing, that each individual unit satisfies F.C.C. Specifications.
2. The manufacturer shall be required to furnish a statement attesting to the fact that the microwave detector unit in no way compromises public safety; specifically, they do not cause interference with pacemakers and similar electronic devices which may be used to sustain life.

### 825.19 MICROWAVE VEHICLE DETECTOR ISOLATION MODULE WITH 12 VAC OUTPUT

#### A. PURPOSE

1. The purpose of this specification is to describe the minimum acceptable requirements for a single channel isolation module with a 12 VAC output.
2. The isolation module shall be a rack mounted device for use in a Type 170 Microprocessor Based Traffic Signal Controller with a Model 336 S or a Model 336 SS ground mounted cabinet. The isolation module shall act as an interface between the controller unit and the microprocessor based microwave detector unit mounted in the field. The isolation module will also supply a low voltage power source for the operation of the microwave vehicle detector.

#### B. GENERAL TECHNICAL REQUIREMENTS

1. The module is a unit containing 1 isolated channel and one 12 V power supply channel. Each module shall work independently. It shall provide isolation between electrical external to the module and microcomputer input.
2. The 12 VAC supply will power the lower channel with 750 MA of power to supply the detectors.
3. 1 isolation module with 12 VAC output shall be supplied with each microwave vehicle detector unit.

#### C. ELECTRICAL REQUIREMENTS

1. **Electrical Input Interface** - Each isolation channel input shall be turned on (true) when the resulting contact closure causes an input voltage less than 8 VDC, and shall be turned off (false) when the resulting contact opening causes the input voltage to exceed 12 VDC. Each input shall deliver no less than 15 nor more than 20 MA to an electrical contact closure or short from the internal 24 volt supply.
2. **Isolation** - The minimum isolation shall be 1 billion ohms and 2,500 VDC from input to output.
3. **Lightning Protection**
  - a. Lightning protection shall be installed inside the isolation module.
  - b. The lightning protection shall enable the isolation module between either the input signal, the signal common, or the Earth ground to withstand the discharge of up to 20 joules of energy at a maximum peak current of 500 amps for one (1) microsecond.

4. **Power Supply Unit** - A 12 VAC, 0.750 mA transformer shall be installed on the PC board to supply the AC power for the external detectors. The transformer shall be of such design as to be used on a single rack location.

#### D. FUNCTIONAL REQUIREMENTS

1. The Isolation module shall be mounted on an edge connected printed circuit board.
2. Each isolation channel shall not draw more than 0.400 mA from the 24 VDC cabinet supply for its operation.
3. The isolation module front panel shall be provided with a hand pull to facilitate insertion and removal from the rack enclosure.
4. The isolation channel shall have a front panel mounted indicator to provide visual indication of each electrical contact closure and a test switch to place an input on the isolation channel. Both the indicator and the switch shall be on the input side of the optical coupler. The test switch shall be a single pole-double throw, 3 position switch; momentary On, Off, and 1 maintained On positions. The contacts shall be either silver or coin silver with gold over nickel plate rated for 5A at 115 VAC.
5. Each isolation output shall be an optoisolated NPN open collector capable of sinking 50 mA at 30 V. This output shall be compatible with the Type 170 Controller Unit with a Model 336 S or a Model 336 SS Cabinet. Each isolation channel shall represent ground true logic to the controller unit inputs.
6. The front panel of the module shall be labeled as to model number and titled.

#### 825.20 LOOP DETECTOR SLOT SEALANT

The loop slot sealant shall be a 1-component, moisture-curing, flexible polyurethane, formulated to encapsulate loop wires embedded in asphaltic cement and Portland Cement Concrete pavements. The sealant shall remain flexible at all temperatures of -40°F and higher to protect the wire or cable from the stress of pavement movement. The flow characteristics of the sealant shall allow full depth wire encapsulation and resist flow-out on inclined roadways. Application equipment shall be capable of filling slots from the bottom up.

The sealant shall permit the Roadway to be opened to traffic over the slot immediately after application without tracking, sticking to vehicle tires, or pulling out of the slot. The cured sealant shall have the following performance characteristics when tests are conducted on de-aerated, 20 mil (0.020 inch) thick, dry film liquid immersion, after curing for twenty-eight (28) days at 77° F.

**TABLE 825.20**

Description	Specification Limits	Test and Conditions
Hardness	65- 85	ASTM D 2240 Rex, Type A, (Indentation) Model 1770, at 77° F and 50% relative humidity
Tensile Strength	500 psi, (minimum)	ASTM D 412 Die C, pulled at 20 fpm
Elongation	400%,(minimum)	ASTM D 412 Die C, pulled at 20 fpm.
Flex	No Cracks at -40°F	25 Mil Free Film Bend (180 degrees) over 1/2 inch mandrel
Weathering	Slight Chalking	ASTM D 8122 Weatherometer, Resistance350 hours. Cured 7 days at 77° F and 50 percent relative humidity

#### 825.21 CLAMP ON MAST ARM

- A. **PURPOSE** - The purpose of this specification is to define the minimum acceptable requirements for a clamp on mast arm and removable end cap.

#### B. MAST ARM

1. The length of the mast arm shall vary between 8 feet and 15 feet. The exact length to be provided shall be that specified on individual Project Plans.
2. The units to be supplied must be identical to those currently in service. The mast arm shall be made from one length of steel not less than No. 12 gauge, and shall conform to the requirements of ASTM A 570 Grade 50 steel. The mast arm shall be octagonal (octofluted) in cross section with a continuous taper of 0.17 inches to 0.23 inches per foot depending upon the length of the mast arm.

3. The design of the mast arm shall fully comply with the latest edition of AASHTO Specifications for loads, as specified. The manufacturers shall supply detailed Shop Drawings and load calculations for the Department approval prior to fabrication. The length of the mast arm shall be as specified on individual Project Plans with a removable end cap.

#### C. CLAMP

1. The clamp shall be made of the same material conforming to the ASTM A 216 (WCB). The clamp shall be fabricated so as to provide full contact around the existing fluted pole to which the mast arm is to be attached. The exterior of the 8 inch clamp shall be smooth and fluted to provide an aesthetically pleasing connection between the pole and the mast arm.
2. The clamp shall be fabricated to allow for arm elevation adjustments of 18 inches above or below the set mounting height.
3. A 2 inch diameter smooth wiring hole shall be provided in the clamp to facilitate the wiring of the signal head through the interior of the mast arm.
4. Each clamp shall be furnished with high strength galvanized connecting bolts. These bolts are to be furnished in accordance with the manufacturer's specification, and they shall be designed to safely support the weight of the mast arm and all signal heads currently in use in the District of Columbia.

#### D. FINISH

1. The mast arm, the clamp, and associated hardware shall be coated with fusion bonded polyester, or an epoxy polyamide primer followed by an aliphatic polyester polyurethane finish.
2. The total film thickness of the finish is to be 4.5 to 6.5 mils.
3. The color of the finish is to be DC Gray or Federal Black, as specified in Project Plans, or as directed by the Engineer. The color of the mast arm shall be the same as the color of the pole to which it is to be attached. The manufacturer shall supply a color chip for the Department review and approval prior to final finishing.
4. A 6 ounce can of touch up paint shall be supplied with each mast arm assembly.

**E. HANDLING** - Handling and shipping shall not be performed until all painted merchandise is thoroughly dry. All items shall be wrapped for shipment, delivered, and unloaded in such manner to eliminate the possibility of abrasions of the finish.

**F. SHOP INSPECTION** - All items shall be manufactured domestically. The manufacturer shall provide full access to Washington, D.C. inspectors during mast arm fabrication and finishing.

### 825.22 20-FOOT TALL STEEL TRAFFIC SIGNAL POLE

The purpose of this specification is to define the minimum acceptable requirements for a 20 foot long steel traffic signal pole.

The pole will be comprised of a shaft, a removable ornamental pole top finial, and a pole base casting welded to the shaft. A drawing showing pole details can be found in the Department Standard Drawings.

The shaft shall be fabricated from 11 gauge steel satisfying the requirements of ASTM – A 595 GRA with a yield point not less than 55,000 psi. The cross section shall be octoflute. The shaft diameter at the base of the pole shall be 6.50 inches and the diameter at the top of the pole shall be 3.70 inches. The shaft shall be continually and consistently tapered at a rate of 0.14 inches per foot. Poles that are not mounted on transformer bases shall feature a 3 inch by 5 inch hand hole with a reinforced frame and cover centered 12 inches above the base. The shafts shall be fabricated from open hearth sheet steel formed into a continuous tapered tube with 1 continuous longitudinal, automatically electrically welded seam; no intermediate or horizontal joints or welds are permitted.

The pole base casting shall be a 1 piece steel anchor base of grade 65-35 steel conforming to ASTM A 27. When the anchor base is welded to the shaft, it shall develop the full strength of the shaft section to resist bending action. The pole casting will feature four 1.25 inch diameter holes arranged so that the center of the holes form a 9.50 inch diameter bolt circle. A total of 4 ornamental cast leaf bolt covers secured with a 0.38 inch plated hex head cap screws shall be provided to conceal the hardware used to affix the pole to the top of the transformer base.

A removable ornamental pole top finial shall be sized and detailed in accordance with the Department Standard Drawings.

The shaft and the pole base casting shall be welded to form a continuous unit with a minimum yield strength of 55,000 psi. All traffic

signal poles intended for use on a bridge structure shall feature a vibration damper and damper pads. A vibration damper consisting of a weighted device will be attached inside the pole to dampen the vibration of the pole. The vibration damper will be suitable for mounting in steel poles and will be fabricated from corrosion resistant materials. The dampers will be factory installed and blocked in place during shipping. A damper pad will be provided at the base of each pole. The vibration and damper pads will be tested and the approved designed and certified copies of test reports will be submitted together with installation details for approval.

The arms will be fabricated from steel. The pole will be cleaned of all rolled-in mill scale, impurities, and non metallic foreign materials. The welds will be clean of all wax flux. The pole is to be degreased by immersion into a heated, caustic solution, and subsequently pickled in a heated sulfuric acid solution. The base will then be rinsed in a fresh water bath to remove any residual effects of the caustic or the acid baths. The pole will then be immersed in a concentrated ZINC ammonium chloride solution and allowed to air dry before being galvanized. The pole is to be hot-dip galvanized to the requirements of either ASTM A 123, or ASTM A 153. The final galvanized coating shall be free of any debris or flux ash.

All galvanized exterior surfaces visually exposed are to be coated with a Urethane or Triglycidyl Isocyanurate (TGIC) polyester powder to a minimum dry film thickness of 2.0 mils. Prior to application, the surfaces to be powder coated are to be mechanically etched by brush blasting (ref. SSPC-SP7) and the zinc coated substrates preheated to 450 degrees F. for a minimum of one (1) hour in a gas-fired convection oven. The coating is to be electrostatically applied and cured by elevating the zinc coated substrate temperature to a minimum of 350 degrees F. in a gas convection oven. The color will either be DC Battleship Gray matching Federal Color Chip Number 16099 or Federal Black. The color of each pole will be determined by the Engineer prior to final coating.

Traffic signal poles shall be identical in design, materials, and workmanship to those currently in inventory and in use in the District of Columbia. It shall be the responsibility of the Contractor to survey existing poles and to supply exact duplications of those poles currently in use. The assembled pole shall be of such design and construction as to be capable of withstanding, when installed with attachments, a static wind load of 80 MPH. The technical Specifications for galvanized steel transformer bases contain technical Specifications for anchor bolts and for hardware to attach poles to the transformer bases. The Contractor shall use these anchor bolt Specifications in the event that traffic signal poles are supplied without transformer bases.

The pole will be wrapped in either a 3/16 inch U.V. inhibited plastic backed packing foam or cradled in a 1 inch rubberized foam base. The arms will be wrapped in a 3/16 inch U.V. inhibited plastic packed packing foam.

As part of the catalog cuts, the Contractor shall submit to the Department copies of the following certifications:

- A. That the welds meet the requirements of AWS D1.1.
- B. Documentation certifying that all materials are in full compliance with each of the ASTM numbers referenced in this specification.
- C. A copy of the factory certification that it meets the requirements of the American Institute of Steel Construction (AISC) category.

### **825.23 GALVANIZED STEEL TRANSFORMER BASE**

The transformer base shall have dimensions as detailed in the drawing entitled GALVANIZED STEEL TRANSFORMER BASE, as featured in the Department Standard Drawings.

The transformer base shall be fabricated from hot rolled carbon steel meeting ASTM A 36. The transformer base shall be 20 inches high, 16 inches square at the base and 13 inches square at the top. The top and bottom plates shall be made of 0.75 inch minimum thickness steel plate. The sides of the transformer base shall be constructed from 7 gauge steel. 1 side of the transformer base shall feature a trapezoidal door made of 11 gauge steel. The door opening in the transformer base shall be 13.25 inches tall, 8.50 inches wide at the top and 9-7/8 inches wide at the base. The door shall be secured at the top with a stainless steel piano-type hinge designed so that the door opens by rotating up around the top hinge. The door shall be secured in place by an approved locking device.

The bottom of the transformer base shall feature four 1.25 inch diameter holes (1 at each corner) arranged so that the center of the holes form a 15 inch diameter bolt circle. The foundation anchor bolts will protrude through these holes.

The top of the transformer base shall feature 4 slots in an oval pattern measuring 1.28 inches by 2.03 inches (1 at each corner) aligned so that the inside of the slots are arranged to form a 9.5 inch bolt circle, and so that the outside of the slots are arranged to form an 11.0 inch bolt circle. Bolts attaching the pole to the top of the transformer base will protrude through these holes.

The transformer base will be provided with 4 loose steel plate anchor clips to fasten the base to the foundation anchor bolts. Each transformer base shall feature a 0.50 inch nut holder to secure the ground cable. Each transformer base shall also be provided with four

1"X3" galvanized steel bolts with nuts and washers to secure the pole shaft to the top of the transformer base. Each transformer base shall also be provided with four 1 inch X 40 inch anchor bolts with washers, nuts and shims to secure the transformer base to the pole foundation. The anchor bolts shall be made from steel conforming to ASTM A 36 Grade C. The anchor bolts, nuts, and washers shall be galvanized in accordance with ASTM A 36 Grade C. The anchor bolts, nuts and washers shall be galvanized in accordance with ASTM A 153. 1 end of the 40 inch long anchor bolt shall be provided with at least a 4 inch long right angle hook.

The transformer base shall be cleaned of all rolled-in mill scale, impurities, and non metallic foreign materials. The welds shall be cleaned of all weld flux. The transformer base is to be degreased by immersion into a heated caustic solution, and subsequently pickled in a heated sulfuric acid solution. The transformer base will then be rinsed in a fresh water bath to remove any residual effects of the caustic or the acid baths. The transformer base will then be immersed in a concentrated zinc ammonium chloride solution and allowed to air dry before being galvanized. The transformer base, the door and the anchor clips are to be hot-dip galvanized to the requirements of either ASTM A 123 or ASTM A 153.

The final finish of the transformer base shall remain in its galvanized state or painted DC Gray or Federal Black to match the color of the pole mounted on the transformer base. The Department Project Engineer will make the final determination of the required finish prior to the procurement of the transformer base.

#### **825.24 LIGHT EMITTING DIODE (LED) ELECTRONIC SIGN**

**A. DESCRIPTION** - Work under this item includes provision of acceptable design and operating requirements for Light Emitting Diode (LED) Electronic Signs, for display of specific messages, as required in the Contract Documents.

**B. GENERAL REQUIREMENTS** - All sign messages shall meet the standards contained in the most recent edition of the Manual on Uniform Traffic Control Devices, and Standard Highway Signs, unless otherwise indicated.

All sign messages shall be at least standard size, as defined in the Standard Highway Signs. Signs shall have message display capabilities on both sides of the sign. Signs shall be capable of displaying 1 or more multiple messages on each side of the sign.

Sign messages shall be formed of rows of Light Emitting Diodes (LEDs).

Sign messages shall be clear and legible under any ambient lighting condition. When not illuminated, the sign message shall not be visible regardless of outside ambient lighting conditions.

Signs shall be no more than 8 inches in depth, excluding the visor. All sign messages shall be displayed at full intensity within a 15° cone of vision centered about the optical axis. Signs shall be provided in 3 sizes:

1. 18 inches by 24 inches. This sized sign shall be clear and legible at distances up to 200 feet.
2. 30 inches by 30 inches. This sized sign shall be clear and legible at distances up to 500 feet.
3. 36 inches by 36 inches. This sized sign shall be clear and visible at distances up to 500 feet.

The sign assembly shall be designed to ensure that all internal components are adequately supported to withstand mechanical shock and vibration from wind ratings meeting AASHTO requirements for sustained winds of 80 mph with a 30 percent gust factor.

Unless otherwise specified, only red and lunar white LED shall be used to portray messages. Red shall be used to form all letters, one way arrows, and the left turn arrow in the symbolic No Left Turn sign.

Each sign delivered to the District of Columbia must include a full complement of 6 drive modules in the driver rack. Drive modules not used for the sign application shall be retained by the District of Columbia for maintenance purposes.

Each sign delivered to the District of Columbia must include 2 visors; 1 to be mounted on the sign during field installation, and 1 to be used for future maintenance purposes.

#### **C. SIGN HOUSING CONSTRUCTION**

**1. General** - The sign housing shall be fabricated from extruded aluminum with a minimum thickness of 0.125 inches.

Signs featuring messages on 1 side of the sign only shall feature a flat aluminum panel welded to the back of the housing.

All housing corners and seams shall be heli-arc welded to provide and ensure a weatherproof seal around the entire housing.

The housing shall meet the requirements of NEMA Type 4 enclosures

The housing shall be reinforced as necessary at proper locations to provide structural integrity.

Each sign housing shall include 4 screened holes, 3/16 inch in diameter at the bottom of the housing.

**2. Housing Door** - Each sign housing shall include an extruded aluminum door with minimum thickness of 0.125 inches.

Each door shall be appropriately welded and reinforced for structural integrity and to prevent excessive door flexure when open.

Each door shall include a drip edge around the mating flange.

The extruded aluminum sign door shall be hinged on the left side with a continuous, full length stainless steel hinge.

Each door shall be locked on the right side of the sign using a minimum of 2 Number 3 stainless steel ¼ turn link-locks to allow tool free access to the interior of the sign.

Door gaskets shall be 3/16 inch x 1 inch neoprene and shall provide a continuous weatherproof seal between the door and the housing.

1 side of the door shall be removable to allow access to the sign face.

A retaining rod shall be provided to hold the front door in the open position.

**3. Mounting Hubs** - Each sign housing shall feature mounting hubs on the top and the bottom of the sign for cable access and to facilitate mounting and affixing to poles.

Mounting hubs shall be cast aluminum alloy with 1-½ inch standard pipe threads.

Hubs are to be mounted on a gasket to the sign housing by three 5/16 x 1 inch stainless steel hex head bolts and nuts.

Gaskets shall be serrated and shall lock into the housing to prevent sign mis-alignment. The connection between the sign housing and the mounting hubs shall be waterproof. The holes in the sign housing at the mounting hubs shall be 1-½ inches in diameter and shall be machined to eliminate burrs that may snag electrical cables.

**4. Visor** - The entire housing shall feature a visor that extends over the top and both sides of the sign.

Each visor shall be 0.063 inch thick aluminum.

Each visor shall be six6 inches in length and shall extend off the housing door. Each visor shall be affixed to the sign housing using stainless steel screws.

**5. Face Lens** - The face lens shall fit into the door. The entire sign face shall be protected by a ¼ inch clear polycarbonate lens in the door frame.

The lens shall be non-glare matte-finished polycarbonate with UV resistant surface treatment and light transmission properties of at least 82 percent.

The lens shall minimize all unwanted reflections.

The entire display face, including the face lens and the LED Message Display Board, shall be assembled as a 1-piece self-contained module that can be easily removed from the sign housing without the need of any tools.

**6. Sign Finishes** - The entire sign housing shall be acid etched and painted with 2 coats of zinc chromate primer.

The interior of the sign housing assembly and the inside of the visor shall be painted with 2 coats of high quality flat black enamel.

The exterior of the sign housing, sign door frame, and the outside of the visor shall be painted with 2 coats of high quality enamel, colored battleship gray (MVC 1417, GE LEXAN No. 7040Z, Federal Color No. 16099). In certain specified applications, Federal Black, Color No. 27038 may be substituted for battleship gray.



- 7. **Vents** - 2 air vents shall be installed on the sides of the housing; 1 at the lower left hand side and 1 at the upper right hand side of the sign. Vents shall be designed to prevent moisture or rainfall from penetrating the housing and both shall have replaceable air filters to keep the enclosure dust-free.
- 8. **Modularity** - The sign construction shall be of a modular configuration consisting of hand- removable, self-contained modules, message display, rack-mounted individual message drivers, driver rack assembly and the housing shell.
- 9. **Fasteners and Hardware** - All mechanical fasteners and hardware shall be corrosion- resistant stainless steel.
- D. **ENVIRONMENTAL REQUIREMENTS** - The sign shall be rated for use in ambient operating temperatures in the range of minus 40 ° C (minus 40 ° F) to plus 74 ° C (plus 165 ° F). The LED display module shall be completely sealed against dust and moisture intrusion in conformance with NEMA Moisture Resistant Standard 250-1991, Section 4.7.2.1 and 4.7.3.2 for Type 4 enclosures to protect all internal components.
- E. **CHROMATICITY** - The measured chromaticity coordinates for red, yellow, green, lunar white and Portland orange shall conform to the chromaticity requirements of section 8.04 and Figure 1 of the VTCSH Standards. Chromaticity requirements shall remain unchanged over the input line voltage of 95 VAC to 135 VAC.

The measured chromaticity coordinates of LEDs shall conform to the following requirements:

**TABLE 825.24**

<b>RED</b>	Y	not greater than 0.308 or less than 0.998 – X
<b>YELLOW</b>	Y	not less than 0.411, not less than 0.995 – X, not less than 0.452
<b>GREEN</b>	Y	not less than 0.506 – 0.519 X, nor less than 0.150 + 1.068 X, not more than 0.730 – X
<b>PORTLAND</b>	Y	not greater than 0.390, not less than 0.331, nor less than 0.997 – X
<b>LUNAR WHITE</b>	X	not less than 0.290 nor greater than 0.330
	Y	not less than 1.5X-0.175, or greater than 1.5X-0.130

- F. **LED MESSAGE DISPLAY BOARD** - The message display shall consist of LEDs mounted on a PCB Matrix with a matte black solder mask. The universal PCB matrix shall have the capabilities to display sign messages conforming to MUTCD requirements. LEDs shall be arrayed on the mat to depict the required message.
 

The LEDs shall be arranged in a manner to form the outline of the symbols and shall be distributed evenly along the message outline.

The maximum distance between consecutive LEDs shall be .550 inches and shall vary by more than 10 percent.

The PCB matrix shall have a maximum thickness of 0.93 inches. The PCB shall have a component identifier screen.

The red LEDs shall be of the latest Alln GaP Technology; the lunar white LEDs shall be of the latest In GaN Technology.

The minimum nominal luminous intensity of the LEDs shall be 6,000 mcd at 20mA.

The individual LED light sources shall be interconnected so that a catastrophic failure of a single LED will result in a total loss of not more than 5 percent of the signal light output.

There shall be no electronic components visible from the front of the display. The display face shall consist solely of LEDs mounted on a mat black PCB.

The rear side of the PCB shall be protected by a molded polymeric back cover to seal and protect it from any possible damages.

The display PCB with back cover shall fit into the front door which consists of an aluminum frame and face lens.

The display module shall have a multi-conductor cable with an individual 2-pin connector for each message.
- G. **DRIVE CIRCUITRY** - The sign shall feature 1 individual LED drive module for each message. A drive module shall be provided for each individual symbol, for each message line and for each overlapped message on any given line. The drive modules shall be designed to be rack-mounted as per standard industry dimensions of 6.5 inches x 4.5 inches.

The drive modules shall consist of a PCB (0.62 inches in thickness) with an aluminum front plate and handle, as used for inductive loop detectors.

The drive modules shall drive the LEDs at a DC current not exceeding the maximum rating as recommended by the LED manufacture (20 mA).

The drive modules shall regulate the LED drive current to compensate for line voltage fluctuations over a range of 95 VAC to 135 VAC. The luminous output of the display shall not vary more than 10 percent over the voltage range and shall not be perceptible to the human eye.

The drive modules shall be fused and shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in the current version of NEMA Standard TS-2.

The on-board circuitry shall meet FCC title 47, sub-part B, section 15 regulations concerning the emission of electronic noise. The circuitry shall ensure compatibility and proper triggering and operation of load switches and conflict monitors in signal controllers currently in use in the District of Columbia.

The drive modules shall have a capacity of 25 watts. The modules shall be designed to maintain a constant LED drive current regardless of the outside temperature, within a range of minus 30 ° C to + 40 ° C.

The drive modules shall be designed to dim automatically based on the ambient light level. In order to reduce the long-term degradation of LEDs, the automatic dimming circuit shall be tuned to reduce the light intensity of the display by 35 percent. The dimming circuit shall have a thirty (30) second delay to prevent interference caused by shadows or headlights. LED drive current shall be regulated effectively when in the dimmed state.

The drive modules shall be designed to monitor the proper operation of the message display and to provide an alarm if the display is not operational. The drive modules shall be capable of providing a confirmation or alarm signal which can be configured for 120 Vac or 24 Vdc PLC application (sinking or sourcing type). In the event of a malfunction in 1 sign drive module rendering that part of the message blank, the monitoring circuit shall detect the malfunction and disable all other drive circuits displaying a blank sign to prevent any possible conflict.

Drive modules shall include a green LED for power status and a red LED for alarm status. All electronic components shall be standard industry type, available from wholesale electronic distributors.

**H. DRIVER RACK ASSEMBLY** - The driver rack assembly shall be a single part self contained module consisting of an interconnect PCB and an ionized aluminum frame. The driver rack shall have the capacity to house up to 6 drive modules.

The aluminum rack shall be vented from top to bottom and shall include latches to secure the modules in place. The rack assembly shall be secured in the sign enclosure by 4 captive type spring-loaded thumbscrews. The entire assembly shall be removable in less than one (1) minute without the need of any tools.

The interconnect PCB shall include connectors for six6 drive modules and six6 display messages. The interconnect PCB shall include terminals for all field wiring, 120VAC controls, external photocell, and alarm signals. The field wiring and display terminals shall be spring-loaded, anti-vibration type.

All interconnections within the sign shall be accomplished through the PCB. No internal wiring shall be permitted with the exception of a single cable for the message display.

The interconnect PCB shall be equipped with a 10 position binary switch for each message to allow the drive current to be calibrated for each individual message and to increase drive current in case of long-term degradation to LEDs. Each step shall provide a 1mA increment up to a maximum of 25 mA.

All connectors and terminals shall be identified via the silk screen identifier on the surface of the PCB.

The driver rack assembly shall be mounted on the left side of the sign enclosure.

All PCBs shall be mounted vertically to facilitate air-cooling and to prevent collection of dust and moisture.

**I. ELECTRICAL REQUIREMENTS** - The sign power rating shall not exceed 15 watts per message. Each sign shall operate from a 60HZ  $\pm$ 3HZ AC line over a voltage ranging from 95 volts to 135 volts. Fluctuations in line voltage shall have no visible effect on

the luminous intensity of the sign message. The operating voltage of the LEDs shall be 120 volts AC. All operating parameters shall be measured at this voltage. Sign circuitry shall prevent perceptible flicker to the unaided eye over the 95 to 135 volt range.

The sign's on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients as stated in the current version of the NEMA Standard TS-2.

Each sign and associated on-board circuitry shall be in compliance with FCC noise regulations and must meet FCC Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

Each sign shall be operationally compatible with controller assemblies and peripheral equipment including solid state load switches, flashers, and conflict monitors currently in use in the District of Columbia. Current controller Specifications are available for review at the specific request of the Contractor or vendor. Each sign shall feature control circuitry to prevent current flow through the LED module in the off state to avoid any false indication as may be perceived by the human eye during daylight and evening hours.

All LEDs will have an expected lifetime of 100,000 hours.

- J. WARRANTY** - All warranties shall pass from the Contractor to the District of Columbia following final acceptance of the sign after it is placed in service.

Individual LEDs shall be warranted against defects in materials and workmanship for a period of sixty (60) months.

The sign assembly shall be warranted against defects in materials and workmanship for a period of twenty-four (24) months.

The warranty period for all products shall begin on the date the sign is placed into operational service in the District of Columbia or ninety (90) Calendar Days after the sign is delivered to the District of Columbia, whichever occurs first.

Replacement signs, LEDs or component parts shall be provided on a 1 for 1 basis after receipt by the manufacturer of the failed unit. Replacement of signs, LEDs, or component parts which failed while under warranty shall occur at no cost to the District of Columbia.

## **825.25 ETHERNET WIRELESS 900MHZ SPREAD SPECTRUM RADIO**

### **A. GENERAL**

1. All external screws, nuts and locking washers used to mount the switch shall be stainless steel; no self-tapping screws shall be used unless approved by the Engineer.
2. All mounting parts shall be made of corrosion-resistant material.
3. **Configuration** - Each single radio can be configured as a Gateway, Access Point or Repeater.
4. **Data Rate** - 867 Kbps/614 Kbps user configurable over-the-air throughput.
5. **Frequency Band** - 902-928 MHz ISM, FCC part 15.247 (DTS).
6. **Spreading Mode** - DTS/FHSS.
7. **Range** - 15 miles typical with clear line-of-sight, point-to-point.
8. **MTBF** - 340,000 HRS.

### **B. TRANSMITTER & RECEIVER**

1. **Channel Access** - CSMA/CA.
2. **Carrier Output Power** - 5mW up to 1W.
3. **Output Impedance** - 50 Ohms.
4. **Modulation** - CPFSK (continuous phase FSK).
5. **Occupied Bandwidth** - 611.2 kHz.
6. **Hopping Patterns** - 15 per Band, 105 total, user selectable.
7. **Hopping Channels** - 41.

8. **Hopping Band** -: 7, user selectable.
9. **Frequency Zones** - 16 Zones, 2-3 channels per zone.
10. **Receiver Sensitivity** -102 dBm at 614 Kbps with 10<sup>-4</sup> BER, and -96 dBm at 867 Kbps with 10<sup>-4</sup> BER.
11. **System Gain** - 129 dB.

#### C. DATA TRANSMISSION

1. **Error Detection** - 32 bit CRC, Retransmit on Error.
2. **Data Encryption** - AES 128-bit encryption and proprietary spread spectrum technology.
3. **Data Interface** - Ethernet.
4. **Ethernet** - IEEE 802.3 Ethernet II, IEEE 802.1Q (trunk, access, and native), STP, IGMP, Multicast.
5. **Protocols** - TCP/IP, DHCP, ICMP, UDP, ARP, multicast, SNMP, TFTP.

#### D. INTERFACE

1. **Ethernet** - 10/100 Base T auto MDX, RJ45.
2. **Serial** - COM1: RS-232/422/485, DB-9F, DCE; COM2: RS-232/422/485, DB-9F, DCE 1,200-115,200 bps serial ports.
3. **Antenna** - TNC connector (female).
4. **LEDs** - CD, TX, CTS, LAN, COM1, COM2, ERR.

#### E. MANAGEMENT

1. SSL, SSH, HTTPS, Telnet, Local Terminal
2. SNMPv1/v2/v3, MIB II, enterprise MIB
3. SYSLOG
4. Discovery Server

#### F. SECURITY

1. AES 128-bit encryption
2. **RADIUS Central Authentication** - Allows system to have connectivity with only system-administered authenticated devices.
3. **VLAN Tagging (802.1Q)** - Allows multiple segregated data flows over single radio for data separation.
4. **MAC Address Filtering** - Allows each port to be secure by only allowing connectivity with known MAC addresses.

#### G. POWER

1. **Input Voltage Range** - 6 to 30 VDC.
2. **Current Draw at 12 Volts** - 150 mA in full time receive, 550 mA transmit current.

#### H. ENVIRONMENTAL

1. **Operating Temperature Range** - -40° C to +60° C.
2. **Humidity** - 0 to 95 percent non-condensing.

#### I. PHYSICAL

1. Small form factor physical configuration.
2. Light weight
3. **Mounting Options** - Flat surface mount brackets, DIN rail.
4. UL/CSA Approved for Class 1 Div 2.

**J. ANTENNA AND CABLE**

1. Directional Yagi, 8dBi, 4-element antenna
2. 100 °H / 60 °V Beamwidth

**K. MANAGEMENT SOFTWARE AND PROGRAMMING CABLE**

1. Software shall be Microsoft Windows compatible and provide user friendly configuration, troubleshooting, and diagnostic tools, along with centralized configuration storage for individual radios.
2. A 3 foot min length serial programming cable shall be provided.

**825.26 3G CELLULAR DATA RADIO**

- A.** The radio shall provide highly-reliable 2-way real-time data exchange over commercial cellular 3G compliant networks and meeting or exceeding the following Specifications:

**1. Network Technology**

- a. HSUPA supporting 2.0Mbps uplink and 7.2 Mbps downlink (AT&T network) with automatic fallback to HSDPA, UMTS, EDGE, GPRS, (MS-12)
- b. EV-DO Rev A with automatic fallback to: CDMA 1x EV-DO Revision 0 CDMA 1xRTT, CDMA IS-95
- c. Each radio shall include SIM (Subscriber Identify Module) card interface to support various carrier networks

**2. Bands**

- a. Tri-Band UMTS/HSDPA/HSUPA, 850/1900/2100 MHz
- b. Quad-Band GPRS/EDGE, 850/900/1800/1900 MHz
- c. Dual Band EV-DO Rev A 800 Mhz Cellular, 1900 Mhz PCS

**3. Host Interface**

- a. *Ethernet* - 10/100 Base T auto-sensing, RJ45
- b. *Serial* - RS-232, DB-9F, DCE (300-230400 baud)
- c. *Antenna* - Primary 50 Ohm SMA; Rx Diversity 50 Ohm SMA
- d. *LEDs* - Network, Signal, Activity, Service, Power

**4. Application Interface**

- a. TCP/IP
- b. UDP/IP
- c. DHCP
- d. HTTP
- e. SNMP
- f. SMTP
- g. SMS
- h. XML-based protocol to query and set modem parameters

**5. Management**

- a. Events Reporting Engine
- b. Routing Protocols

- c. Highly Configurable
- d. Remote configuration, administration, and control of deployments of any size, from 1 device to thousands

#### 6. Security

- a. IPsec VPN
- b. GRE Tunnel
- c. Friends List (dial-up PPP)

#### 7. Power

- a. *Input Voltage* - 9-28 VDC.
- b. *Power consumption* - 235 mA.

#### 8. Standards / Approvals

- a. FCC
- b. PTCRB
- c. UL/CSA Approved for Class 1 Div 2
- d. Carrier Specific Approvals

#### 9. Environmental

- a. *Operating Temperature Range* - -30° C to +70° C.

#### 10. Physical

- a. *Dimension* - 143mm x 37mm x 75mm.
- b. *Weight* - 317 g.

**B. CONSTRUCTION AND INSTALLATION** - The cellular data radio shall be mountable inside the DMS controller cabinet in a location and method shown on the Plans and designated by the Engineer.

1. The radio shall be rack mounted inside the controller cabinet in a secure location, accessible by field technicians.
2. All external screws, nuts and locking washers used to mount the radio shall be stainless steel; no self-tapping screws shall be used unless approved by the Engineer.
3. All mounting parts shall be made of corrosion resistant material.
4. The Contractor shall not use existing GFI outlets in the controller cabinets to plug in the radio power cord.
5. The radio antenna cable shall be routed through an access hole in the top of the cabinet to a surface-mounted antenna as shown on the Plans and as designated by the Engineer.
6. The Contractor shall program the radio to receive signals from existing Ethernet communications equipment within the controller cabinet as shown on the Plans.
7. The Contractor shall configure all necessary radio network and operating parameters. All information shall be provided by the Engineer.

### 825.27 HARDENED ETHERNET SWITCH

#### A. MATERIAL

##### 1. General Requirements

- a. All materials furnished, assembled, fabricated or installed under this specification shall be a new product from the Manufacturer or Reseller, and a Commercial Off-The-Shelf (COTS) product.
- b. No reconditioned equipment or parts shall be used.

- c. All equipment and appurtenances shall be identified with name, model number, serial number, technical support and warranty phone numbers, and any other pertinent information required to facilitate equipment maintenance.
  - d. Every conductive contact surface or pin shall be gold plated or made of non-corrosive, non-rusting metal.
- 2. Copper Ports** – The following Category 5 requirements shall be met for all 10/100Base TX ports:
- a. All CAT 5 UTP/STP ports shall be EIA/TIA 568-A Compliant.
  - b. All ports shall be type RJ45.
  - c. All ports shall auto-negotiate for speed (10/100) and duplexity (Auto-MDI/MDIX for Full or Half duplex operation).
  - d. The unit shall have at least six 10/100Base TX ports (100Mbps).
- 3. Switch Properties**
- a. *Switching method* - Non-blocking Store & Forward
  - b. *Switching latency* - 8 us (100Mbps)
  - c. *Switching bandwidth* - 1.8Gbps
  - d. *MAC address table size* - 4096
  - e. *Priority Queues* - 4
  - f. *Frame buffer memory* - 1 Mbit
  - g. *Simultaneous VLANs* - 255
  - h. *VLAN ID Range* - 1 to 4094
  - i. *IGMP multicast groups* - 256
  - j. *Port rate limiting* - 128kbps, 256, 512, 4, 8Mbps
  - k. *Packet forward filtering rate* - 14,880 pps for 10Mbps, 148,800 pps for 100 Mbps
- 4. Network Management**
- a. HTTP graphical web-based
  - b. SNMP v1, v2c, v3
  - c. Telnet, VT100
  - d. Command Line Interface (CLI)
  - e. BootP
  - f. TFTP or FTP file transfer access
  - g. Diagnostics: syslog, logfile, RMON, port mirroring, Topology Discovery IEEE 802.1AB (LLDP)
  - h. Auto-configuration Adapter
- 5. Security**
- a. Packet filtering and port security: Port enable/disable with source/destination MAC/IP filtering
  - b. Access control to agent (VLAN/IP)
  - c. Port mirroring
- 6. Indicator LEDs** – The unit shall contain the following status and diagnostic LEDs:
- a. Link/Activity Status
  - b. 100 Mbit/s operation (Speed)

- c. Auto-negotiation
- d. Full-duplex
- e. Error
- f. Redundancy Management
- g. Ring-port
- h. LED Test
- i. Power

**7. Power Supply**

- a. The switch shall include an integrated power supply
- b. *Operating Voltage* - 9.6 to 60 VDC and 18 to 30 VAC
- c. *Current Consumption at 24VDC* - max. 221 mA

**8. Physical** – The switch shall be of compact design allowing it to be mounted in a space-constrained field equipment cabinet. Maximum dimensions shall be as follows:

- a. *Dimensions* - 47mm x 131mm x 111mm
- b. *Weight* - 400g
- c. *Mounting* - Shelf, DIN rail, or panel mounted

**9. Environmental Compliance**

- a. *Operating temperature range* - zero degrees C to +60 degrees C without the use of fans
- b. *Relative Humidity* - 10 percent-95 percent non-condensing

**10. IEEE Compliance**

- a. 802.3-10BaseT
- b. 802.3u-100BaseTX, 100BaseFX
- c. 802.3x-Flow Control
- d. 802.1D-MAC Bridges
- e. 802.1D-Spanning Tree Protocol
- f. 802.1p-Class of Service and QoS port prioritization
- g. 802.1Q- port-based VLAN Tagging
- h. 802.1w-Rapid Spanning Tree Protocol
- i. 802.1x-Port Based Network Access Control
- j. 802.1Q-2005 (formerly 802.1s) MSTP

**11. IETF RFC Compliance**

- a. RFC768-UDP
- b. RFC783-TFTP
- c. RFC791-IP
- d. RFC792-ICMP
- e. RFC793-TCP



- f. RFC826-ARP
- g. RFC854-Telnet
- h. RFC894-IP over Ethernet
- i. RFC1112-IGMP v1
- j. RFC1541- DHCP, DHCP Option 82
- k. RFC2030-SNTP client
- l. RFC2068-HTTP
- m. RFC2236-IGMP v2
- n. RFC3414-SNMPv3-USM
- o. RFC3415-SNMPv3-VACM

**B. CONSTRUCTION AND INSTALLATION**

1. The switch shall be mountable inside the DMS controller cabinet in a location and method shown on the Plans and designated by the Engineer.
2. The switch shall be rack mounted inside the controller cabinet in a secure location, accessible by field technicians.
3. All external screws, nuts and locking washers used to mount the switch shall be stainless steel; no self-tapping screws shall be used unless approved by the Engineer.
4. All mounting parts shall be made of corrosion resistant material.
5. The Contractor shall not use existing GFI outlets in the controller cabinets to plug in Ethernet Field Switch power cord.

**825.28 FIBER OPTIC CABLE SYSTEM MATERIALS**

**A. REQUIREMENTS**

1. Use fiber coating that is a dual layered, UV cured acrylate applied by the fiber manufacturer. It shall be removable with commercially available stripping tools in a single pass without damaging the fiber.

The fiber optic cable type, configuration, and installation method will be detailed on the Plans, Drawings, Details, Specifications and in the Pay Items. The cable and cable installation shall conform to all requirements within the Plans and Specifications.

**TABLE 825.28 (A) OPTICAL FIBER SPECIFICATION**

<b>Optical Fiber Specification Table</b>	
<b>Multimode Optical Fiber</b>	
Core Diameter	62.5 ± 3.0 μm
Cladding Diameter	125.0 ± 2.0 μm
Core-to-Cladding Offset	≤ 3.0 μm
Cladding Non-Circularity <sup>a</sup>	≤ 2.0%
Core Non-Circularity <sup>b</sup>	≤ 5.0%
Coating Diameter	250 ± 10 μm
Index	Graded
Numerical Aperture	0.275 ± 0.015
Maximum Attenuation	≤ 3.5 dB/km at 850 nm ≤ 1.0 dB/km at 1300 nm

<b>Optical Fiber Specification Table</b>	
Attenuation Uniformity	No point discontinuities greater than 0.2 dB at 850 nm and 1300 nm
Bandwidth	≥ 160 MHz•Km at 850 nm ≥ 500 MHz•Km at 1300 nm
Tensile Strength	100 kpsi
<b>Single Mode Optical Fiber</b>	
Typical Core Diameter	8.3 μm
Cladding Diameter	125.0 ± 1.0 μm
Core-to-Cladding Offset	≤ 0.6 μm
Cladding Non-Circularity*	≤ 1.0%
Coating Diameter	245 ± 10 μm
Maximum Attenuation	≤ 0.40 dB/km at 1310 nm ≤ 0.30 dB/km at 1550 nm
Attenuation Uniformity	No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm
Attenuation at the Water Peak	The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km
Cutoff Wavelength	The cabled fiber cutoff wavelength shall be ≤ 1260 nm
Mode-Field Diameter	9.3 ± 0.5 μm at 1310 nm 10.50 ± 1.00 μm at 1550 nm
Zero Dispersion Wavelength (λ <sub>o</sub> )	1301.5 nm ≤ λ <sub>o</sub> ≤ 1321.5 nm
Zero Dispersion Slope (S <sub>o</sub> )	≤ 0.092 ps/(nm <sup>2</sup> •km)
Polarization Mode Dispersion	≤ 0.5 ps/sq.rt km
Maximum Dispersion	≤ 3.2 ps/(nm•km) for 1285 nm to 1330 nm ≤ 18 ps/(nm•km) at 1550 nm
Tensile Strength	100 kpsi

a Defined as:  $\left[1 - \left(\frac{\text{min.cladding dia.}}{\text{max.cladding dia.}}\right)\right] \times 100$

b Defined as:  $\left[1 - \left(\frac{\text{min.core dia.}}{\text{max.core dia.}}\right)\right] \times 100$

2. **Additional Requirements for Loose Tube Cable** - Use only cable that is all dielectric, loose tube design. Ensure buffer tubes are stranded around a central member using the reverse oscillation, or "SZ", stranding process.
3. **Additional Requirements for Ribbon Cable** - Ensure that all fibers in a ribbon are parallel and do not cross over each other for the entire length of the cable.

Dimension the ribbon fiber in accordance with FOTP-123, "Measurement of Optical Fiber Ribbon Dimensions." Include in the ribbon markings both fiber number and color printed on each fiber.

4. **Additional Requirements for Armored Cable** - Provide armored cables with an inner sheath of medium density polyethylene. The minimum nominal jacket thickness of the inner sheath shall be 0.04 in (1 mm). Apply the inner jacket directly over the tensile strength members and water blocking material.

Ensure the armor is a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and is applied with an overlapping seam with the corrugations in register.

Apply the outer jacket over the corrugated steel tape armor. Use an outer jacket with a medium density polyethylene and a minimum nominal jacket thickness of 0.06 inches (1.5 mm). For the polyethylene, use carbon black to provide ultraviolet light

protection and without promoting the growth of fungus.

Use only cable that can withstand a simulated lightning strike with a peak value of the current pulse two 105 kA when tested in accordance with the proposed FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components." Use a test current that is damped oscillatory with a maximum time-to-peak value of 15 ps (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to halfvalue of the waveform envelope (t percent) shall be from 40 - 70 ps. Ensure that in addition to the analysis criterion set forth in FOTP-18 1, the integrity of the buffer tubes (or analogous loose tube, i.e. core tube) and strength members to be intact after removal of the cable specimens from the test box.

- 5. Additional Requirements for A11 Dielectric Self Supporting (ADSS) Cable** - When shown as such in the Plans, use only cable that is all dielectric and designed for fully self-supporting installation (no messenger cable).

Use high tensile strength, aramid yarns to provide tensile strength.

Ensure that the cable is designed for spans up to 600 feet (183 m) with a typical sag value of 2 percent.

- 6. Cable performance** - All OSP cable shall meet or exceed the requirements of the Fiber Optic Test Procedure (FOTP) criteria referenced in 7 CFR 1755.900. Upon the request of the Department, provide certification from an independent testing laboratory that certifies that the cable conforms to the Specifications and test procedures.
- 7. Pulling tension** - Ensure that the cable can withstand a maximum pulling tension of 600 lbs (2669 N) during installation (short term) and 200 lbs (890 N) long term installed.
- 8. Temperature range** - Provide only OSP cable with shipping, storage, and operating temperature range of -40 °F to +160 °F (-40° C to +71° C). The installation temperature range of the cable shall be -20° F to + 160° F (-30 °C to + 71 ° C).

## B. PATCH CORDS AND PIG TAILS

- 1. Patch cords** - Use patch cords consisting of a length of fiber optic cable terminated on both ends. Ensure that all factory preconnectorized assemblies adhere to the applicable cable, cordage, and fiber Specifications stated in these Specifications.

- a. All inside plant (IP) patch cords shall meet NEC jacketing requirements** - Use orange outer jackets for multi-mode and yellow jackets for single mode. Use connector boots of 2 colors for all duplex patch cords, zip cord or round. Use white or off white for one leg of the duplex cord (non-printed zip leg) and red for the opposite leg (printed zip leg) of the duplex cord.

For all assemblies for outside plant (OSP) where loose tube is used, include a fan-out kit installed at each connected end.

Ensure that all connectors conform to Subsection 613.3.A.

No splices of any type are allowed within a patch cord assembly.

- b. Testing** - Fully test each assembly and place those test results on a test tag for each mated pair of connectors. Attach the tag to 1 end of each pair within the assembly.

Individually package each assembly within a plastic bag and clearly mark on the outside of that bag the submitted manufacturer's part number.

- 2. Pig tails** - Use pig tails that consist of a length of fiber optic cable terminated on 1 end. Use only pig tails with factory installed. Provide pig tails with 900 micron tubing or 3mm fan out tubing as required for the application. Ensure that the other end of the cable is suitable for splicing to another cable. The pig tail shall conform to the same construction and testing requirements as patch cords.

- C. DROP CABLE ASSEMBLY** - Outside Plant - Drop cable assembly is defined as a connected fiber optic cable and appropriate fan out (if required) used for connectivity between a primary fiber trunk or feeder cable and field devices such as signal controllers, closed circuit television cameras, video detection system cameras, changeable message signs, etc.

1. **General requirements** - Provide a central core design drop cable assembly meeting the requirements for outside plant cable. Provide the drop cable assembly type (multimode, single-mode or hybrid) and fiber count specified in the Plans. Provide a drop cable with a maximum pulling tension of 300 lbs (1334 N) unless the manufacturer's requirements are more stringent.
2. **Assembly construction** - Provide a drop cable assembly meeting the following requirements. Drop cables may be factory pre-terminated or may use splice-on factory-connected pig tails.
  - a. *Pre-terminated Drop Cable Assembly* - Install pre-terminated drop cable assemblies with central core design fiber optic cable, factory-installed fiber optic on each drop cable fiber, and factory-assembled fan outs with 3mm fan out tubing. Use metallic crimps between the drop cable strength members and the fan out tubing strength members, and use heat-shrink tubing seals.
  - b. *Field-spliced Drop Cable Assembly* - Install field-spliced drop cable assemblies with central core design fiber optic cable, fusion spliced factory connected pig tails on each drop cable fiber.
  - c. *Fan Out - Central Core Cable Design* - Install field-installed fan outs (if required). Additionally, secure the fan out tubing to the main cable sheath in a hard epoxy plug transition that extends a minimum of 2.0 inches (50 mm) onto the cable and 2.0 inches (50 mm) onto the 3 mm tubing.

**D. FIBER OPTIC CONNECTORS** - Furnish and install ST compatible connectors unless otherwise specified. Use ceramic ferrule connectors for single-mode and multi-mode applications. Install connectors as per manufacturer application and recommendations, including proper termination to the outer-tubing (900 micron tubing, 3mm fan out tubing, etc.) required for the application.

Use connectors rated for an operating temperature of -40° F to +167° F (-40° C to + 75° C).

Use only factory-installed connectors for all applications except for connectors installed on outside plant drop cables in traffic signal cabinets. Use factory-installed connectors installed with a thermal-set heat-cured epoxy and machine polished mating face.

Where barrel couplers are used in passive termination applications such as FDCs, use only ST compatible ceramic-insert couplers. Use only manufacturer recommended single-mode couplers for single-mode connector applications. Provide dust caps for both sides of couplers at all times until permanent connector installation.

Provide connectors listed below that do not exceed the maximum loss listed for each connector.

**TABLE 825.28 (B)**

Connector Type	Installation	Max. Loss	Typical Loss	Optical Return Loss
Multimode	Field	0.70 dB	N/A	N/A
Single-mode	Field	0.70 dB	0.35 dB	>35 dB
Multimode	Factory	0.50 dB	N/A	N/A
Single-mode	Factory	0.50 dB	0.25 dB	>45 dB

**E. SPLICE CLOSURE – UNDERGROUND**

1. **Use** - Install closures designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes. Splice closures shall pass the factory test procedures and minimum Specifications listed below.
2. **Physical requirements**
  - a. The closure shall handle up to 8 cables in a butt configuration.
  - b. Ensure that the closure prevents the intrusion of water without the use of encapsulate.
  - c. Provide a closure that is capable of accommodating splice organizer trays that accept mechanical, fusion, or multi-fiber array splices. Use a splice closure that has provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or non-spliced fiber. Use splice organizers that are re-enterable and re-sealable. Splice cases shall hold a minimum of 2 splice trays to a maximum of 18 splice trays with each tray housing 12 or 24 splices depending on splice type.

- d. Use only UL rated splice cases. Where high fiber count (144 to 432) splice cases are required, use cases that have an external pressurization port for optional pressurization.
  - e. Verify that closure re-entry and subsequent reassemble does not require specialized tools or equipment. Further, these operations cannot require the use of additional parts.
  - f. Provide a splice closure with provisions for controlling the fiber bend radius to a minimum of 1.5 inches (38 mm).
- 3. Quality assurance requirements** - Install only underground splice closures that pass the following factory testing:
- a. *Compression Test* - Provide a closure that does not deform more than 10 percent in its largest cross-sectional dimension when subjected to a uniformly distributed load of 300 lb (1334 N) at a temperature of 0° F and 100° F (-18° C to 38° C).  
Perform the test after stabilizing at the required temperature for a minimum of two (2) hours. Place an assembled closure between 2 flat paralleled surfaces, with the longest closure dimension parallel to the surfaces. Place the weight on the upper surface for a minimum of fifteen (15) minutes. Take the measurement with weight in place.
  - b. *Impact Test* - Provide an assembled closure capable of withstanding an impact of 21 A-lb (28.5 Nam) at temperatures of 10° F and 100° F (-12 ° C and 38° C). Perform the test after stabilizing the closure at the required temperature for a minimum of two (2) hours. The test shall consist of 20 lb (9 kg) cylindrical steel impacting head with a 2 inches (50 mm) spherical radius at the point where it contacts the closure. Drop it from a height of 12 inches (300 mm).  
Ensure that the closure does not exhibit any cracks or fractures to the housing that would preclude it from passing the water immersion test. There shall be no permanent deformation to the original diameter or characteristic vertical dimension by more than 5 percent.
  - c. *Cable Gripping and Sealing Testing* - The cable gripping and sealing hardware shall not cause an increase in fiber attenuation in excess of 0.05 dB fiber at 1550 nm when attached to the cables and the closure assembly. Test by measuring 6 fibers, 1 from each buffer tube or channel, or randomly selected in the case of a single fiber bundle. Take measurements from the test fibers, before and after assembly to determine the effects of the cable gripping and sealing hardware on the optical transmission of the fibers.
  - d. *Vibration Test* - Provide splice organizers that securely hold the fiber splices and store the excess fiber. Use fiber splice organizers and splice retaining hardware tested per EIA Standard FOP-II, Test Condition I. The individual fibers shall not show an increase in attenuation in excess of 0.1 dB/fiber.
  - e. *Water Immersion Test* - Provide a closure capable of preventing a 10 foot (3 m) water head from intruding into the splice compartment for a period of seven (7) days. Ensure that testing of the splice closure has been accomplished by the placing of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent to 10 feet (3 m) on the closure and cable. Continue this process for seven (7) days. Remove the closure and open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure.

## F. SPLICE CLOSURE - AERIAL

- 1. **Use** - Design the closure for use in aerial applications and to conform to the requirements below.
- 2. **Physical requirements**
  - a. Ensure that the closure has the capacity to accommodate up to 144 fibers using six 24 fiber capacity trays.
  - b. The closure shall allow for the storage of at least 12 unopened buffer tubes and/or fiber ribbons.
  - c. Design the closure for free breathing splice protection without the use of encapsulate.
  - d. Provide a closure with fully assembled weather tight closure design.
  - e. The closure shall have flexible thermoplastic rubber end seals with pre-template cable ports.
  - f. Ensure that the closure has a high density polyethylene body.
  - g. The closure shall have corrosion resistant aluminum or stainless steel hardware. Design the aerial closure in such a way as to allow complete splice access after closure placement, without removal of the closure or electrical bonds from the cable. The closure shall be suitable for straight, butt or branch splices. Include provisions for strain relief, both around the cable

jacket and to internal cable strength members. The aerial closure design shall eliminate the need for drip collars and sealing collars. Package the closure with all necessary hardware for aerial mounting.

3. **Optical fiber organizer** - The fiber organizer is a system that holds splice or organizer trays in such a way as to protect and support cable splices within an environmentally protected area. Provide organizer trays capable of storing all common splices; fusion and mechanical, in all configurations; butt, inline and branch (with up to 4 branch cables). All trays shall be completely re-enterable. Provide only trays able to accept both multi-mode and single mode fibers. The organizer itself shall accept a minimum of 4 trays, and offer bonding and grounding hardware. The organizer shall offer a simple 1-piece cable strapping system.

## G. MECHANICAL LAB SPLICE

### 1. Insertion Loss

- a. Multi-Mode < 0.30 dB
- b. Single Mode < 0.30 dB

### 2. Operating Temperature - -23° F to 77° F (-31° C to 25° C)

## H. FIBER DISTRIBUTION CENTER (FDC) - Use rack-mount and wall-mount FDCs and FDC splice cabinets with enclosures and mounting components of metallic construction.

Use rack-mount FDCs that fit standard 19 inch (483 mm) EIA equipment racks or cabinets.

Use rack-mount FDCs of specified sizes 6-fiber through 24-fiber that have front-opening swing-out drawers for access to the fiber splicing trays and the fiber termination couplers. When closed, the swing-out drawer shall provide a dust-tight seal that completely encloses the fiber splicing trays, fiber termination couplers, and the connecting ends of fiber patch cords connected to the couplers.

Use rack-mount FDCs of specified sizes 36-fiber through 96-fiber that have front-mounted front-facing fiber termination couplers accessible behind a removable transparent plastic dust cover.

Use rack-mount FDCs of specified sizes 6-fiber through 48-fiber that include fiber splicing trays integral to the FDC enclosure, accessible through the rear of the FDC or through the swing-out drawer. Use rack-mount FDCs of specified sizes 6-fiber through 48-fiber with a maximum horizontal depth of 24 inches (600 mm) and of the following maximum vertical heights:

- 6-fiber and 12-fiber: 1.75 inches (45 mm)
- 24-fiber: 3.50 inches (90 mm)
- 36-fiber and 48-fiber: 7.00 inches (175 mm)

Where splice-on fiber pigtailed are to be used, provide 900 micron tubing or 3mm fan out tubing from the splice trays to the connectors.

Use rack-mount FDCs of specified sizes 60-fiber through 96-fiber that include a separate FDC splice cabinet installed adjacent to the FDC. Alternately, rack-mount FDCs with splice cabinets integral to the overall FDC enclosure but contained in a separated compartment either above or below the FDC termination couplers. Use rack-mount FDCs of specified sizes 60-fiber through 96-fiber with a maximum horizontal depth of 24 inches (600 mm) and of the following maximum vertical height, combined FDC and FDC splice cabinet of 17.50 inches (445 mm). Where splice-on fiber pigtailed are to be used, provide only 3mm fan out tubing from the splice trays in the splice cabinet to the connectors in the FDC.

Provide couplers with dust caps. Use only ST compatible couplers unless otherwise specified

Provide rack-mount and wall-mount FDCs with the appropriate quantity of couplers, panels, splice trays, organizers, pig tails, and ancillary materials to terminate the number of fibers as specified by the FDC size, regardless of the cable size to be terminated as shown in the Plans. Where factory pre-terminated drop cable assemblies are permitted and to be used, do not provide splice trays.

## I. TRANSCEIVERS

### 1. External transceiver - Ensure the transceiver meets the following requirements:

The transceiver shall be designed for daisy chained, linear multi-drop configuration.

The transceiver supports asynchronous, full duplex RS 232 communication.

The transceiver meets NEMA TS-1-1989 environmental standards for power interruption, temperature and humidity, power service transients, non-destruct transients, vibration and shock. Conformance with equivalent environmental standards by other entities may be submitted for consideration.

The connectors shall be external, female ST connectors with T1,R1,T2,R2 ports for fiber connection.

The equipment data connector shall be a female DB-25, DB-9, or terminal block RS 232 connector.

The transceiver shall have external indicator LEDs for power, transmit & receive (each channel).

A multimode transceiver operates at 1300 nm (minimum 14 dB power budget).

A single mode transceiver operates at 1310 nm (minimum 21 dB power budget).

Transceivers shall have a receiver dynamic range that is a minimum of 2 dB greater than the manufacturer's specified power budget. The transceiver shall fully maintain all operational performance characteristics throughout the full receiver dynamic range, including a zero dB path loss.

The transceiver communications shall be anti-streaming.

A single mode transmitter shall incorporate laser diode optical emitters.

The transceiver shall have an internal, nickel-cadmium trickle charge battery for a minimum of six (6) hour backup operation. The battery shall be designed to have minimized degradation to reliability during extended periods of trickle charge operation. Use corrosion resistant battery contacts.

The transceiver shall have a metal housing with maximum dimensions of 8" x 5" x 2" (200 x 125 x 50 mm). The metal housing shall have flanged mounting brackets to allow for permanent mounting with screws.

Do not use internal card-type units.

**2. External star transceiver** - Provide an RS232 data optical star transceiver with the following modifications:

The star transceiver shall be designed for multi-drop configuration with 3 optical data ports and 1 electrical equipment data connection port, to be applied in a drop-and-repeat optical 3-way to "T" installation.

Verify the star transceiver is fully compatible and operable with the linear drop-and-repeat transceiver **DELIVERY, STORAGE, AND HANDLING** - Package the cable for shipment on reels. Each package shall contain only 1 continuous length of cable. Construct the packaging so as to prevent damage to the cable during shipping and handling.

Seal both ends of the cable to prevent the ingress of moisture.

Include with each reel a weatherproof reel tag attached identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.

Include with each cable a cable data sheet containing the following information:

Manufacturer name

Cable part number

Factory order number

Cable length

Factory measured attenuation of each fiber

Bandwidth specification (where applicable)

Index of refraction

When the length of an order requires a reel greater than 3 feet (1 m) in diameter, apply a protective coating around the cable before shipment. Cover the cable with a thermal wrap. Securely fasten the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit. Project the inner end of the cable a minimum of 6.5 ft (2 m) into a slot in the

side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing. Plainly mark each reel to indicate the direction in which it is to be rolled to prevent loosening of the cable on the reel.

### **825.29 MAGNETIC SENSOR DETECTOR**

The 2-way wireless battery-powered magnetometer vehicle detector shall consist of the following:

- Battery-powered sensors installed in-pavement in each traffic lane, which can be programmed to eliminate surrounding natural or man-made magnetic forces as to not interfere with its operation. Each sensor shall transmit its detection data within 150 ms of a detected event.
- Access Points (AP) mounted on the side of the Roadway may be utilized as the communications hub for the installation, in addition to its collection and processing functions.
- Repeaters (RPs) mounted on the side of the Roadway, could be utilized to extend the radio range of an AP.
- Each sensor shall communicate by radio to a nearby AP or RP.
- Interface between an AP and a modem uses an Ethernet communication cable (CAT-5E).
- Software to control and configure the sensors, APs, and RPs and to store and retrieve detection data.
- 2-way wireless communications between the sensors and the AP or RP and between the RP and AP.
- Create up to 3 vehicle classifications, based on vehicle length.

### **825.30 ROAD WEATHER INFORMATION SYSTEM MATERIALS SPECIFICATION**

The system shall include all hardware, software, and licenses to operate as follows:

- Active and passive in-pavement surface sensors shall measure roadway pavement surface temperature, freeze point temperature, chemical concentration, surface conditions, and communicate these signals to the RPU.
- Atmospheric sensors shall measure their respective weather parameters and communicate the signals from each to the RPU
- A Pan-Tilt-Zoom (PTZ), low light, color, snapshot video camera shall capture video images and transfer the images to the RPU.
- Optionally, a wireless in-pavement or side-fire radar traffic counter shall measure the count, speed and length of passing vehicles, and transfer this data to the RPU.
- Optionally, the RPU shall monitor and control a fixed anti-icing spray system to automatically apply anti-icing chemical to the bridge deck and roadway approaches.
- The RPU shall process and temporarily store the output from the camera(s), pavement sensors and atmospheric sensors.
- The RWIS server shall poll each RPU on a scheduled basis via communications telemetry as specified in the Project plans. The RPU shall respond to the poll and transfer all of its data and images to the RWIS server.
- All data transfers between the RWIS server and RPUs shall be compliant with the most current Federal standard NTCIP ESS protocols.
- The RWIS server system shall store the RWIS data and video images in a standard SQL Server database for access by the Department users
- Optionally, a twenty-four (24) hour pavement specific weather forecast shall be provided by the RWIS vendor for display by the server as an advanced ice/snow control-planning tool for DOT maintenance personnel.
- The RWIS user displays shall include all sensor, forecast and video data in a browser-based data display format.

The system shall consist of:

- Remote Processing Unit
- Passive Pavement Sensor



## *TRAFFIC SIGNAL MATERIALS*

- Active Pavement Sensor
- Subsurface Temperature Probe
- Classifying Precipitation and Visibility Sensor
- Precipitation Occurrence Sensor
- Air Temperature/Relative Humidity Sensor
- Wind Speed/Direction Sensor
- PTZ Color Video Camera
- RWIS Central Software
- RWIS Central Hardware

The pole for mounting the sensors, the foundation and base, power and communication to the field unit will be considered as separate items.

### 826 GREEN COLORED PAVEMENT

#### 826.01 ALLOWABLE USES

Green colored pavement may be used within a bicycle lane or within an extension of a bicycle lane to enhance the conspicuity of the bicycle lane or extension.

The use of green colored pavement under this Interim Approval is limited to the following applications:

- A. Green colored pavement may be installed within bicycle lanes as a supplement to the other pavement markings that are required within bicycle lanes as a supplement to the other pavement markings that are required for the designation of a bicycle lane. Green colored pavement shall not be used instead of the longitudinal line required by the MUTCD or instead of the word, symbol, and arrow pavement markings illustrated in the MUTCD and required by the MUTCD. The green colored pavement may be installed for the entire length of the bicycle lane or for only a portion (or portions) of the bicycle lane. Green colored pavement may be installed as a rectangular background behind the word, symbol, and arrow pavement markings in a bicycle lane as a means of enhancing the conspicuity of these word, symbol, and arrow pavement markings.
- B. If a pair of dotted lines is used to extend a bicycle lane across an intersection or driveway (see the MUTCD) or a ramp, green colored pavement may be installed between these lines as a supplement to the lines. Green colored pavement shall not be used instead of the dotted lines to extend a bicycle lane across an intersection, driveway, or ramp. The green colored pavement may be installed for the entire length of the bicycle lane extension or for only a portion (or portions) of the bicycle lane extension. The pattern of the green colored pavement may be dotted in a manner that matched the pattern of the dotted lines, thus filling the only areas that are directly between a pair of dotted line segments that are on opposite sides of the bicycle lane extension.
- C. If a pair of dotted lines is used to extend a bicycle lane across the beginning of a turn bay where drivers who desire to turn must cross the bicycle lane when moving out of the through lane in order to turn (see the MUTCD), green colored pavement may be installed between those lines as a supplement to the lines. Green colored pavement shall not be used instead of these dotted lines to extend a bicycle lane across the beginning of a turn bay. The green colored pavement may be installed for the entire length of the bicycle lane extension or for only the portion (or portions) of the bicycle lane extension. The pattern of the green colored pavement may be dotted in a manner that matched the pattern of the dotted lines, thus filling in only the areas that are directly between a pair of dotted line segments that are on opposite sides of the bicycle lane extension.

#### 826.02 DESIGN OF GREEN COLORED PAVEMENT

- A. The daytime chromaticity coordinated for the color used for green colored pavement shall be as follows:

TABLE 826.01 (A) DAYTIME CHROMATICITY

1		2		3		4	
x	y	x	y	x	y	x	y
0.230	0.754	0.266	0.500	0.367	0.500	0.444	0.555

- B. The nighttime chromaticity coordinated for the color used for green colored pavement shall be as follows:

TABLE 826.01(B) NIGHTTIME CHROMATICITY

1		2		3		4	
x	y	x	y	x	y	x	y
0.230	0.754	0.336	0.540	0.450	0.500	0.479	0.520

- C. Green colored pavement may be retroreflective, but there is no requirement or recommendation that it be retroreflective.
- D. If green paint or other marking materials applied to the Roadway surface are used to simulate a green colored pavement, consideration should be given to selection pavement marking materials that will minimize loss of traction for bicyclists (see the MUTCD).

#### 826.03 OTHER

Except as otherwise provided above, all other provisions of the MUTCD that are applicable to colored pavements shall apply to green colored pavement.

## **DIVISION 900 EQUIPMENT**

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**901 GENERAL**

The equipment, as herein specified, is for use under general conditions of construction as included in these Specifications.

It is not the intent of these Specifications to prohibit the use of equipment that, in the opinion of the Engineer, would produce a satisfactory construction result.

The Engineer may, therefore, by written permission, allow the Contractor to use new types of improved equipment on a trial basis for evaluation. If the results of the trial are unsatisfactory and the Engineer withdraws his approval, the Contractor will be required to use the original equipment and shall remedy any defective work all at no added expense to the District.

All vehicles and equipment used on construction Site shall:

- A. Have a functioning audible reverse signal alarm, audible above the surrounding noise level; **and**
- B. Be operated in reverse only under the following conditions:
  - 1. When a designated observer or ground guide signals that it is safe to do so; **or**
  - 2. Before operating the vehicle in reverse, the driver visually determines that no person is in the path of the vehicle.

## 902 EARTHWORK EQUIPMENT

### 902.01 TANDEM ROLLERS

All rollers shall be in good mechanical condition and shall comply with the specification for the individual items of Work.

All tandem rollers shall be power driven, shall at all times be capable of being reversed smoothly, and shall be free from backlash, loose-link motion, faulty steering mechanism, worn king bolts and bearings. Any roller that has been improperly weighted or that has in any way been thrown out of its original balance by the application of attachments, not approved or not of the manufacturer's standard design, will not be permitted on any project; nor will any roller that does not have displayed thereon, in permanent legible characters, the manufacturer's guaranteed net operating weight as distributed on each axle, be permitted on any project. The net operating weight shall be defined as the actual net weight plus 1/2 the total maximum weight of fuel and water.

### 902.02 TAMPING OR SHEEPSFOOT ROLLERS

Use either towed or self-propelled tamping rollers that can obtain the required compaction. A metal roller, drum or shell with tamping feet projecting a minimum of 6 1/2 inches from the surface of the roller, drum or shell. The cross-section area of each tamping foot, measured perpendicular to the axis of the tamping foot, shall be 4 to 12 square inches;

Tamping feet spaced 6 to 12 inches, measured diagonally center to center; and the weight is such that the load on each tamping foot is a minimum of 200 pounds per square inch,

The drum shall be watertight and shall be provided with suitable plugs so that it may be weighted with water, sand, or other suitable material to meet the loading requirements.

### 902.03 PNEUMATIC TIRED ROLLERS

Pneumatic tired rollers shall be of a multi-axle, multi-wheel type with smooth-tread pneumatic tires of equal size staggered on the axles at such spacings and overlaps as will provide uniform compactive pressure for the full compacting width of the roller, when operating. Oscillation of the wheels, if provided, shall be in vertical plane only. The pneumatic tired roller shall be capable of (a) being ballasted sufficiently to bring its loaded weight to at least 2-1/2 times its own weight, and (b) exerting compactive ground contact pressures of at least 80 pounds per square inch.

In operation of the pneumatic tired roller, (a) all tires shall be inflated to equal air pressure, within a tolerance of 5 psi, and to the pressure designated for use; (b) the roller shall be ballasted to the extent required or designated; and (c) within limits prescribed above, the roller shall provide the compactive ground pressure per square inch which is most efficient under the conditions and for the purpose of its use, as designated by the Engineer.

The Contractor shall furnish to the Engineer charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor tire furnished.

### 902.04 VIBRATORY ROLLERS

Vibratory rollers shall be self propelled, have a minimum drum diameter of 48 inches and be capable of developing a minimum frequency of 1600 vibrations per minute. A variable amplitude shall be required with a minimum of 2 settings. The unit static force shall be a minimum 125 pounds per inch with a total applied force of at least 325 pounds per inch. The roller must be equipped so that the vibrating can be turned off before stopping the roller or reversing direction. The rate of travel of roller while vibrating shall be 3 mph.

### 902.05 TAMPERS

All tampers of any kind must be of such size that they are capable of producing the specified results. Prior to use they must be approved by the Engineer. If a tamper consistently does not obtain specified results the equipment shall be removed from the job.

- A. **MECHANICAL TAMPERS** - Vibratory plate tampers shall be capable of exerting a minimum of 3,000 pounds of impact force. The exciter speed shall be a minimum of 4,500 rpm.
- B. **RAMMERS** - Rammers shall be capable of exerting a minimum of 2,500 pounds of impact force.
- C. **PNEUMATIC TAMPERS** - Tampers of this type shall be capable of compacting soils materials to the specified density.

**902.06 EQUIPMENT IDENTIFICATION**

All compaction equipment shall be marked by a permanently attached manufacturer's identification plate designating the name of the manufacturer, model number and serial number of the machine. This plate shall be installed in a readily visible location. Compaction equipment lacking such an original manufacturer's plate will not be recognized as acceptable compaction equipment.

## 903 GENERAL CONSTRUCTION EQUIPMENT

### 903.01 MILLING MACHINE

The equipment shall be self-propelled with sufficient power, traction and stability to accurately maintain the depth of cut and to remove the pavement thickness to provide the specified profile and cross slope. The equipment shall have an automatic system to maintain the cross slope and control grade elevations by referencing the existing pavement by means of a ski, matching shoe or from an independent grade control. The machine shall have a self contained water system for control of dust and fine particles. The equipment shall have a loading system or support equipment to completely recover milled material at the removal rate and shall have a means for limiting dust and other particulate matter from escaping into the atmosphere.

- A. MILLING MACHINES** – Milling machines shall be cold planers capable of removing bituminous pavement or asphalt concrete from roadways. They shall utilize a rotomil or rotating mandrel head capable of being brought into contact with the Roadway at an exact depth and/or slope. This is accomplished by bringing a rotating mandrel or “head” into contact with the pavement at an exact depth or slope. Milling machines shall be capable of rendering a milled surface smooth enough to be suitable for opening to traffic.
- B. GRINDING MACHINE FOR ASPHALT** - The equipment shall have a cutting mandrel with carbide tipped cutting teeth and designed specifically for grinding asphalt surfaces to close tolerances. The equipment shall accurately establish slope elevations and profile grade controls. The grinding machine shall be equipped with a vacuum sweeper capable of removing all loose material from the Roadway without causing dust to escape into the air.
- C. GRINDING MACHINE FOR CONCRETE** - Provide a self-propelled machine equipped with diamond blades designed for grinding and texturing concrete surfaces. Ensure that the machine is properly sized to grind a strip at least 3 feet in width without operating in adjacent traffic lane. Ensure that the grinder machine will not damage or cause strain to the underlying concrete surface course, or cause excessive ravels, aggregate fractures, spall, or, disturbance of transverse or longitudinal joints. Ensure that the grinder machine is capable of immediately collecting slurry produce from the operation. The Contractor may use a grinder machine that does not collect slurry if the Project engineer reapproves an alternate slurry collection method.

### 903.02 JOINT SEALER MELTING - APPLICATOR APPARATUS

The apparatus for melting and pouring joint-sealing material of the hot-poured type shall be of the double-boiler, indirect heating type. The heat transfer medium shall be a high flash point oil or other material approved by the Engineer. Gasoline, bottled gas, or other approved fuel may be used for heating the oil bath and the heating shall be thermostatically controlled.

The apparatus shall be equipped with an effective mechanically operated agitator and shall have a permanent recording device to indicate the temperature of the joint-sealing material at all times.

The apparatus shall be a melting-applicator combination with means of applying the joint-sealing material under pressure and a means of receiving the cold material without interfering with the dispensing of the melted material.

It is intended that all joint sealing will normally be accomplished with the above described equipment. However, in very special cases where an extremely small amount of material is required, the material may be heated in the melting-applicator apparatus and poured from a double-boiler pouring apparatus if approved by the Engineer. In the event such equipment is approved, it shall be of the indirect, thermostatically controlled heating type capable of maintaining the material at a satisfactory pouring temperature. It shall be equipped with a mechanical or hand operated agitator. A thermometer with a suitable temperature range for determining the temperature of the material shall be provided. Under no circumstances will hand-pouring pots be permitted.

### 903.03 STRAIGHTEDGES

Straightedges shall be 10 feet in length, constructed of a light, durable metal, and have handles securely attached. The straightedge shall not vary more than 1/32 inch in 10 feet from a true plane.

Rolling straightedges with deviation marking abilities may be used upon approval of the Engineer.



**904 BITUMINOUS EQUIPMENT****904.01 BITUMINOUS MIXING PLANTS**

- A. GENERAL** - Plants used for the preparation of hot mix bituminous mixtures shall be a batch, continuous or drum type. The Plant shall be approved prior to use and conform to the appropriate sections of AASHTO M 156.

The Plant shall be of sufficient capacity to adequately handle the proposed construction and be maintained in good mechanical condition. Any defects that adversely affect the proper function of the Plant or the quality of the mixture shall be repaired immediately.

The Plant shall be equipped with all necessary scales, measures and weighing devices to insure proper proportioning of all ingredients and shall be so designed, coordinated and operated to produce a mixture within the job mix tolerances. Testing and checking these weighing devices and meters shall be done in the presence of the Department Personnel.

The Plant shall be equipped with a Laboratory in accordance with 106.06.

All moving parts, pulleys, belts and drive mechanisms shall be covered or otherwise protected. Stairways and platforms shall be unobstructed and have secure handrails. Particles shall be controlled within the requirements of Environmental Protection Agency. Dust collectors are required. Bag-house fines, when used, shall be re-circulated to the mineral filler bin.

- B. SCREENING** - In batch plants, the aggregates shall be screened into 3 or more fractions and conveyed into separate compartments immediately after heating. In any compartment there shall be not more than 5 percent of the aggregate larger than the screen controlling the top size of the material or more than 20 percent smaller than the screen size controlling the smallest material for the particular separation. When continuous mixing plants are used, a minimum of 3 aggregate cold feed bins shall be used to proportion aggregates to obtain the specified gradation.

- C. SURGE AND STORAGE BINS** - The Contractor may elect to store hot mixed bituminous concrete in a surge or storage bin provided said bin has received prior evaluation and approval by the Engineer. Use of the bin is to be in conformance with all limitations on retention time, type of mixture, heater operation, bin atmosphere, bin level or other characteristics set forth in the applicable Specifications. Affixed to each bin shall be an indicator device that will be activated when the material in the bin drops below the top of the sloped portion of the bin. The indicator devices shall be visible from the Inspector's office and to the loading operator.

An evaluation of a surge or storage unit will determine the degree of composition uniformity, temperature characteristics and the degree of asphalt cement hardening of mixture processed through the surge or storage unit. Approval will be granted for bin usage that consistently results in mixtures having gradation and temperature properties of no less quality than specified mixtures discharged directly from the Plant's mixing operation and resulting in asphalt hardening properties which do not exceed the limits specified below. Materials for use as open graded coarse material should not be stored because of the likelihood of asphalt migration. Mixtures that the Engineer determines visually to be segregated will be rejected.

Asphalt hardening due to storage shall not exceed 10 percent of the original values determined from the asphalt prior to mixing.

Original asphalt properties shall be determined from samples of asphalt taken prior to incorporation into the mix. Test procedures shall be in accordance with AASHTO M 320.

The amount of hardening due to storage shall be determined by comparison of tests on samples of the mixtures taken after exit from the pug mill or drum but before entry into the storage bin and before samples are taken after exit from the storage bin.

When asphalt hardening, due to mixing, exceeds the amount allowed for original asphalt by AASHTO M 320, use of a bin for other than as a surge bin will not be permitted unless storage can be determined to have no significant effect on asphalt hardening.

The system shall be capable of conveying the hot mix from the Plant to the storage bins and storing the hot-mix without a loss in temperature, segregation of the mix or oxidation of the mix.

Storage and surge bins shall be designed in such a manner as to prevent segregation of the hot mix during discharge from the conveyor into the bins and shall be equipped with discharge gates that will not cause segregation of the hot mix while loading the mix into the trucks.

### 904.02 TRUCKS FOR TRANSPORTING BITUMINOUS MIXTURES

Trucks for transporting bituminous mixtures shall have a solid metal, dump type bed. The bed shall be free of debris, clean, smooth and have a tight fitting rear gate to prevent loss of materials while in transit.

The inside surface of the bed shall be sprayed with a Department approved material. Petroleum derivatives or other coating materials that contaminate or alter the characteristics of the mix will not be approved nor will excessive quantities of approved material be permitted.

Each truck shall be equipped with a waterproof canvas or other suitable material of sufficient size to cover the material and protect it from the weather. When necessary to maintain temperature, the truck bodies shall be insulated to prevent temperature loss while in transit. The trucks shall not have appreciable oil leakage that may cause damage to the new bituminous construction.

A hole, 1/4 to 1/2 inch in diameter, shall be provided in the truck bed at an appropriate height to facilitate the insertion of an asphalt thermometer.

All trucks shall be equipped with a back-up alarm meeting D.C. safety code.

### 904.03 PRESSURE DISTRIBUTORS

Distributors used for the application of bituminous materials shall be of the pressure type mounted on trucks or semi-trailers equipped with pneumatic tires. The tires shall have sufficient width of rubber in contact with the prepared road surface to avoid breaking the bond or forming a rut in the surface. The rear axles of semi-trailer units shall be mounted on dual wheels.

The distributor shall be equipped with a suitable means to provide a uniform temperature of the entire mass of material. The heating unit shall be designed to heat the bituminous material without burning or overheating any portion and with effective and positive control of the heat at all times. The distributor shall be provided with at least 1 thermometer that shall be maintained in good condition at all times and placed to register accurately the temperature of the tank content.

The distributor shall be constructed and operated to be capable of evenly and uniformly applying accurately measured quantities from 0.05 to 1 gallon of bituminous material per square yard of surface. The specified rate of application shall be maintained during the distribution of the entire load regardless of change in grade or direction.

The spray bar and nozzle shall be of such size to insure uniform distribution of the material in specified quantities, and the nozzles shall be designed to issue a fan-shaped spray without streaks or bare spots. A strainer shall be provided in the discharge line to prevent the nozzles from becoming clogged.

The distributor shall be equipped with a tachometer that will show the speed in feet per minute. It shall be located as to be easily visible to the truck driver to enable him to maintain the constant speed necessary for the correct application of the specified quantity of material.

A pressure gauge shall be provided to indicate accurately the pressure at which the bituminous material is applied. If an air-pressure type distributor is used, the air relief valve shall be discharging at all times during the distributing operations. All distributors, except those of the air-pressure type, shall be equipped with auxiliary motors for pumping material to the spray bars.

The distributor shall be designed so that the application of bituminous material can be started and stopped instantly at all nozzles without dribbling and without the driver leaving his seat. It shall have sufficient pressure to provide a spray that will cover completely and uniformly the entire surface receiving the application.

A hand spray bar and nozzle attachment capable of operating under the required pressure and that can be gauged shall be provided with the distributor. It shall consist of a suitable length of flexible steel hose with packed couplings and will be used for touching up spots inaccessible to or unavoidably missed by the distributor.

### 904.04 BITUMINOUS PAVERS

Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thicknesses shown on the Plans. The pavers shall be equipped with adjustments of the manufacturer's standard design that will permit the bituminous material to be spread and finished in widths shown on the Plans. The machine shall be capable of placing a minimum width of 8 feet.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The paver shall be equipped with automatic feed controls, properly adjusted to maintain a uniform depth of material ahead of the screed. The paver shall be

equipped with a system for heating the screed or strike-off assembly.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

When laying mixtures, the paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

All pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed and providing the automatic signals that operate the screed to maintain the desired grade and transverse slope. The sensor shall be constructed to operate from a reference line or a ski-like arrangement.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

Manual operation may be permitted by the Engineer for the construction of irregularly shaped small areas.

Whenever a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods for the remainder of the normal working day on which the breakdown or malfunction occurred provided this method of operation will produce results meeting Specifications.

Reference lines will be required for both outer edges of the traveled way for each main line roadway for vertical control. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines or by means of a ski and a slope control device or a dual ski arrangement. When the finish of the grade prepared for paving is superior to the established tolerance and when, in the opinion of the Engineer, further improvement to the line, grade, cross sections, and smoothness can best be achieved without the use of the reference line, a ski-like arrangement may be substituted subject to the continued approval of the Engineer. The use of the reference lines shall be reinstated immediately whenever the Contractor fails to maintain a superior pavement. The Contractor shall furnish and install all pins, brackets, tensioning devices, wire and accessories necessary for satisfactory operation of the automatic control equipment.

#### **904.05 ASPHALT ROLLERS**

Rollers shall be self-propelled, reversible and steel wheeled or pneumatic tired. Rollers may be vibratory or non-vibratory, and they may be operated in the vibratory mode as long as the Engineer determines that the roller is not cracking or damaging the aggregate in the mix. Rollers shall not be used in the vibratory mode on bridge decks. Pneumatic tired rollers shall have multiple tires of equal size with smooth tread. Tires shall be uniformly inflated at the operating pressure approved by the Engineer. The Contractor shall furnish the Engineer with charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor furnished. Rollers shall be operated according to the recommendation of the manufacturer.

#### **904.06 HAND TOOLS FOR FINISHING ASPHALT SURFACES**

- A. ASPHALT LUTE** - The asphalt lute shall be of aluminum or wood with a rigid blade 3 to 6 feet in length and 6 inches in width. The blade shall be edged on the contact surface. The handle, to 1 end of which the blade shall be firmly affixed with adequate bracing, shall be 16 feet in length.
- B. RAKES** - Rakes shall be made of metal and shall be not less than 14 inches wide. The tines shall be of sufficient depth to penetrate and rake the material for its full depth.
- C. SMOOTHING IRONS** - Smoothing irons shall be made of metal and shall weigh not less than 40 pounds. The bearing surface shall be not less than 80 square inches.
- D. HAND TAMPERS** - Hand tampers for compaction of bituminous material in locations inaccessible to rollers shall be of metal construction, weigh not less than 25 pounds and shall have a tamping face of not less than 48 square inches.

## 905 PORTLAND CEMENT CONCRETE EQUIPMENT

### 905.01 BATCH PLANTS FOR PORTLAND CEMENT CONCRETE

- A. GENERAL** - Batch plants shall meet requirements of AASHTO M 157. Before starting deliveries, the Plant from which the Contractor proposes to obtain materials shall be approved by the Engineer. The batching plant for Portland Cement Concrete shall include bins for either the stationary or portable type, with adequate separate compartments for cement, cement substitutes, fine aggregates and for each size of coarse aggregate. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. The Plant shall be equipped with a Laboratory in accordance with 106.06.

The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. Particles shall be controlled within EPA requirements. The batch plant shall be equipped with a suitable non-re-settable batch counter that will correctly indicate the number of batches proportioned.

All batching plant structures shall be properly leveled within the accuracy required by the weighing mechanism design.

- B. BINS AND HOPPERS** - Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batch plant.

Hoppers shall be constructed so as to eliminate accumulation of tare materials and to fully discharge without jarring the scales.

All hoppers, except cement hoppers, shall have a means of removing an overload of any one of the several materials.

Partitions of sufficient size to prevent spilling under working conditions shall separate the cement and aggregates in the weighing bins and in the hoppers.

- C. SCALES** - Use beam scales, Springless dial scales or electronic load cell scales with a readout when weighing aggregates and cementitious materials. The scales for weighing aggregates and cement shall conform to the requirements of 109.01 and the following requirements. When beam-type scales are used, the provision such as a "tell-tale" dial shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on weighing beams shall indicate critical position clearly. The weighing beam and "tell-tale" device shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

Graduated dials shall be provided with suitable markers, inside the glass cover and in front of the dial that may be set to indicate the position of the dial indicator for predetermined loads in the weighing hopper.

The hopper and scales shall be suitably enclosed to protect against the influence of wind. Ten 50 pound standard test weights shall be provided at each batch plant for testing weighing equipment.

The scales shall be maintained within a tolerance of 0.5 percent of the net load in the hopper. The minimum graduation on the beam or dial shall not be greater than 0.2 percent of the rated capacity of the scales. All cement handling, weighing and batching apparatus shall be protected from the weather.

Clearance between scale parts, hoppers and bin structures shall be such as to avoid displacement of or friction between parts due to accumulations, vibration or other causes. Pivot mountings shall be designed so none of the parts will loosen and to assure constant spacing of knife edges under all circumstances. Scales shall be designed so that all exposed fulcrums clevises and similar working parts may be readily cleaned. The weighing mechanism of the scales shall be constructed of non-corrosive materials and of hardness greater than brass. Weighing beams shall have leveling lugs, and weighing parts of other types shall be provided with means for precision adjustment. Scales shall be inspected, calibrated and properly sealed at the expense of the Contractor when required by the Engineer.

- D. AUTOMATIC WEIGHING DEVICES** - Batching plants shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices of an approved type.
- E. WATER MEASURING EQUIPMENT** - The accuracy of the water measuring equipment shall be within 1.5 percent error. The measurement shall not be affected by variations of pressure in the water supply line and shall be accurate under all construction conditions encountered. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to check the setting

unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be equal to or greater than that of the measuring tank.

- F. **CHEMICAL ADMIXTURES** - Use an automatic dispenser for adding each admixture. Ensure the Plant is equipped with a separate dispensing system with a visual sight gauge for each chemical admixture incorporated into the concrete mix,

### 905.02 MIXERS, PAVERS, AND DELIVERY EQUIPMENT

- A. **TRUCK MIXERS AND AGITATORS** - Truck mixers and agitator trucks shall meet the requirements of AASHTO M 157 for Ready-Mixed Concrete and be equipped with a back-up alarm meeting the D.C. Safety Code. Each truck shall be numbered in a permanent, readily visible manner. Each mixer and agitator shall have attached to it a metal plate or plates on which is marked the capacity of the drum or container in terms of the volume of mixed concrete for the various uses for which the equipment is designed and the speed of rotation of the mixing drum or blades.
- B. **CENTRAL PLANT** - The mixer shall be of an approved design of the batch type and have a rated capacity of not less than 27 cubic feet of mixed concrete. The mixer shall be capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mixture without segregation. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing that each batch is mixed in ninety (90) seconds. The mixer shall be equipped with a suitable batch counter which shall correctly indicate the number of batches mixed.

The mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 1/4 inch or more. The Contractor shall (1) have available at the job Site a copy of the manufacturer's design showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 1/4 inch wear from new conditions. Drilled holes of 1/4 inch diameter near each end and at midpoint of each blade are recommended.

### 905.03 FORMS FOR CONCRETE PAVING

- A. **PAVEMENT, BASE AND ALLEY FORMS** - Straight side forms shall be made of a metal having a thickness of not less than 7/32 inches and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to the depth of the forms. Forms shall be provided with adequate devices for the secure setting so that, when in place, they will withstand the operation of the paving equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Forms with a battered top surface, and bent, twisted or broken forms shall be removed. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the Project is less than 2,000 square yards. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall contain provision for locking the ends of abutting form sections together tightly and for secure setting.
- B. **CURB, GUTTER, CURB AND GUTTER AND SHOULDER FORMS** - Forms for this Work shall meet the requirements of (A) above with the following exceptions, changes or additions.

Forms for Portland Cement Concrete curb shall be of a depth equal to the depth of the curb. The face form shall have a batter of 1/2 inch from the top of the curb to the flow line of the gutter.

Back forms for combination curb and gutter shall be of a depth equal to the combined depth of the curb and gutter. The forms for the face of the curb and the face of the gutter shall be a depth equal to the depth of the curb and gutter respectively. The face form of the curb portion shall have a batter of 1/2 inch from the top of the curb to the flow line of the gutter and shall be so designed that it may be securely attached to the back form. When so attached, it shall be of such rigidity as to maintain a true line when concrete is placed against it.

Forms for curb, the face forms for combination curb and gutter, and the back forms for combination curb and gutter will not be required to have a base width equal to or greater than the depth of the form nor will flange braces be required; however, other means for bracing will be required.

Forms of curb, gutter, curb and gutter, or shoulder, that have attachments or plates of any type that create planes of weakness at other than the specified intervals will not be permitted.

- C. SIDEWALK FORMS** - Sidewalk forms shall conform to the requirements of (A) above except that the steel shall be not less than 10 gauge in thickness; the requirements pertaining to base width/face depth relation and the requirements for flange braces need not apply. Only 2 stake pockets will be required for each 10 feet of form; however, fabrication of the forms shall be such that they will withstand handling and remain true to line and grade under construction conditions.

#### 905.04 GRADE TEMPLATES

Templates for checking final grades of the base course material shall be rigidly constructed and shall be of such length as to span, from form to form, the section to be tested. The template shall be adjustable to the crown desired and shall be provided with shoes to ride the top of the forms without variation from the desired Elevation. Adjustable tines of equal length and spaced at 6 inch intervals shall be attached to the bottom and aligned throughout the entire length of the template.

#### 905.05 SPREADING MACHINES

The concrete spreading machine shall be power driven and capable of spreading the concrete to the full width and depth specified. It shall have multiple speeds in both reverse and forward gears.

The apparatus shall be capable of spreading the concrete to both the depth specified for reinforcement and the full thickness of the slab without segregation and without interfering with the joints or reinforcement. It shall not disturb the form due to lateral pressure of the spreading operation, and the weight of the machine shall not cause settlement of the forms.

The spreader shall be equipped with traction wheels with dismountable rims to be used when operating on concrete. Suitable means shall be provided to keep material off the wheels and the top of the forms or slab.

The spreading shall be accomplished by a suitable device of the reversing type, followed by a strike-off screed. The strike-off screed shall be adjustable to the specified crown and section.

#### 905.06 CONCRETE FINISHING MACHINES

- A. ROADWAY** - The concrete-finishing machine shall be power driven and of the transverse-screed type. It shall be equipped with traction a wheel or wheels with dismountable rims to be used when operating on concrete. Suitable means shall be provided to keep material off the wheels and the top of the forms or slab.

The finishing machine shall be equipped with 2 oscillating type transverse screeds that shall be maintained in the best possible condition and adjustment throughout their use. The front screed shall be used for striking off excess concrete to exact grade and crown.

The rear screed shall be used for finishing and smoothing. All screeds shall be constructed of steel, capable of being adjusted to the specified cross section and shall be of such rigidity as to produce the specified crown and cross section.

Each screed shall be of the floating or suspended type and at least 1 ½ feet longer than the width between the forms. They shall be easily and quickly adjustable to the width required.

Both the machine and the screeds shall have variable speeds and be independently controlled. The weight of the machine shall not cause settlement of the forms upon which it operates.

Bridge Deck Finishing Machines should not be used on pavements greater than 7 inches in depth.

- B. BRIDGE DECK FINISHING MACHINES** - The specific method and equipment that the Contractor proposes to use will be subject to the approval of the Engineer. Approval of method and equipment will not relieve the Contractor of full responsibility for obtaining the required finished surface.

The concrete finishing machine shall be hydraulically driven, capable of variable traveling speeds in both forward and reverse directions. The machine shall have a rotating auger and cylinder device that shall oscillate in the transverse direction for leveling and finishing concrete. The auger shall be 8 to 12 inches in diameter and shall be capable of leveling the concrete to the approximate finished grade. The cylinder shall have the same diameter as the auger and shall be approximately 4 feet long. The cylinder shall be capable of consolidating the surface and screeding to the final finished grade while traveling in 1 transverse direction and

finishing while traveling in the opposite direction. A pan-type vibrator shall be mounted directly ahead of the auger to insure final compaction of any surface voids caused by workers after initial vibration. A steel float pan shall be mounted directly behind the cylinder and shall be capable of imparting a final seal to the concrete.

The machine carriage shall be fully adjustable. The machine shall be capable of being adjusted in the vertical direction to within 1/16 inch of the Elevation and cross section shown on the Plans, including parabolic and straight crowns. The machine shall be capable of being adjusted to any width from 12 feet to the full width of the bridge deck. The machine shall be capable of automatically widening or narrowing to finish tapered deck areas. The machine shall be kept in true adjustment. Machines out of adjustment shall not be used until proper adjustments have been made and the adjustments approved by the Engineer.

- C. **COMBINATION MACHINES** - Machines that have both spreading and finishing capabilities shall conform to both requirements of 905.05 and 905.06(A). When 2 screeds are not provided by a combination machine, the Engineer will require that a minimum of 2 passes with the same machine be made to provide adequate floating and consolidation.

### 905.07 VIBRATORS

- A. **MOUNTED** - Vibrators for full width vibration of concrete paving slabs shall be the internal type with either immersed tube of multiple spuds. They may be attached to the spreader or the finishing machine or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, base course material, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute, and the frequency of the internal type shall not be less than 7,000 impulses per minute for spud vibrators.

When spud type internal vibrators, attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

- B. **HAND HELD** - Internal vibrators, such as the spud type, for compacting concrete at joints and manholes shall be of an approved type and shall operate at a frequency capable of producing at least 5,000 impulses per minute. They shall not be of such weight as to be unwieldy in application and shall have sufficient cable to permit movement to any location by the Engineer.

### 905.08 MEMBRANE CURING EQUIPMENT

- A. **PAVEMENT WIDTHS OF NINE FEET OR MORE** - For pavement widths 9 feet or more, membrane curing, if used, shall be applied by equipment meeting the following requirements:

The equipment shall be an approved, self-propelled, mechanical pressured sprayer delivering a fine, even spray with uniform coverage and shall be operated upon the pavement forms. A suitable shield or apron shall be provided to effectively protect the spray from the wind. Sufficient nozzles shall be on hand at all times so that any inefficient nozzle can be immediately replaced. Suitable means of cleaning and repairing the nozzles shall also be on hand and shall be considered as being part of the spraying equipment.

- B. **PAVEMENT LESS THAN NINE FEET WIDE** - For pavement widths less than 9 feet, for sidewalks, curb and gutter, or irregular shapes, the equipment used to apply membrane curing compound may be equipped with a container having not less than 5 gallons in which a constant pressure shall be maintained by a mechanical means. The equipment does not have to be self-propelled.

### 905.09 HAND TOOLS

- A. **HAND STRIKE-OFF SCREEDS** - Hand screeds for striking off concrete prior to final finishing shall be made of metal or metal shod wood construction with convenient handles for even operation. The length shall measure 4 feet greater than the slab upon which it is used. The screed shall weigh not less than 15 pounds per linear foot and shall be of such rigid construction that it will not reduce the crown of the slab nor disturb the center longitudinal joint because of any sag in the midsection.
- B. **EDGING TOOLS** - Edging tools for use on finished concrete shall be made of metal and be 2-1/2 inches in width. They shall have radii of 1/4, 1/2, 3/4 or 1 inch as required.
- C. **FLOATS** - The small hand float used to finish the pavement surfaces adjacent to the curb shall be made of wood and be at least 12 inches in length.

The float used to finish concrete pavement shall be 8 inches in width and a minimum of 4 feet in length. The minimum length of attached handle shall be 16 feet and at least 4 feet longer than the width of the slab on which it is used.

**D. BROOMS**

1. **For Use On Pavement Surfaces** - The brooms used to produce a roughened surface on the Portland Cement Concrete pavement shall be street brooms with split bamboo bristles or metal-bristle brooms made especially for this purpose. The length of the broom handle shall be at least 1/2 the slab width and the broom width shall not be less than 14 inches.
2. **For Use On Sidewalk Surface** - Brooms used for finishing sidewalk surfaces shall be of the hair or bristle type, and shall be not less than 14 inches in width. Nylon brooms shall not be permitted.

**E. HAIR BRUSHES** - Brushes used for finishing concrete curb shall be of the hair or bristle type. Nylon brushes shall not be permitted.

**F. METAL TINES** - For texturing concrete surfaces on bridge decks, metal tines shall be 0.03 inches thick, 0.08 inches wide and 4 to 6 inches in length. Average transverse groove spacing shall be approximately 1/2 inch. Broom shall be a minimum of 18 inches wide



## **APPENDIX PAVEMENT SMOOTHNESS SPECIFICATION**

<b>APPENDIX I PAVEMENT RIDE QUALITY</b>	<b>823</b>
APPENDIX I.01 DESCRIPTION	823
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**APPENDIX I PAVEMENT RIDE QUALITY****APPENDIX I.01 DESCRIPTION**

This special provision describes pavement surface smoothness construction and quality control, using the International Roughness Index (IRI), for concrete and asphalt paved surfaces. It includes incentives and disincentives. The Contractor shall use an inertial profiler or rolling inclinometer to collect Quality Control (QC) data on pavement ride quality. The profiler shall conform to ASTM E 950 and the Department Equipment Specification and Test Method for Ride Quality Data Collection.

This work shall consist of:

- A. Furnishing and operating a certified profiler to measure ride quality according to the International Roughness Index (IRI).
- B. Maintaining the profiler in calibration and good working order.
- C. Providing a certified profiler operator.
- D. Preparing and submitting a Ride Quality Measurement Plan and, if required, a corrective action plan to the Engineer for acceptance.
- E. Ensuring that the pavement on which ride quality measurements are taken is sufficiently clean prior to ride quality measurements.
- F. Performing all ride quality measurements as required by this special provision.
- G. Completing all corrective action.

This special provision supersedes the longitudinal tolerances specified in subsection *401.14, Surface Tolerances*, of the Standard Specifications for Construction, with the exception as noted in Section 3. Subsections *501.13 (F), Surface Correction*, and *501.16, Surface Testing*, of the Standard Specification for Construction shall remain in force.

**APPENDIX I.02 RELATED STANDARDS****A. AASHTO STANDARDS**

- 1. PP 37-04, Determination of International Roughness Index (IRI) to Quantify Roughness of Pavements
- 2. PP 49-03, Certification of Inertial Profiling Systems
- 3. PP 50-03, Operating Inertial Profilers and Evaluating Pavement Profiles
- 4. PP 51-03, Pavement Ride Quality When Measured Using Inertial Profiling Systems
- 5. MP 11-03, Inertial Profiler

**B. ASTM STANDARDS**

- 1. ASTM E 950-98, Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
- 2. ASTM E 1926-98, Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile

**C. THE DEPARTMENT STANDARDS**

- 1. The Department Equipment Specification and Test Method for Ride Quality Data Collection
- 2. Subsection 401.14, Surface Tolerances
- 3. Subsection 501.13 (F), Surface Correction
- 4. Subsection 501.16, Surface Testing

**APPENDIX I.03 TERMINOLOGY**

- A. DEFECT SEGMENT** – Any 25-foot segment with measured IRI greater than the IRI threshold for defect penalty/correction (IRI<sub>d</sub>) (section 9.4(b)).
- B. CONTRACTOR QUALITY CONTROL MEASUREMENT OF RIDE QUALITY** -- Informational run(s) made by the Contractor to determine the ride quality acceptability, the need for corrective action, or the need for a process change. It can also include runs made after corrective action to determine if corrective action has been sufficient.
- C. CORRECTION SEGMENT** – Any 25-foot segment with measured IRI greater than the IRI threshold for defect correction (IRI<sub>c</sub>) (section 9.4(b)).
- D. INTERNATIONAL ROUGHNESS INDEX (IRI)** – A statistic used to determine the amount of roughness in a measured longitudinal profile. Computer programs to calculate the IRI statistic from a longitudinal profile are referenced in AASHTO PP 37-00.
- E. PREDETERMINED EXEMPT AREAS** – Pavement within the project where this Pavement Ride Quality special provision does not apply, but straightedge requirements of subsection 401.14 or 501.16 of the Standard Specifications will be in force as applicable. Predetermined exempt areas include:
1. Ramps other than freeway-to-freeway ramps
  2. All ramp tapers
  3. Shoulders
  4. Drainage grates in the wheelpath
  5. Railroad crossings and pavement within 50 feet thereof
  6. Bridges – The predetermined exempt area is that area between the 2 end reference lines or between the outermost limits of any Structure expansion joint devices and pavement within 50 feet thereof
  7. Brick crosswalks.
  8. Bus pads (unless constructed by the same contractor)
- F. PROFILE** – The Elevation of a pavement surface along a line parallel to the centerline of the pavement. Also defined as a 2-dimensional plot of the Elevation of a pavement surface, taken in a longitudinal direction. Profiles are measured separately along each wheelpath of a lane.
- G. PROFILER** – In general, a device that measures the Elevation of a pavement surface and creates a profile. In particular, a device that meets the requirements of the Department Equipment Specification and Test Method.
- H. PROJECT FEATURE AREAS** – The 25-ft segments associated with pavement features such as manholes and intersections. The IRI values from these segments are not included in computing the section IRI<sub>AVG</sub>. However, they are used to determine defect costs and correction areas.
- I. RIDE QUALITY CERTIFICATION** – A formal process required by the Department to assure that ride quality measuring equipment and operators are capable of measuring ride quality to the standards established in the Department Equipment Specification and Test Method. The equipment shall display the equipment certification sticker indicating the expiration date of certification. The operator shall provide a copy of the operator certification to the Engineer.

- J. RIDE QUALITY MEASUREMENT AREA** – The local, collector, and arterial Roadways, freeway-to-freeway ramps, and other areas as shown on the project Plans.
- K. RUN OF RECORD** – The formal ride quality measurement submitted by the Contractor that includes all data files associated with the profile run, IRI values for every 25 foot segment, and the  $IRI_{AVG}$  (section 8.1) value for the submittals listed in section 8.3.1. A Run of Record is measured in the direction of travel. Each Run of Record must be labeled using a format approved by the Engineer.
- L. QUALITY ASSURANCE RUN** – A ride quality measurement made by the Engineer on a project, or portion of a project, to determine the ride quality. A verification run is conducted and the quality assurance (QA) results are compared to the Contractor Run of Record on the same pavement area to determine if the Contractor's entire Run of Record may be used as part of the acceptance decision.
- M. TEST LOT** – A continuous segment of Roadway as defined by the street name, direction, lane number, and from and to stations. Profile measurement shall be performed and recorded for each individual test lot as *Run of Record*.
- N. VERIFICATION LIMIT** – The allowable variation between the QA and the quality control (QC) data. This limit accounts for the expected variability of ride quality measurements taken by the same operator using the same piece of equipment on the same test lot. The Verification Limit is defined in section 6.2 of this specification.
- O. WHEELPATH** – The longitudinal locations 33 to 35 inches on either side of the centerline of each lane. The spacing between the right and the left wheelpath shall be between 67 and 70 inches, especially near Roadway features such as manholes.

#### APPENDIX I.04 RIDE QUALITY MEASUREMENT PLAN

A QC Ride Quality Measurement Plan shall be submitted to the Engineer for review at least fourteen (14) Calendar Days before the start of paving operations for major construction projects, as determined by the Engineer. For minor construction projects, a QC Ride Quality Measurement Plan shall be submitted to the Engineer for review at least seven (7) Calendar Days before the start of paving operations. Do not begin paving operations before receiving written acceptance from the Engineer. All paved lanes shall be tested for smoothness. All exempted areas shall be documented as to the location and reason for exemption in all data reports submitted to the engineer in charge. The Engineer will notify the Contractor of any objections to the plan within five (5) Calendar Days of receipt of the plan.

Include the following minimum requirement details in the Ride Quality Measurement Plan:

- A.** Equipment used to measure ride quality on the project.
- B.** Equipment certification or verification records for profiling equipment scheduled to be used in the QC measurements. This should include more than 1 device (additional 1 as backup) and should include the certification agency, certifying agency contact information, certification number, and expiration date.
- C.** A signed statement shall be provided that no changes to the profiling system have been made since the certification.
- D.** Certification records for any operator that might conduct the QC measurements.  
The records should include the certifying agency contact information and the operator(s) certification expiration date(s).
- E.** Planned locations for profile run of record data collection
- F.** Planned length of the profile run of record data collection
- G.** Traffic Control Plans for ride quality measurement (as required)
- H.** Planned method(s) to correct surface irregularities, when necessary
- I.** Ride quality testing and reporting time frames in relation to paving and staging operations
- J.** Feature labeling format description and other relevant notes for the run of record

**APPENDIX I.05 GENERAL RIDE QUALITY MEASUREMENT REQUIREMENTS**

Testing procedures, equipment, operators, and reporting shall be in accordance with the Department Equipment Specification and Test Method for Ride Quality Data Collection. Notify the Engineer at least twenty-four (24) hours before measuring a profile Run of Record or performing any pavement corrections.

**APPENDIX I.06 RIDE QUALITY DETERMINATION**

- A. UNITS OF MEASUREMENT** - Calculate and report ride quality as International Roughness Index (IRI) in units of inches/mile.
- B. CALCULATION METHOD** - Calculate and report an IRI value, according to ASTM E 1926, for the left and right wheelpath of each 25-foot segment of the project. Compute the  $IRI_{AVG}$  from each run as the average IRI from both wheelpaths for all 25-ft segments that do not contain features. A run is defined as a day's product, or a pre-determined test lot length no longer than 1 mile, as approved by the Department representative.

Report all ride quality values rounded down to the nearest whole number. Segments shorter than 25 feet (due to exempt areas or the project end) shall be ignored. A full 25-foot segment shall be started after each exempt area. Segments less than 25 ft that precede exempt areas shall not be included in the  $IRI_{AVG}$  calculations.

- C. CORRECTION METHOD** - When the IRI of any 25-foot segment ( $IRI_{25}$ ) is greater than the IRI threshold for defect penalty/correction ( $IRI_e$ , see section 9.4(b)), that segment is deemed *defective*, and one of the following corrective actions shall be taken, as directed and approved by the Engineer. The Contractor shall take corrective action(s) at no additional cost to the Department.

**1. Actions for Segments with  $IRI_e < IRI_{25} \leq IRIf$** 

- a. For hot mix asphalt (HMA) pavement, remove and replace a minimum of 1½ inches of HMA 1 full lane width wide for the defective segments, or
- b. For Portland cement concrete (PCC) pavement, grind the segment to bring the segment IRI into conformance with these Specifications, i.e.  $IRI_{25} < IRI_e$ , or
- c. For either HMA or PCC pavements, accept the Defect Cost ( $P_{defect}$ ) for any defect segment where corrective action is not performed. This is applicable only when the IRI of any 25-foot segment is within the IRI threshold for defects correction ( $IRIf$ ) (section 9.4(b)).

One of these corrective actions shall be applied to each defective segment as directed by the Engineer. Any approval from the Engineer to waive action 1 or 2 shall not constitute a waiver of action No. 3 unless explicitly stated in writing by the Engineer. The Contractor shall re-profile all the corrected segments and 50 feet of length before and after each corrected segment. The re-profiled data shall be used for pay calculations regarding defect segments.

**2. Actions for Segments with  $IRI_{25} > IRIf$** 

- a. For hot mix asphalt (HMA) pavement, remove and replace a minimum of 1½ inches of HMA 1 full lane width wide for the defective segments, or
- b. For either HMA or Portland cement concrete (PCC) pavement, grind the segment to bring the segment IRI into conformance with these Specifications, i.e.  $IRI_{25} < IRI_e$ .

One of these corrective actions shall be applied to each defective segment as directed by the Engineer. The Contractor shall re-profile all the corrected segments and 50 feet of length before and after each corrected segment. The re-profiled data shall be used for pay calculations regarding defect segments.

If the resulting  $IRI_{25}$  is still greater than  $IRI_f$ , after corrective action was applied, with the Department Engineer's approval, the contractor may accept the Failed Segment cost ( $P_{failed}$ , section 9.4(d)).

**APPENDIX I.07 RIDE QUALITY MEASUREMENT VERIFICATION**

- A. **GENERAL** - At the Department’s discretion, the Department may perform QA testing on sections of the pavement to verify the Contractor’s QC data. If the QA testing by the Department has not been performed within fourteen (14) Calendar Days from the date that the final, 100 percent QC data submittal is received by the Engineer, the QC data shall be used for pay adjustments on the project, if any.

Testing procedures, equipment, operators, and reporting of the QA profile testing shall be in accordance with the requirements set forth in this specification, as well as the Department Equipment Specification and Test Method for Ride Quality Data Collection, with the following exception:

If the first QA run, along with the QC data, meets the criteria specified in section 7.2.1 below, then no additional QA profile runs are required. Otherwise, the Department will carry out a total of 3 QA runs on all 25-foot segments of the project. The coefficient of variation of the QA IRI<sub>AVG</sub> for the entire project should be less than or equal to 5 percent for all 3 runs. When the 3 QA runs do not meet this criterion, additional 3 runs shall be performed until 3 measured QA runs meet this criterion. The QA run that yields the median IRI<sub>AVG</sub> value shall be used as the QA results.

**B. VERIFICATION LIMIT**

- 1. **QC Data Acceptance** - The QA and QC results will be compared to determine acceptance of the Contractor’s QC data. For each test lot, the verification limit for IRI<sub>AVG</sub>, the number of defective segments, and the number of tested segments are as follows:

PARAMETER	UNIT	QC DATA TOLERANCE WITH RESPECT TO QA DATA
IRI <sub>AVG</sub>	Inches/mile	± (5 %)
Number of Defective Segment	25-ft Segments	± (10 % )
Number of Tested Segments	25-ft Segments	Same

If the Contractor’s QC data fall within all the above tolerances, the Contractor’s QC data shall be used for all pay adjustments.

- 2. **QC Data Resolution** - When the Contractor’s QC data do not agree with the initial Department QA data as described above, both profilers shall be retested on a Department verification section to determine if either profiler does not conform to the Department Specification.

If either profiler is out of specification, that equipment shall be recalibrated or repaired as necessary, and it shall be retested to bring the device back into compliance with the Department Spec. When the Contractor’s out of specification profiler is not re-standardized and brought into compliance with the Department Equipment Specification and Test Method within three (3) paving days, the Contractor shall cease paving operations or use another standardized profiler for QC data collection. Once the Contractor’s profiler complies with the Department Equipment Specification and Test Method, the Contractor may retest sections for comparison with the Department’s data or accept the Department QA data as the basis for any pay adjustment on all sections.

If only the Department’s profiler is out of specification, the Contractor’s QC data for all sections will be accepted, from the point the conflict arose until the Department profiler is brought to compliance. When both profilers are found to be in noncompliance with the Department Equipment Specification and Test Method, both profilers shall be repaired or recalibrated as necessary, and all QC and QA testing since the previous QC/QA comparison shall be repeated.

**APPENDIX I.08 MEASUREMENT AND REPORTING**

The contractor shall compute and report the IRI average and 25-ft feature area segment IRI values as define below.

- A. **IRI<sub>AVG</sub>(OVERALL AVERAGE IRI FOR THE PROJECT)** - shall be calculated as the average of the left and right wheelpath IRI value of all tested 25-foot segments on the project, with the following exceptions. The IRI values for the 25-foot feature area segments (section 8.2) shall not be used to compute IRI<sub>AVG</sub>.
- B. **FEATURE 25-FOOT SEGMENTS EXCLUDED WHILE COMPUTING IRI<sub>AVG</sub> FOR THE PROJECT** - The IRI values from

the following 25-foot feature area segments shall not be included in computing the section IRI<sub>AVG</sub>. They will, however, be used to determine the defect costs as well as correction area, as described in section 9.

1. Pavement within 25 feet of the transverse joints that separate these joints from the existing pavement. Note that the last segment before the end of the project may be a partial segment (i.e. a length less than 25 feet). This does not apply when a transverse joint is paved on both sides as part of one contract.
2. Segments with manholes or other approved Roadway features (whose edges are within 1 foot of the wheelpath).
3. If a feature is identified within 2.5 feet of the bordering segment, the bordering segment shall also be labeled as a feature segment.
4. Major at-grade intersections with part width or staged construction (where traffic flow is maintained during construction) may be considered for exclusion from IRI<sub>AVG</sub> computation. In such cases, the excluded area shall extend 25 feet on either side of the intersection.

**C. QUALITY CONTROL REPORTING**

1. **Submittal Timing Requirements** - Results of QC testing shall be submitted to the Department Engineer in conformance with the following schedule:

Submittal	Percentage of paving completed <sup>1</sup>	Reporting time limit <sup>2</sup>
Field	Any	On the day of testing
First	10 %	Within 72 hr of completion
Interim	50 %	Within 72 hr of completion
Draft Final	100 %	Within 72 hr of completion
Re-profiled data for corrected segments	ALL	Within 72 hr of completion

<sup>1</sup> The percentage of all pavement requiring profiling that has been paved. Areas not required to be profiled are not considered in the percentage computation.

<sup>2</sup> Completion is defined as opening to traffic following paving or corrections for HMA pavement and curing sufficiently to support traffic following paving or corrections for PCC pavement. Official 25-ft segment IRI values must be submitted immediately following data collection.

When any profile testing and data submission has not been completed within the specified times and in conformance with draft Department YYYY Equipment Specification and Test Method and the Department Ride Quality Specification for all segments on the project, the tested pavement will not be eligible for incentive payment as stated in section 9.

When any profile testing and data submission has not been completed within seven (7) days and in conformance with the Department Equipment Specification and Test Method and the Department Ride Quality Specification for all segments on the project, the tested pavement will not be eligible for payment.

2. **Submittal Information Requirements** - The contractor shall submit the data and reports according to both the Department Equipment Specification and Test Method, and the schedule defined in 8.3.1.

**APPENDIX I.09 PAYMENT**

All costs associated with ride quality measurements, including all measurements required for construction and final acceptance, are included in Other Items of Work and will not be paid for separately. All corrections within the limits of ride quality shall be carried out at the Contractor’s expense.

- A. **PAY ADJUSTMENTS** - Incentive, full pay, and disincentive pay adjustments for the project shall be computed according to the following methods. Descriptions of the abbreviations used in these computations are included in table 1.



TABLE 1. FACTORS USED IN PAYMENT COMPUTATIONS

	DESCRIPTION	VALUE	UNITS
P <sub>max</sub>	Maximum Incentive for Overall IRI	+	Percent
P <sub>min</sub>	Maximum Disincentive for Overall IRI	+	Percent
P <sub>defect</sub>	Defect Segment Cost	+	Percent
P <sub>failed</sub>	Failed Segment Cost	+	Percent
PF	Pay Adjustment Factor for Overall IRI	*	Percent
INCENTIVE	Incentive for Overall IRI	*	Dollars
DISINCENTIVE	Disincentive for Overall IRI	*	Dollars
DEFECT COST	Cost for Defects	*	Dollars
FAILURE COST	Cost for Failures	*	Dollars
IRI <sub>a</sub>	Threshold IRI <sub>AVG</sub> for Maximum Incentive	+	Inches per mile
IRI <sub>b</sub>	Minimum IRI <sub>AVG</sub> for Full Pay	+	Inches per mile
IRI <sub>c</sub>	Maximum IRI <sub>AVG</sub> for Full Pay	+	Inches per mile
IRI <sub>d</sub>	Threshold IRI <sub>AVG</sub> for Maximum Disincentive	+	Inches per mile
IRI <sub>e</sub>	IRI <sub>25</sub> threshold for Defects correction/penalty	+	Inches per mile
IRI <sub>f</sub>	IRI <sub>25</sub> threshold for Defects correction	+	Inches per mile
IRI <sub>AVG</sub>	Overall average IRI for the project, excluding 25-foot feature segments	*	Inches per mile
IRI <sub>25</sub>	IRI for individual 25-foot segments	*	Inches per mile
NS <sub>nonfeat</sub>	Number of tested 25-foot non-feature segments	*	Segments
NS <sub>feat</sub>	Number of tested 25-foot feature segments	*	Segments
NS <sub>TT</sub>	Number of ALL tested 25-foot segments: NS <sub>TT</sub> = NS <sub>nonfeat</sub> + NS <sub>feat</sub>	*	Segments
NS <sub>defect</sub>	Number of 25-foot defect segments	*	Segments
NS <sub>failed</sub>	Number of the failed 25-foot defect segments	*	Segments
BP <sub>Lot</sub>	Bid price of the entire test lot	*	Dollars
BP <sub>seg</sub>	Bid price of each 25-foot segment	*	Dollars
TPA	Total Pay Adjustment	*	Dollars

\* Value to be determined on the test lot or contract.

+ The ride specification limits for P<sub>max</sub>, P<sub>min</sub>, P<sub>defect</sub>, P<sub>failed</sub>, IRI<sub>a</sub>, IRI<sub>b</sub>, IRI<sub>c</sub>, IRI<sub>d</sub>, and IRI<sub>e</sub> for Roadways will be determined by the Engineer in conformance with this specification.

1. Incentive

$$PF = P_{max}, \text{ when } IRI_{AVG} \leq IRI_a$$

$$PF = P_{max} \times \frac{(IRI_b - IRI_{AVG})}{(IRI_b - IRI_a)}, \text{ when } IRI_{AVG} > IRI_a < IRI_b$$

$$INCENTIVE = PF \times NS_{nonfeat} \times BP_{seg}$$

$$DISINCENTIVE = 0$$

## 2. Full Pay

$$\text{When } IRI_{AVG} \geq IRI_b \leq IRI_c$$

$$INCENTIVE = 0$$

$$DISINCENTIVE = 0$$

## 3. Disincentive

$$PF = P_{min} \times \frac{(IRI_{AVG} - IRI_c)}{(IRI_d - IRI_c)}, \text{ when } IRI_{AVG} > IRI_c < IRI_d$$

$$PF = P_{min}, \text{ when } IRI_{AVG} \geq IRI_d$$

$$INCENTIVE = 0$$

$$DISINCENTIVE = PF \times NS_{nonfeat} \times BP_{seg}$$

**B. DEFECTS** - A separate deduction will be assessed for all 25-foot segments within the project with IRI<sub>25</sub> levels greater than the defect level. The pay adjustment for defects (Defect Cost) shall be calculated based on the factors shown below. This pay adjustment applies only to the pavement within the tested segments, including the feature area 25-foot segments, but not including the predetermined exempt areas.

### 1. Defect Cost

$$NS_{defect} = \text{Number of segments with an } IRI_{25} \geq IRI_e < IRI_f$$

$$DEFECT COST = P_{defect} \times NS_{defect} \times BP_{seg}$$

**2. Correction Required** - Segments with an IRI<sub>25</sub> greater than or equal to IRI<sub>f</sub> will need to be corrected to reach an IRI<sub>25</sub> that is less than IRI<sub>f</sub> as defined in section 6.3.

### 3. Failure Cost

$$NS_{failed} = \text{Number of segments with an } IRI_{25} \geq IRI_f \text{ and not able to be corrected}$$

$$FAILURE COST = P_{failed} \times NS_{failed} \times BP_{seg}$$

**C. TOTAL PAY ADJUSTMENT** - The Total Pay Adjustment (TPA) for pavement surface profile on the Contract shall be the total of any incentive or disincentive for overall IRI minus any cost for defects.

$$TPA = (INCENTIVE - DISINCENTIVE - DEFECT COST - FAILURE COST)$$

This Total Pay Adjustment shall be subject to conditions (a) and (b) below:

**1.** Regardless of the measured profile of any test section, incentive payments shall not be permitted for the project when the Contractor's QC data were not submitted within fourteen (14) days of the scheduled submittal date. All other sections of this specification shall still apply. In this case, the Total Pay Adjustment is calculated as follows:

$$TPA = (0 - DISINCENTIVE - DEFECT COST - FAILURE COST)$$

**2.** The total value of Overall IRI Disincentive and Defect Cost shall not be more than the Maximum Disincentive pay adjustment (section 9.4c) for all of the profiled 25-foot segments.

$$\text{Max Disincentive} = -P_{\min} \times NS_{TT} \times BP_{\text{seg}}$$

*TPA = Max. Disincentive, if TPA is negative and smaller than Max. Disincentive*

**D. PAY LIMIT DETERMINATION** - The pay limits and levels will be determined in conformance with the following tables.

**1. Select Specification Limits For IRI<sub>A</sub>, IRI<sub>B</sub>, IRI<sub>C</sub> & IRI<sub>D</sub>**

Functional Class	IRI <sub>a</sub> (in/mi)	IRI <sub>b</sub> (in/mi)	IRI <sub>c</sub> (in/mi)	IRI <sub>d</sub> (in/mi)
Interstates, Freeways/Expressways, and Principal Arterials with Posted Speed Limit ≥ 45 mph	40	60	80	100
Principal Arterials with Posted Speed Limit < 45 mph; Minor Arterials, and Collectors	80	130	160	200
Local Roads	100	160	180	220

Note: IRI<sub>a</sub> – Threshold IRI<sub>AVG</sub> for Maximum Incentive; IRI<sub>b</sub> – Minimum IRI<sub>AVG</sub> for Full Pay; IRI<sub>c</sub> – Maximum IRI<sub>AVG</sub> for Full Pay; IRI<sub>d</sub> – Threshold IRI<sub>AVG</sub> for Maximum Disincentive.

**2. Select Defect Threshold For Correction/Penalty (IRI<sub>E</sub>) And Only Correction (IRI<sub>F</sub>)**

Functional Class	IRI <sub>e</sub> (in/mi)	IRI <sub>f</sub> (in/mi)
Interstates, Freeways/Expressways, and Principal Arterials with Posted Speed Limit ≥ 45 mph	120	160
Principal Arterials with Posted Speed Limit < 45 mph; Minor Arterials, and Collectors	250	300
Local Roads	300	350

Note: IRI<sub>e</sub> – IRI<sub>25</sub> threshold for Defects correction/penalty; IRI<sub>f</sub> – IRI<sub>25</sub> threshold for Defects correction.

**3. Select The Appropriate Pay Level For IRI<sub>AVG</sub>**

Functional Class	Maximum incentive (P <sub>max</sub> in % of total cost)	Maximum disincentive (P <sub>min</sub> in % of total cost)
Interstates, Freeways/Expressways, and Principal Arterials with Posted Speed Limit ≥ 45 mph	3%	2%
Principal Arterials with Posted Speed Limit < 45 mph; Minor Arterials, and Collectors	1.5%	1%
Local Roads	1.2%	0.8%

**4. Select The Appropriate Pay Level For Defective And Failed Segments**

Functional Class	Defect Segment Cost (P <sub>defect</sub> in % of segment cost)	Failed Segment Cost (P <sub>failed</sub> in % of segment cost)
Interstates, Freeways/Expressways, and Principal Arterials with Posted Speed Limit ≥ 45 mph	15%	60%
Principal Arterials with Posted Speed Limit < 45 mph; Minor Arterials, and Collectors	12%	50%
Local Roads	10%	40%

## APPENDIX II EQUIPMENT SPECIFICATION AND TEST METHOD FOR RIDE QUALITY DATA COLLECTION

### APPENDIX II.01 SCOPE

This specification defines the required attributes of a high-speed inertial profiling system, lightweight inertial profiling system or a rolling inclinometer profiling system used to measure longitudinal pavement profiles for construction quality control and acceptance. The system shall be able to measure and record pavement surface profiles, calculate International Roughness Index (IRI), flag Roadway features such as manholes and intersections, and provide other features necessary to meet the Department pavement smoothness quality control Specifications.

### APPENDIX II.02 RELATED STANDARDS

#### A. AASHTO STANDARDS

1. PP 37-04, Determination of International Roughness Index (IRI) to Quantify Roughness of Pavements
2. PP 49-03, Certification of Inertial Profiling Systems
3. PP 50-03, Operating Inertial Profilers and Evaluating Pavement Profiles
4. PP 51-03, Pavement Ride Quality When Measured Using Inertial Profiling Systems
5. MP 11-03, Inertial Profiler

#### B. ASTM STANDARDS

1. ASTM E 950-98, Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
2. ASTM E 1926-98, Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements

#### C. THE DEPARTMENT STANDARDS

1. Draft the Department XXXX, Special Provision For Pavement Ride Quality
2. Subsection 401.14, Surface Tolerances
3. Subsection 501.13 (F), Surface Correction
4. Subsection 501.16, Surface Testing

### APPENDIX II.03 TERMINOLOGY

- A. **ACCELEROMETER** - transducer that provides an output proportional to vertical acceleration.
- B. **ALIASING** - the error that can result when a signal is sampled at a rate less than twice the frequency of the various sinusoidal components that compose the signal. It is also described as the error that results from sampling a long wavelength signal that is mixed with a short wavelength noise signal.
- C. **ANTI-ALIASING FILTER** - a low-pass filter that suppresses short wavelength contamination of longer wavelength measurements to improve the accuracy of the sampling process.
- D. **FILTERING** - a procedure to extract desired information from a signal that also contains unwanted information (commonly called noise). Digital filtering is a calculation procedure that takes 1 set of numbers and transforms them into another set in which the noise

is reduced. Moving averages are 1 type of such transform or filter.

- E. HIGH-PASS FILTER** - reduces the effect of long wavelengths that are associated with gradual Elevation changes such as hills.
- F. INDEX** - measure or standard. Within the context of this test method, a suitably chosen index quantifying the ride quality of a pavement.
- G. INFRARED LASER SENSOR** - non-contacting transducer that provides an output proportional to the distance from the sensor to a reflecting surface. These sensors are mounted at a nominal height, or standoff distance, above the Roadway surface when the test vehicle is in a static position.
- H. LOW-PASS FILTER** - smoothing type filter that reduces the effect of short wavelengths that are associated with rapid Elevation changes such as expansion joint ribs.
- I. MEASUREMENT RANGE** - the detectable range of heights measurable by the laser sensor.
- J. MOVING AVERAGE** - filtering process whereby each data point is replaced with the average value of several adjacent points or Elevations. It is a smoothing process because the changes from 1 Elevation point to the next will not be as significant because the difference has been divided by the total number of data points in the averaging scheme. It is a type of low-pass filter.
- K. PROFILE** - 2-dimensional slice of the Roadway surface taken along an imaginary line, such as the wheelpath, in the longitudinal or travel direction. It represents the perpendicular deviations of the pavement surface from an established reference parallel to the horizontal.
- L. REFERENCE LINE** - the imaginary line formed by the infrared laser sensor and the accelerometer in a static mode.
- M. REPEATABILITY** - consistency in successive measurements of the same quantity over time. It is a quantifier of the variability in measurement error.
- N. REPORTING INTERVAL** - the travel distance between the outputs of a profile Elevation or index value.
- O. REPRODUCIBILITY** - the ability of 2 independent measurement systems to accurately, and with precision, measure and record a known or fixed value.
- P. ROUGHNESS** - according to ASTM E 867, the deviation of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics and ride quality.
- Q. RUN OF RECORD** - The formal ride quality measurement submitted by the Contractor that includes all data files associated with the profile run, IRI values for every 25 foot segment, and the IRIAVG (section 8.1) value for the submittals listed in section 8.3.1. A Run of Record is measured in the direction of travel. Each Run of Record must be labeled using a format approved by the Engineer.
- R. RUNNING INTERVAL** - set travel distance that is stepped through a test segment by an increment shorter than its length.
- S. SAMPLING OR SAMPLE INTERVAL** - the longitudinal distance between data capture points. The data includes location, height, and accelerometer values. These data points are combined to create 1 profile data point. These points may be averaged to create a final value on the reported profile.
- T. SAMPLING RATE** - the rate at which the height sensor measures vertical displacement. This sampling rate and the vehicle operating speed determine the sample interval.
- U. SENSORS** - devices that measure physical quantities. They are responsive to changes in a physical measurement such as distance, temperature, and acceleration.

- V. **STANDOFF DISTANCE** - the distance from the light source to a point in the center of the measurement range.
- W. **TEST LOT** - A continuous segment of Roadway as defined by the street name, direction, lane number, and from and to stations. Profile measurement shall be performed and recorded for each individual test lot as Run of Record.
- X. **TRANSDUCER** - device that converts variables of 1 type (i.e., voltage) into those of another type (e.g., distance). These conversions must conform to a known transformation (i.e., are proportional) to be useful.

#### APPENDIX II.04 GENERAL SYSTEM REQUIREMENTS

- A. **GENERAL** - The high-speed and lightweight inertial profiling systems shall meet the general system requirements of AASHTO MP-11 with the following additions and modifications:
  - B. **MEASURING PROFILES**
    - 1. The profiling system shall satisfy the following conditions: collect accurate profile data at testing speeds ranging from 10 to 30 mi/hr for lightweight profilers, 15 to 70 mi/hr for high-speed profilers, and up to 2.4 mi/hr for a rolling inclinometer; collect accurate profile data on pavements having roughness values (IRI's) that range from 5 in/mi to 400 in/mi, and collect accurate profile data on asphalt surfaced, surface treated (chip seal) and non- longitudinally grooved, tined, or ground portland cement concrete surfaces. The profile data shall not be affected by pavement markings that are traversed by the sensors. The collected profile data shall not be affected by pavement color, texture, or ambient lighting.
    - 2. The triggering system shall be capable of repeatability within  $\pm 3$  in over the range of operating speeds. Manual triggering is allowed for the rolling inclinometer.
    - 3. The system shall be capable of accurately collecting surface profile wavelengths from 2 in to 300 ft when operated between 10 and 70 mi/hr for the high-speed profilers, 10 to 30 mi/hr for the low-speed profilers, and up to 2.4 mi/hr for a rolling inclinometer.
    - 4. The system shall be capable of determining a profile value (sampling interval) every 1 in or less with a recording interval of no more than 2 in at the maximum collection speed of the vehicle.
  - C. **CALCULATING ROUGHNESS INDICES** - The system shall compute International Roughness Index (IRI) in real time at 25- ft intervals.
  - D. **CALIBRATION**
    - 1. Calibration of the distance and acceleration sensors and checks of the height sensors shall be easily and quickly achievable using the equipment and software provided by the manufacturer.
    - 2. The hardware required for checking the calibration of the height sensors, such as leveling plates and gage blocks, and/or other calibration devices shall be provided with each profiler.

#### APPENDIX II.05 EQUIPMENT REQUIREMENTS

- A. **GENERAL** - The high-speed and lightweight inertial profiling system shall meet the equipment requirements of AASHTO MP-11 with the following additions and modifications.
  - B. **FUNCTIONAL HARDWARE MODULES**
    - 1. **Initiation Control** – The inertial profiler shall be capable of initiating data collection with manual initiation by striking a key on the computer keyboard or provided event marker board or by using an automated photo-triggering device. The procedure used shall be user selectable, with the automated method being the default and the manual method being the secondary option. A mechanism for automatically initiating profile measurements shall be mounted on the front bumper of the vehicle. The photo-triggering device shall be mounted to a protected case that can be swiveled to face the pavement surface or to the side of the Roadway. The operator shall be able to select one of the following methods to initiate data collection: (1) the mechanism shall be triggered by reflective highway marking tape that is placed on the middle of the travel lane or (2) by tape on a cone or other device that is placed adjacent to the test lane at distances up to 10 ft from the outside lane edge. Manual

initiation of the rolling inclinometer is allowed.

2. **Event Marker System** – The event marker system shall allow the operator to mark measurement limits using both the photocell and reflective cones or manual triggering. The event marker system shall also allow the operator to mark feature locations through manual triggering.
3. **Distance Transducer** – A DMI display unit shall be placed at a position that is easily visible to the operator. The DMI shall be capable of automatically displaying distance and system speed in either English or SI (metric) units, as selected by the operator. In addition, the running DMI stationing shall be displayed on the inertial profiler computer monitor during data collection. The measured distance using this system shall be accurate to at least  $\pm 0.1$  percent. Accuracy of the rolling inclinometer transducer shall be  $\pm 0.25$  percent or below.
4. **Height Sensor** – The inertial profiler reference height of the vehicle above the pavement shall be obtained through a laser module as required. The laser should be equivalent to a Selcom laser, which has a resolution of 0.002 inches. The laser shall have a measurement range of at least 7.5 in and provide continuous coverage of the Roadway at up to 65 mi/hr. Each height sensor shall be mounted on the vehicle with its measuring axis perpendicular to the traveled surface and in line with the sensitive axis of the accelerometer. The height sensor shall be mounted such that the center of the measurement range is at the surface of the pavement when the vehicle is at rest. The spacing between the right and the left sensors shall be between 67 and 70 inches. No laser height sensors are required with the rolling inclinometer.
5. **Inclinometer Sensor** – The inclinometer sensors shall provide the profile and IRI accuracy required in section 6.
6. **Vertical Acceleration Sensor** – The accelerometers used to measure the vertical acceleration shall be of high quality, capable of measuring accelerations in the range of  $\pm 5g$ . The accelerometer shall have a resolution of at least 5 micro-g, and a bandwidth of at least 150 Hz. The accelerometer shall be biased to account for 1g acceleration of gravity and capable of being quickly calibrated using a 1g signal. The accelerometer shall be mounted such that its sensitive axis is perpendicular to the traveled surface. No accelerometers are required with the rolling inclinometer.

### C. FUNCTIONAL SOFTWARE MODULES

1. **Calibration Software** – Calibration software that will perform calibration of the accelerometer, inclinometer, and distance measuring system (DMI) and calibration checks on the height sensors. Calibration software shall be menu driven and complete, not requiring manual adjustment to any system component. Calibration constants shall be automatically computed. At the operator's request, a new calibration constant shall replace the previous inaccurate constant, and the old constant shall be recorded in a log file along with the time, date, and operator's comments, if feasible.
2. **Accelerometer Calibration Software** – The inertial profiler accelerometers shall have internal or external calibration features. After calibration, a measure of the accelerometer's error and the computed calibration factor shall be displayed on the computer monitor. The software shall be capable of replacing the inaccurate constant with the new calibration constant at the operator's keyboard command, and recording the old constant in a log file along with the time, date, and operator's comments, if feasible.
3. **Distance Measuring Software** – The distance measuring system shall be capable of being calibrated by measuring a predetermined distance on a straight section of Roadway. The distance measuring system shall be capable of calibration at measuring speeds that will be used for profiling. The inertial profiler calibration software shall be capable of detecting 2 marks that are at a known distance apart with the aid of a photocell. These 2 marks may be placed on the pavement surface (e.g., white pavement marking tape or reflective tape) or on the Shoulder of the pavement (e.g., cones with reflective markings). Manual triggering is allowed for the rolling inclinometer. The system software shall be capable of recording the distance traveled between the 2 specified marks to 3 decimal places in meters. The software shall be capable of automatically computing the calibration constant based on the actual distance between these 2 markings. At the operator's keyboard command, the new calibration constant shall replace the inaccurate constant and the old constant shall be recorded in a log file along with the time, date, and operator's comments, if feasible. The DMI calibration software shall be capable of indicating whether the measurements obtained on the section are within a user-defined tolerance limit.
4. The system shall output profile Elevation data in ERD format that is immediately readable by the current FHWA ProVAL software.

5. The system shall have an alarm system that alerts the operator if speed or height signals are out of range.

## APPENDIX II.06 SYSTEM ACCURACY REQUIREMENTS

### A. GENERAL COMPONENT REQUIREMENTS

1. **Profile Accuracy** – The profile precision of lightweight and high-speed inertial profilers shall be confirmed at least yearly by an independent review, and shall meet the AASHTO PP 49 point-to-point requirements. AASHTO PP 49 requires no more than  $\pm 20$  mils for 10 repeated measurements sampled at intervals 2 in or less. Equipment profile bias shall meet the AASTHO PP 49 point-to-point requirements that allow a maximum deviation of the average Elevations from 10 runs versus the average of 3 reference profile runs to be no more than  $\pm 60$  mils.
2. **IRI Ride Statistic Accuracy** – The IRI precision of the lightweight profilers shall be confirmed by the Pennsylvania DOT certification program. PA DOT requires single sensor IRI standard deviation of 5 repeat runs to be within  $\pm 3$  percent on the PA DOT test tracks. PA DOT also requires the mean wheelpath IRI values, based on the 5 repeat runs, to be within  $\pm 5$  percent of the reference wheelpath IRI value. They use a long wavelength cutoff of 100 ft for analysis. High speed profiler and rolling inclinometer IRI accuracy using a 300-ft long wavelength cutoff shall be confirmed in the Department profiler verification program under section 6.2.2.
3. **Distance Measurement Accuracy** – The inertial profiler distance measuring instrument accuracy shall be measured in accordance with AASHTO PP 49 over a 1,000-ft test Site. The distance obtained from the distance measuring system shall be capable of satisfying the following criteria over a reference distance of 1,000 ft ( $\pm 3$  in) over the range of equipment's operating speeds. 3 runs over a distance of 1,000 ft are required to verify the distance measurement accuracy. Accuracy of the average value within  $\pm 1$  ft per 1,000 ft is required.

### B. EQUIPMENT CERTIFICATION OR ACCURACY VERIFICATION - Profile equipment shall either be certified in accordance with section 6.2.1, or verified in accordance with section 6.2.2.

1. **Equipment Certification** - Annual certification is required for the lightweight profiler equipment. Additional recertification may be required for equipment due to repairs, replacement, and/or upgrades to the equipment's hardware or software, or questionable results on a construction or maintenance project. Certification obtained for lightweight profilers in the following manner will be recognized by the agency:
  - a. From a state agency that has a Department approved equipment and operator certification program based on AASHTO PP 49 criteria; or
  - b. Certification carried out by The Bureau of Maintenance and Operations, Roadway Management Division, Pennsylvania Department of Transportation, in accordance with the *Light Weight Profiling System Calibration Verification & Operator Certification Program Manual and Pennsylvania Test Method (PTM) # 428, Method of Test for Measuring Pavement Profile Using A Light Weight Profiler*.
2. **Equipment Accuracy Verification**
  - a. *Verification Testing Requirement* - Verification of the equipment profiles and indices shall be completed at least annually, within the same construction season, prior to any QC or QA testing using high- speed or lightweight profilers or rolling inclinometers. The same construction season is defined as from March to November of any calendar year. The Department verification shall include collecting profile and IRI data from a Department approved reference test section. The results of this testing shall be submitted to the Department for review. Upon approval, the equipment can be used for QC/QA testing. A copy of the Department approval document shall be included with the results of all QC or QA testing.
  - b. *Reference Site Description* – The Department will maintain at least 2 baseline profile testing Sites during the paving season, within or outside the District. 1 will allow for low-speed, off-road testing and the other will allow for high-speed testing. These Sites shall be 1,000 ( $\pm 0.25$ ) ft long, straight, on a grade less than 1 percent, and with minimal variation in the transverse pavement profile. The pavement surfaces shall be asphalt that is in good condition with IRI values no more than 135 in/mi. The lightweight inertial profiler off- road test Site shall allow test speeds of 15 and 30 mph. The high- speed profiler test Site shall allow test speeds of 45 to 55 mph without traffic control. Rolling inclinometers shall be used at 0.1 to 2.4 mi/hr.



- c. *Reference Site Baseline Testing* – The Department will conduct reference testing for these sections in the first weeks of March and July of each year, weather permitting. Reference testing shall include the collection of 3 profiles in each wheelpath using an approved, calibrated rolling inclinometer with a sampling interval of 1.0 in and high accuracy in wavelengths from 2 inches to at least 300 feet. During the March testing, the reference profiles shall be checked and adjusted using high accuracy rod and level measurements at 50-ft intervals. The accuracy of the Site length will also be confirmed during the March testing.
  - d. *Verification Testing* – This shall include collecting 3 sets of profiles from both wheelpaths, at both of the verification test Sites. These profiles shall be filtered using a 300-ft high-pass filter and the manufacturer’s recommended low-pass filters. If needed, traffic control and associated permits must be provided and obtained by the contractor for such testing. The contractor shall also ensure that the Verification Test Site is clean of debris for profile testing purpose.
  - e. *Verification Test Reporting* – Contractors shall submit to the Department profiler field printouts of left and right wheelpath IRI values at 25-ft intervals beginning at the start of the test Site. Profiler provider shall submit electronic copies on CD of their verification profile data to the Department within seven (7) days of verification testing in approved ERD format. Paper reports shall be submitted at the same time that include, at a minimum, the following information:
    - i. Section information – List the verification test Site number and location.
    - ii. Testing date and conditions – List the testing date and times and average air temperature.
    - iii. Calibration Confirmation Form – A signed Profiler Calibration Form, as shown in Attachment A, list the results of all pretesting calibration activities.
    - iv. Filter settings – Note the long and short wavelength cutoff values.
    - v. Software version – List the software version used for collecting and processing the profile data.
    - vi. Sampling and recording intervals – List the sampling and reporting intervals used in data collection.
    - vii. Profile printouts – Print and include the profiles from each run and wheelpath.
    - viii. IRI Summary Data – List the overall IRI values (in/mi) for each run and wheelpath on the verification Site. Also list the IRI average and standard deviation for each wheelpath.
    - ix. IRI Detail Data – List the 25-ft IRI values (in/mi) for each run and wheelpath of the verification test Site. Also include IRI average and standard deviation values for each 25-ft segment.
  - f. *Verification Testing Acceptance* – The Department will review the precision and bias of the submitted IRI values. Evaluation results will be provided in writing within seven (7) working days of submittal. The Department will evaluate the overall IRI values to ensure that the mean of the 3 runs is within 5 percent of the reference average IRI. The Department will also ensure that the coefficient of variation (standard deviation/mean) of the overall IRI in each wheelpath is no more than 3 percent.
- C. OPERATOR CERTIFICATION** - The profiler operators are required to be certified, and must be recertified a minimum of every three (3) years. Certification obtained for the profiler operators in the following manner will be recognized by the agency:
- 1. From a state agency that has a Department approved equipment and operator certification program based on AASHTO PP 49 criteria; or

2. Certification carried out by The Bureau of Maintenance and Operations, Roadway Management Division, Pennsylvania Department of Transportation, in accordance with the *Light Weight Profiling System Calibration Verification & Operator Certification Program Manual* and *Pennsylvania Test Method (PTM) # 428, Method of Test for Measuring Pavement Profile Using A Light Weight Profiler*.

## APPENDIX II.07 TESTING PROCEDURE

Quality control and quality assurance testing shall include the following procedures and any additional manufacturer's recommendations that are not in conflict with these Specifications. In addition, ride quality testing shall be consistent with the Ride Quality Measurement Plan as defined in the Department Ride Quality Specification.

### A. PROJECT TEST AREA SETUP

1. **Boundary Marking** – Mark on the pavement surface with temporary marking paint the beginning and end of the area to be tested, designated by the project stationing, the words "Begin" or "End," and a test date, e.g., 9/16/2007. Mark on the pavement the boundaries of all exempt areas, as defined in the Department Ride Quality Specification.
2. **Feature Location Identification And Wheelpath Marking** – It is strongly recommended that each Roadway feature be identified before testing, and that a reflective cone be placed at each feature location to allow automatic feature event triggering during profile testing. It is further recommended that temporary marks be placed in one or both of the wheelpaths where Roadway features are present, and at every 150-ft interval. Wheelpaths shall be marked at manholes, especially where lateral offset needs to be measured in order to determine whether the manhole should be considered as a feature or not.
3. **Exempt Area Event Marking** – Place event triggers on the side of the pavement at the start of each exempt area. Event marks at each of these locations shall be included in the profile data.

### B. DAILY EQUIPMENT CHECKS

1. **Equipment Settings** – A certified operator shall ensure that the long wavelength filter setting on the profiler is set at 300 feet and the short wavelength filter is set at no greater than 0.5 feet.
2. All maintenance, repair, cleaning, and calibration should be completed as recommended by the equipment manufacturer.
3. Pretest calibration and calibration checks shall be completed prior to testing. Any problems noted in these daily calibration checks shall be resolved prior to official data collection. The Pretest Calibration Report in Attachment A shall be completed, signed, and provided to the Engineer prior to leaving the test Site.
4. **Static Height Measurement Calibration** – Certified operators shall complete inertial profiler static height measurement testing according to AASHTO PP 49, Section 6.2. The average of the absolute difference between the measured and certified height of 0.25, 0.5, and 1.0 inch blocks shall be no more than 0.01 in.
5. **Accelerometer Calibration** – Accelerometer calibration of inertial profilers shall be calibrated using the manufacturer's automated calibration software.
6. **Bounce Testing** – Certified operators shall complete inertial profiler static and dynamic bounce testing following calibration of the accelerometers and vertical height sensors. The average static (no bounce) IRI from each wheelpath sensor for at least 300 ft shall be no more than 4 in/mi. For dynamic bounce testing, the vehicle shall be bounced from the rear or the front to produce 0.5 in of total vertical displacement of the height sensors. Average dynamic bounce test IRI for at least 300 ft of simulated data collection shall be no more than 7 in/mi for lightweight profilers and 9 in/mi for high speed profilers, unless approved by the Engineer.

### C. DATA ACQUISITION

1. Prior to data collection, the operator shall update the profile project software to include the project number, direction of travel, operator, test date, test time, beginning station, and equipment parameters.
2. Project profile data shall be collected in the direction of travel using a constant speed that is within the allowable range confirmed during certification. The system shall be brought to the desired testing speed far enough in advance of the beginning mark to ensure accurate profile and IRI data. Collect profile data on a length of pavement as long as practical and between

predetermined exempt areas. Label each Run of Record according to the Engineer's approved format.

3. The operator shall activate all inertial profiler testing and recording equipment so that it is stabilized at the test speed prior to reaching the project test location. The test speed shall be maintained throughout the length of the project test area.
4. The inertial profiler equipment shall trigger data collection automatically at the beginning of the project test location using a photocell and reflective device. The operator shall maintain a smooth driving pattern with the height sensors centered in the wheelpaths, particularly ensuring wheelpath positioning over pavement features. The equipment shall also automatically place an event mark at the end of the measured project test location using a photocell and reflective device. Rolling inclinometer operators shall manually insert an event marks at the end of the section.
5. The profiler operator shall conduct a single run of profile testing and data acquisition. If the computed  $IRI_{AVG}$  is within 15 in/mi from an IRI threshold value (i.e.  $IRI_a$ ,  $IRI_b$ ,  $IRI_c$ ,  $IRI_d$ ,  $IRI_e$  &  $IRI_f$ ) as defined in the Department Ride Quality Specification, and with approval of the on-site Department personnel, the contractor may choose to conduct additional error-free 2 runs. The test run that yields the median  $IRI_{AVG}$  shall be used as the run of record.

## APPENDIX II.08 REPORTING

The operator shall submit to the Engineer Operator and Equipment Certification Records, a Pretest Calibration Report, and a Field Data Report prior to leaving the Site, unless approved by the Engineer.

- A. **OPERATOR CERTIFICATION AND EQUIPMENT CERTIFICATION OR VERIFICATION RECORDS** – A copy of the current operator certification, and a copy of the current equipment certification, or the Department approved verification report approving the testing equipment shall be provided to the Engineer prior to data collection. The verification testing shall have been done at least annual and within the same construction season.
- B. **PRETEST CALIBRATION REPORT** – All pretest calibration shall be completed and reported on the form in Attachment A. 1 signed original of the Pretest Calibration Report shall be submitted to the Engineer for each day of testing on 1 project. The operator shall provide equipment and operator certification information, and verification reports sufficient to confirm their adequacy for testing.
- C. **FIELD DATA REPORT** – A field IRI printout from all runs of record shall be submitted to the Engineer. The printout shall include the left and right wheelpath IRI values for each full 25-ft segment between predetermined exempt areas or from the end of an exempt area and the end of the testing area. The field data report shall define the project stations for all exempt areas and project feature location, as defined in the Department Ride Quality Specification. Descriptions or explanations shall be provided for each exempt area. All 25-ft segments that include features shall be marked on the Field Data Report with a description or code for the feature type.

Within seventy-two (72) hours of profile QC data collection, the contractor shall submit an electronic copy in Microsoft® Excel format, and if requested by the Engineer a printed copy, of the test results for the pavement being measured as generated by the test equipment performing the test. This report shall be for project-level QC or QA data and shall include:

1. Header information including the equipment identification and approval date, Site description (route, lane, limits, and direction), date and time of testing, equipment filter and sampling settings, the operator's name, profile collection equipment software versions, and test speed data (if not given for each segment)
2. A column identifying the project station number for each measured 25-ft segment
3. Columns associated with (b) for the left, right, and average wheelpath 25-ft segment IRI values for each run of record
4. The exact stationing limits and description for all feature segments which are not included in  $IRI_{AVG}$  computations but are subject to defect evaluation
5. The exact stationing limits and a description of all exempt areas which are not to be included in pay adjustment calculations

These data shall be provided in the Microsoft Excel format shown in Attachment B: Electronic Data Format. Raw profile data

(distance and Elevation values) shall be saved and archived by the contractor and shall be available for all project QC data review until the project is closed.

**ATTACHMENT A PRETEST CALIBRATION REPORT**

<u>Date:</u>	
<u>Contractor:</u>	
<u>Job Location:</u>	
<u>Operator (print):</u>	
<u>Operator Certification Date:</u>	
<u>Operator Certification Expiration Date:</u>	
<u>Test Vehicle Certification Number:</u>	
<u>Test Vehicle Certification / Expiration Date:</u>	/
<u>Test Vehicle Verification Date:</u>	

DMI Check:

Test Site Length, ft	Measured Length, ft			
	Run 1	Run 2	Run 3	Average

*Note: Average measured length must be within 0.1 percent (0.1%) of the test section length*

Height Sensor Calibration Block Check:

Left	Block height, in		Right	Block height, in	
	Nominal	Actual		Measured	Nominal
0.25 inch			0.25 inch		
0.5 inch			0.5 inch		
1.0 inch			1.0 inch		

*Note: Average measured block height must be within 0.01 in of the actual block height*

Accelerometer Calibrated (circle one): Yes / No

Selected Long Wavelength Cutoff (ft) \_\_\_\_\_

Bounce Test:

Left Sensor		Right Sensor	
Static IRI, in/mi	Dynamic IRI, in/mi	Static IRI, in/mi	Dynamic IRI, in/mi

*Note: Static IRI must be ≤ 4 in/mi. Bounce 0.5 in. .Dynamic IRI must be ≤ 7in/mi (lightweight) ≤ 9 in/mi (high-speed)*

Operator (sign)	
Contractor (sign)	
Inspector (print)	
Inspection Agency (print)	
Inspector (sign)	

**ATTACHMENT B ELECTRONIC DATA FORMAT**

Each page described in this Attachment shall be a separate worksheet in the delivered Microsoft EXCEL Workbook. The expected worksheet name, or an example of a worksheet name, is shown in parenthesis.

- A. CONTRACT INFORMATION PAGE (CONTRACT INFO)** - This page contains general contract information used in the Department ride specification software utility.

Field Names	Information
Contract Name	ARA01
Functionl Class	Minor Arterial
Work Description	resurface
Street	17th st
From Street	Constitution Ave
To Street	C St
Year	2007
Quad	NE
Ward	1
Width, ft	36
Length, mile	0.09
No. Blocks	1
Start SISID	20170020
End SISID	20170020
Total Bid Price, \$	
Bid Price for each 25-ft segment, \$	500
<b>DC Ride Spec Lot Information</b>	
Field Names	Information
Test Lot	N_1_1
From Street	Constitution Ave
To Street	C St

- B. MASTER PAGE (MASTER)** - This worksheet contains the worksheet names for the worksheets contains the header, feature and IRI data for the lot tested.

WorkSheetNames	Description
17STS1_Header	
17STS1_IRI_File_1	QCRun1
17STS1_IRI_File_2	QCRun2
17STS1_IRI_File_3	QCRun3
17STS1_IRI_File_4	QCRun4
end	

C. **HEADER/FEATURES PAGE (EXAMPLE: 17STS1\_HEADER)** - This page contains the header information for the data files collected with the inertial profiler and required for the Department ride specification software utility. It also contains the locations and descriptions of the feature items located within the lot tested.

1. Header Information

File Name	Vehicle Identification	Approval Date	Route	Lane	From Station	To Station	Dir	Test Date
17ST S1.E01	MULE	11/01/2007	17TH ST NE	1	0	437	South(+)	11/4/2007
end								

Test Time	Wave Long	Wave Short	Contractor	Driver	Reporting Software Version	Vehicle Software Version	Speed (Mph)	Sample Rate (Ft)
16:40:42	300 ft	none	ARA/MAD	Brian	RP090L v3.42 – 12 AUG 2003	MD 09 06	12	25

(Please note that the header information needs to be on the same line in the EXCEL Worksheet)

2. Feature Information

SrcFile	Station Location	Event Code	Feature Description
17STS1	0	Section	Section Start
17STS1	0	EVNT	Construction Joint
17STS1	399	EVNT	Manhole
17STS1	413	EVNT	Manhole
17STS1	419	EVNT	Manhole
17STS1	437	SEC_END	/
end			

D. **EXEMPT AREAS PAGE (EXEMPT AREAS)** - This page contains the location and description of all Exempt Areas contained within the lot tested.

Route	Station From	Station To	Exempt Area Description

E. **IRI DATA PAGE (EXAMPLE: 17STS1\_IRI\_FILE\_1)** - This page contains the IRI data for each 25-ft segment within the lot tested.

File Name	Route	Test Date	RefAdj	Station from	Station To	SegLen	IRI1	IRI2	IRIAvg
17STS1.P02	17THSTNE	11/4/2007	(R)=	0	25	25	432	390	411
17STS1.P02	17THSTNE	11/4/2007		25	50	25	244	212	228
17STS1.P02	17THSTNE	11/4/2007		50	75	25	128	206	167
17STS1.P02	17THSTNE	11/4/2007		75	100	25	137	75	106
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