Approved Permanent Specification changes from last Committee meeting (12/5/18)

- Section 604 - Pipe Culverts Complete section rewrite; updates materials and installation
  - Material requirements changes/updates related to the Section 604 & Section 606 revision:
    - 708.5-708.9 Update pipe joint requirements
    - Section 713 - Metal Pipe Update materials of pipe and underdrain
    - Section 714 - Concrete and Plastic Pipe Update materials of pipe and underdrain
- 606.1-Description, 606.2-Materials, and 606.6-Pay Items Updates material and pay items of Underdrain section
- Section 420 - Single / Multiple Course Micro Surfacing Adds section to the spec book
- 716.1-General & 716.1.1.2-Granular Material Updates description and adds 3 inch particle size requirements to the granular subsection. It also incorporates AASHTO T-27 and T-11 wash test
- 207.2.2.2-Gradation, 212.2.5.2-Gradation, 307.2.4.1.2-Gradation, 604.2.4.2-Gradation, & 609.2.5.1-Gradation Updates gradation subsection to various sections; the update clarifies the testing and sublots
- 401.5.1-Procedures, 401.6.4-Compaction, 401.7.3-Compaction, & 401.13-Basis of Payment Revises the compaction requirements
- 607.1-Description, 607.2-Materials, 607.4-Erecting Rail Elements, & 607.5-Guardrail Removed and Rebuilt or Stored Allows use of Zinc-Aluminum-Magnesium-Alloy coated steel deep beam type guardrail
  - Material requirements changes/updates related to the guardrail revision:
    - 712.5-Zinc-Aluminum-Magnesium Alloy Coated Steel Deep Beam Type Guardrail New subsection for Zinc-Aluminum-Magnesium-Alloy coated steel deep beam type guardrail
- 105.6.1-Division Owned Utilities New subsection; for locating Division owned utilities on projects
- 601.13.3-Concrete Protective Coating Updates the concrete protective coating requirements
  - Material requirements changes/updates related to the concrete protective coating revision:
    - 711.1 through 711.22 Update material requirements of Section 711
- 640.4.5-Minimal Field Office Removes the copier requirements from the minimal field office
- Section 657 - Roadside Sign Supports Complete section re-write; update to bring to current standards and in line with revisions to the Standard Details.
  - Material requirements changes/updates related to the Section 657 revision:
    - 709.51 through 709.55 Update sign support material requirements
- Section 658 - Overhead Sign Structures Update to bring to current standards and in line with revisions to the Standard Details.
- Section 661 - Traffic Signs and Delineators Complete section re-write; update to bring to current standards and in line with revisions to the Standard Details.
  - Material requirements changes/updates related to the Section 661 revision:
    - 715.9.3 & 715.9.4 Updates channelizing devices and reflective sign support strip subsections
- 664.2 - Materials and 664.3.1 - Impact Attenuating Devices Updates to MASH implementation requirements
  - Material requirements changes/updates related to the Section 664 revision:
    - 715.41 Updates traffic safety devices subsection
- Section 720 - Smoothness Testing
- 707.15.2-Performance Requirements for Concrete Hydration Control Stabilizing Admixtures Outlines the approval process for the 3-hour discharge time extended mixes
Approved Project Specific Special Provisions (SP) from last Committee meeting (12/5/18)
- **SP655 - Tied Concrete Block Erosion Matting** Permanent erosion control mat for slopes, channels, outlet protection
- **SP695 - Mainline Pavement** Allows contractor to select either asphalt or concrete pavement system
- **SP320 - Truck Escape Ramp** Updates the material requirements
- **SP688 - Water Jetting** Only allow surface preparation via Ultrahigh-Pressure water jetting

Items removed from Committee Agenda
- **SP 105 - Dates of Governing Specifications and Standard Details**

Old Business - Provisions discussed at last Committee meeting

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<table>
<thead>
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<tbody>
<tr>
<td><strong>601</strong></td>
<td><strong>601.4.2-Contractor's Quality Control</strong></td>
<td>2nd time to committee; discussed in December. Proposed specification change to Section 601. It updates the contractor's quality control subsection. It requires direct oversight of concrete batching operations by certified PCC Technician. It also requires any Agency tests Contractor QC cylinders to be certified for testing cylinders in accordance with ASTM C1077. The concrete subcommittee discussed this proposed specification during their December meeting. No update to the proposed specification. A redline copy, showing the proposed changes/updates to the existing specification is included. <strong>Approval is expected in February</strong></td>
</tr>
<tr>
<td><strong>601</strong></td>
<td><strong>601.7-Mixing</strong></td>
<td>2nd time to committee; discussed in December. Proposed specification change to Section 601. It clarifies the 1-hour discharge time doesn’t apply when mixes that use a hydration control stabilizing admixture are used. It also notes that if superplasticizer is used to adjust the slump of a mix at the jobsite, water can’t be used after that to make further slump adjustments. The concrete subcommittee discussed this proposed specification during their December meeting. The provision has been updated per comments at the last meeting. A redline copy, showing the proposed changes/updates to the existing specification is included. <strong>Approval is expected in February</strong></td>
</tr>
<tr>
<td><strong>601</strong></td>
<td><strong>601.8.7-Removal of Forms and Construction of Superimposed Elements</strong></td>
<td>2nd time to committee; discussed in December. Proposed specification change to Section 601. It requires adjacent bridge deck placements within a pour sequence to be treated as superimposed elements in Table 601.8.7. No update to the proposed specification. A redline copy, showing the proposed changes/updates to the existing specification is included.</td>
</tr>
</tbody>
</table>
### New Business - New Provisions for Spec Committee

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>601</td>
<td>601.13.3-Concrete Protective Coating</td>
<td>This is an update to specification approved at the last meeting and included in 2019 Supplemental. 1st time to Committee. Proposed specification change to Section 601. It updates the concrete protective coating subsection. A redline copy, showing the proposed changes/updates to the 2019 supplemental specification is included. The material requirements changes/updates related to the coatings are also included. 1. 711.1 through 711.23</td>
</tr>
<tr>
<td>711</td>
<td>711.1 through 711.23</td>
<td></td>
</tr>
<tr>
<td>604</td>
<td>SP604 - Pipe Lining</td>
<td>This is an update to previously approved SP's. 1st time to Committee. Project Specific provision for HDPE Pipe Liner. The update revises the appendix so that inside &amp; outside pipe diameters are listed. It is a redline copy, showing the proposed changes/updates.</td>
</tr>
<tr>
<td>616</td>
<td>SP616 - Predrilled Piling backfilled with Concrete</td>
<td>This is an update to previously approved SP's. 1st time to Committee. Project Specific provision for predrilled piling and backfilled with concrete. The update allows modified Class B. It is a redline copy, showing the proposed changes/updates.</td>
</tr>
<tr>
<td>108</td>
<td>108.7.1-Failure to Complete on Time and Liquidated Damages</td>
<td>1st time to Committee. Proposed specification change to Liquidated Damages table. The provision is a redline copy, showing the changes/updates to the existing specification is included. There is also a table comparing the proposed LD to that of surrounding states LD.</td>
</tr>
<tr>
<td>492</td>
<td>SP 492 - Cold Central Plant Recycling</td>
<td>1st time to committee. Project Specific Special Provision (SP) for cold central plant recycling.</td>
</tr>
<tr>
<td>601</td>
<td>SP601 - Embedded Galvanic Anode Protection</td>
<td>1st time to committee. Project Specific Special Provision (SP) for embedded galvanic anode protection.</td>
</tr>
</tbody>
</table>
Comments
Comments are requested on these Specification Changes and Project Specific Special Provisions. Please share your comments by February 4, 2019, they help in the decision making process.

Please Send Comments to: DOHSpecifications@wv.gov

Deadline for new items & updates to these provisions is March 6, 2019
If you are the 'champion' of any specification changes and/or project specific special provisions currently in the Specification Committee, it is your responsibility to edit/update/modify them in a timely manner per comments and discussion in Spec Committee. Failure to submit updates may result in removal of item and/or delays.

Next Meeting
Wednesday, April 3, 2019 at 9am
Building 5, Room 855: (If Available. If not available a change in venue will be attached on the door)

2017 Standard Specifications Roads and Bridges & 2019 Supplemental Specifications
Electronic Copy (pdf): The 2017 Standard Specifications Roads and Bridges & 2019 Supplemental Specifications can be viewed, printed, or downloaded from the Specifications Website. A link to the Specifications pages is here:
http://transportation.wv.gov/highways/contractadmin/specifications

Print Version: Hard copies of the 2017 Standard Specifications Roads and Bridges & 2019 Supplemental Specifications are available thru Contract Administration. An order form for the book is on Specifications Website. A link to the pages is here:
http://transportation.wv.gov/highways/contractadmin/specifications

2019 Specifications Committee
The Specification Committee typically meet every other month; on the first Wednesday. 2019 meetings will be held in February, April, June, August, October, and December. Calendar subject to change, updates will be given, as needed.

Specifications Committee Website
A copy of the meeting agenda can be found on the Specifications Committee Website
http://transportation.wv.gov/highways/contractadmin/specifications/SpecComit

Material Procedures
Material Procedures (MPs) referenced in provisions are available upon request.

For questions regarding the Standard Specifications Roads and Bridges, Supplemental Specifications, Project Specific Special Provisions, or the Specifications Committee please e-mail DOHSpecifications@wv.gov
File Format Structure and Progression of items thru Specifications Committee

The purpose of the below protocol is to provide guidance on the file structure of Proposed Specification & Project Specific Special Provision as they progress thru Specification Committee. This procedure would facilitate a means of tracking changes from meeting to meeting; as the agendas & provisions are posted publicly online on the Spec Committee website.

TYPES OF PROVISIONS:
There are three standard types of provisions typically discussed in committee:

1. Specification Changes – These are permanent changes to the WVDOT Standard Specifications.
   ○ Unless inserted into a project proposal, these changes typically go into effect in January (of subsequent year) with the Supplemental Specifications.
2. Project Specific Special Provisions (SP) – Are applied to specifically designated projects.
3. Updates to previously approved SP – Changes/edits/updated to SP that have been approved by spec committee.

NEW BUSINESS ITEMS:
New items to should be setup & submitted in the following format:

1. Specification Changes – Shown as red-line copy (see note)
2. Project Specific Special Provisions (SP) – Will be shown in all black.
3. Updates to approved SP – Shown as red-line copy

Each item should also include a description with:
- Brief overview of item
- Background info and/or reason for change

NOTE: Red-line copy is a form of editing in which indicate removal or addition of text. You can redline a Microsoft Word document by using the built in “Track Changes” feature or you can manually redline document with font color changes & strike-through.

OLD BUSINESS ITEMS:
Updated provisions that were discussed at the last committee meeting should be setup in the following format:

- Redline copy from prior meeting would not be shown
- Redline copy of new changes/updates (from previous meeting)

PROGRESSION OF ITEMS THRU COMMITTEE AND APPROVAL:
Depending on how important the project and/or comments/discussion of item at previous meeting, then several things can happen in no particular order

- Few comments/discussion/minor changes ... will recommend approval of item at next meeting
- A lot of comments/discussion ... will not recommend approval at next meeting; item will be updated and reviewed again at next meeting.
- SP’s in committee may be used in advertised project. Hope to work to address comments & finish approving at subsequent meeting.
Quality control of the structural concrete is the responsibility of the Contractor as designated in MP 601.03.50. The Contractor shall maintain equipment and qualified personnel, including at least one certified Portland cement concrete technician who shall direct all field inspection, sampling and testing necessary to determine the magnitude of the various properties of concrete governed by the Specifications and shall maintain these properties within the limits of this Specification. The Contractor’s personnel who conducts the field sampling and testing shall be a certified Portland Cement Concrete Inspector. The quality control plan designated in MP 601.03.50 shall be submitted to the Engineer at the preconstruction conference. Work shall not begin until the plan is reviewed for conformance with the contract documents.

A certified Portland cement concrete (PCC) Technician shall be present at the Concrete Supplier during all batching operations and shall directly oversee those batching operations and any subsequent necessary mix adjustments. A certified PCC technician may perform this work from an alternate remote location, provided that the PCC Technician uses District approved concrete QC batching software to directly oversee all batching operations and perform any subsequent necessary mix adjustments. The details of this remote monitoring shall be outlined in the Quality Control Plan for plant operations.

The Contractor shall provide a copy of the quality control test results to the Supplier of the concrete which was tested within 48 hours of the completion of the test.

Any Agency or Laboratory which tests Contractor Quality Control concrete compressive strength specimens, that may be used for acceptance by the Division, shall be evaluated by the Cement and Concrete Reference Laboratory (CCRL) and certified as meeting the all the requirements of ASTM C1077 pertaining to testing concrete cylinders.
601.7-MIXING:

DELETE THE CONTENTS OF SUBSECTION AND REPLACE WITH THE FOLLOWING:

Concrete may be central-mixed, truck-mixed, or shrink-mixed as defined in AASHTO M 157 and will be designated as ready-mixed concrete. The production of ready-mixed concrete shall meet the applicable requirements of AASHTO M 157, paragraphs ten and eleven, except as otherwise specified.

Concrete for incidental construction items may be made by volumetric batching and continuous mixing as designated in ASTM C 685, except as otherwise specified. Concrete produced by this method will not be permitted in bridge, box culvert, pavement, or retaining wall construction.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work and discharge completed within one and one-half hours after the addition of the cement to the aggregates. Each batch of the concrete delivered at the job site shall be accompanied by a batch ticket that contains complete batching information, including the batch weights (or batch volume, in the case of water) of all materials in that batch of concrete. In adverse weather or under other conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85° F (30° C) or above, the time between the introduction of the cement to the aggregates and the discharge shall not exceed one hour. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within one hour after the cement has been added to the aggregate.

When placing concrete at remote locations, due to excessive haul time to the site of work from the closest approved batch plant, and when discharge of the concrete within the time limits specified in the previous paragraph is not possible, or in other circumstances when approved by the Engineer, a concrete mix that includes a hydration control stabilizing admixture may be used to extend the allowable concrete discharge time. The subject concrete mix containing this admixture must be approved in accordance with section 601.3.1, and the hydration control stabilizing admixture must be approved in accordance with section 707.15. When conditions are such that a hydration control stabilizing admixture is used, the allowable time between the introduction of the cement to the aggregates and discharge of the concrete shall be increased to
three hours. The limit of 300 maximum revolutions (pertaining to truck mixers or agitators) specified in AASHTO M 157 may be waived when hydration control stabilizing admixtures are used, provided that no additional water is added prior to discharge of the concrete. A single batch of concrete containing a hydration control stabilizing admixture may not be discharged on more than one project. When a mix, containing a hydration control stabilizing admixture is used, and that mix has been approved for the three-hour discharge time, the reduced discharge time required when concrete temperatures are 85 °F (30 °C) or above, and specified in the third paragraph of this sub-section, shall not apply, provided that the concrete supplier has adjusted the hydration control stabilizing admixture dosage rate to account for that higher concrete temperature.

The addition of water after completion of initial mixing will not be permitted, except that when concrete is delivered in truck mixers, additional water may be added to adjust to a specified consistency. In this event, a minimum of 20 additional revolutions of the truck mixer drum at mixing speed shall be required before discharge of any concrete; the maximum allowable time between the addition of the cement to the aggregates and the discharge of the batch shall not be exceeded. Concrete that is not within the specified consistency limits at the time of placement shall not be used. When superplasticizer is used to adjust the consistency of a mix at the job site, as outlined in Section 601.3.2.1, no additional consistency adjustment of that mix with water shall be permitted. When superplasticizer is used to adjust the consistency of a mix at the batch plant, but not at the job site, as outlined in Section 601.3.2.1, additional consistency adjustment of that mix with water shall still be permitted.

For all classes of concrete except Class H and concrete for specialized overlays, the total amount of water in a concrete mix, including any water added at the job site, shall not be more than the amount which would cause the water-cement ratio (w/c) of that concrete mix to exceed the w/c which corresponds to the Mix Design Approved Strength, as outlined in Section 5.4 of MP 711.03.23. The maximum water amount shall also be shown in Attachment 4 or 5 of MP 711.03.23 for all approved concrete mix designs. However, under no circumstances shall the w/c in Table 601.3.1A be exceeded.

Shrink-mixed concrete is a ready-mixed concrete which is initially and partially mixed in a central mix plant and lastly mixed to completion in a truck mixer while in transit to or after arrival at the job site. Shrink-mixed concrete will be allowed for use in the work if specified in the Contract.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.8-FORMS:

601.8.7—Removal of Forms and Construction of Superimposed Elements:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

The forms for any portion of the structure shall not be removed until the concrete is strong enough to prevent damage. Methods of form removal likely to cause overstressing of the concrete shall not be used.

The minimum requirements for removal of forms or supports and the construction of superimposed elements shall be as specified in Table 601.8.7.

Due to continuity of reinforcement between placements and other issues, adjacent bridge deck placements shall be considered superimposed elements and must meet the minimum strength requirement in Table 601.8.7 before an adjacent placement in the sequence may be placed.

In lieu of field cured cylinders for the determination of compressive strength required for from removal and construction of superimposed elements, the Contractor may use the Maturity Method for the estimation of concrete strength as outlined in MP 601.04.21.

<table>
<thead>
<tr>
<th>Structural Element</th>
<th>Removal of Forms</th>
<th>Placing Concrete In Superimposed Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compressive</td>
<td>Compressive</td>
</tr>
<tr>
<td></td>
<td>Strength-psi (Mpa)</td>
<td>Strength-psi (Mpa)</td>
</tr>
<tr>
<td>Bridge Decks</td>
<td>2000 (14.0)</td>
<td>3000 (21)</td>
</tr>
<tr>
<td>Columns</td>
<td>2000 (14.0)</td>
<td>2000 (14.0)</td>
</tr>
<tr>
<td>Walls &amp; Beams</td>
<td>2000 (14.0)</td>
<td>2000 (14.0)</td>
</tr>
<tr>
<td>Footings</td>
<td>500 (3.5)</td>
<td>2000 (14.0)</td>
</tr>
<tr>
<td>Components Supported By Falsework</td>
<td>3000 (21)</td>
<td>3000 (21)</td>
</tr>
<tr>
<td>Parapets</td>
<td>2000 (14.0) (See 601.11)</td>
<td>---------------</td>
</tr>
</tbody>
</table>

TABLE 601.8.7
Requirements for Removal of Forms and Construction of Superimposed Elements
ADD THE FOLLOWING TO SUBSECTION:

603.19-POST-TENSIONING:

The work under this section shall consist of furnishing, installing, stressing, and grouting of post-tensioning tendons in accordance with the details shown on the Plans, Section 603 of the Specifications, and this Special Provision.

603.19.1-Description: Furnish and install all post-tensioning systems and any other pertinent items necessary for the prestressing system used, including but not limited to ducts, anchorage assemblies and supplementary reinforcement. Furnish all components of a post-tensioning system, including deviators for future post-tensioning, but not necessarily the prestressing steel, from a single supplier.

Install prestressing steel, which may be strands or bars, through ducts in the concrete. Stress to a predetermined load and anchor directly against the hardened concrete. Grout ducts to fill all voids and install protection at end anchorages.

Submit shop and working drawings and manuals in accordance with Section 603.19.1.2 of this Special Provision and Section 105 of the Specifications. The Contractor’s Specialty Engineer shall produce all shop drawings related to post-tensioning which shall bear the signature and seal of the responsible engineer.

603.19.1.1-Qualifications and Inspection: Perform all post-tensioning field operations under the direct supervision (crew foreman) of a qualified post-tensioning and grouting technician. Provide project personnel, a crew foreman and crew members in accordance with Section 603.19.1.6 of this Special Provision. Conduct all stressing and grouting operations in the presence of the Engineer.
603.19.1.2-Shop Drawings: Prepare shop drawings to address all requirements stated in Section 105.2 of the Standard Specifications, contract plans and the requirements stated herein.

The Contractor will be required to submit checked detailed Shop Drawings, which include, but are not limited to, the following:

1. A complete description of all details covering each of the post-tensioning systems proposed for permanent tendons.
2. Prestressing details shall include method, sequence, and procedure of prestressing, securing tendons, release procedures and equipment.
3. Limitations of the selected post-tensioning system, tendon geometry and location of the tendons, specifics of the post-tensioning steel, anchorage devices, sheathing material, and accessory items to be used.
4. Anchorage system details, size and type of ducts for all post-tensioning tendons and their horizontal and vertical profiles. Duct supports and grout tubes, inlets, outlets, high point outlet inspection details, anchorage inspection details and permanent grout caps, protection system materials and application limits.
5. A table giving jacking sequence, jacking forces and initial elongation, and estimates of anchor sets of the tendons at each stage of erection for all post-tensioning.
6. Parameters to be used to calculate the typical tendon force such as expected friction coefficients, anchor set, and post-tensioning relaxation curves.
7. Certified copies of reports covering tests performed on post-tensioning steel and anchorages devices as required by Section 603.19.1.5 of this Special Provision.
8. The submittal shall also include information regarding the grout mix design, the method of mixing and placing the grout and the type and capacity of equipment to be used.
9. The details of the anchorage systems shall be shown including local zone reinforcement steel required to resist the concrete bursting stress in the vicinity of the anchorage assemblies.

603.19.1.3-Alternate Post-Tensioning Designs: Alternate designs using a post-tensioning scheme other than that shown on the plans may be submitted for the Engineer’s approval provided that the proposed alternate scheme fulfills the following requirements:

1. The prestress system is a type described in and meeting the requirements of this Special Provision.
2. The net compressive stress in the concrete after all losses is at least as large as that provided by the post-tensioning shown on the plans.
3. The distribution of individual tendons at each cross section generally conforms to the distribution shown on the plans.
4. The ultimate strength of the structure with the proposed post-tensioning scheme meets the requirements of the “AASHTO LRFD Bridge Design Specifications” Current Edition with all applicable interims and shall be
equivalent to or greater than the service and ultimate-strength limit states provided by the original design.

(5) Stresses in the concrete and prestressing steel at all sections and at all stages of construction meet the requirements of the Design Criteria noted on the plans.

(6) All provisions of the Design Criteria noted on the plans shall be satisfied.

(7) The Contractor fully designs and details all the elements affected by the alternative post-tensioning system.

(8) The Contractor submits complete shop drawings including post-tensioning scheme and system, reinforcing steel, and concrete cover; and design calculations (including short and long term prestress losses) for the Engineer’s approval.

(9) Any alternate post-tensioning system approved by the Engineer, which results in a change in quantity from that shown on the Contract Documents, will be paid based on the quantity actually used and accepted or the plan quantity, whichever is less, and at the unit bid price. If approved alternate post-tensioning scheme or system is under a VECP (Value Engineering Change Proposal), the method of payment will be in compliance with the VECP agreement.

(10) Alternative—post-tensioning shall be designed and sealed by the responsible Specialty Engineer.

603.19.1.4-Material Storage: Store all materials in a weatherproof building, shed or container until time of use. Maintain storage environment at 65% Relative Humidity or less for all steel products in storage for more than 30 days.

603.19.1.5-Certification of Post-Tensioning System: The manufacturer of the post-tensioning system must submit test results to the Engineer and include certified test reports from an independent laboratory audited by AASHTO Materials Reference Laboratory (AMRL) which shows the post-tensioning system meets the requirements specified herein. Plastic components shall be tested in a certified independent laboratory accredited through the accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (AALA). Certification of test reports may be performed by an independent laboratory outside of the United States of America. This outside laboratory shall be approved by the Engineer prior to commencement of any work on the project. If any component of the post-tensioning system is modified or replaced, after the approval of the Engineer, the entire system must be retested in accordance with the directions stated herein and new certified test reports must be submitted and approved prior to the submission of Shop Drawings. Certification of test reports may be performed by an independent laboratory located outside of the U.S., if the independent laboratory is approved by the Materials Control, Soil and Testing Division. Certification reports received from testing laboratories outside the United States shall be prepared and submitted in a format that can be easily interpreted by the Division.

Perform certification tests for the plastic components on a sample formed or cut from the finished product. Provide the Engineer with a certification that the plastic from the duct sample complies with all requirements of the specified cell class, stress crack rating...
and the specified amount of antioxidant. Certify to the Engineer that the post-tensioning system being furnished is in compliance with all requirements stated herein.

Ensure all components of a system are stamped with the supplier’s name, trademark, model number and size corresponding to catalog designation.

Prior to installing any post-tensioning hardware, the Contractor shall furnish the Engineer with a certification from the post-tensioning supplier that the system chosen for the project meets all of the requirements stated in this Special Provision, and is the system currently approved with the requirements of this Section. Upon completion of the post-tensioning installation, the contractor shall supply the Engineer a certification that the post-tensioning system supplied was installed without any modification and met the requirements of the contract documents.

Post-tensioning systems which have been tested and approved by the Florida Department of Transportation (FDOT) will be considered as an acceptable alternate to the required testing stated in this Special Provision. A certified copy of approval letter from FDOT including any details associated with the approval shall be submitted to the Engineer with the Shop Drawings prepared by the post-tensioning system supplier.

603.19.1.6-Project Personnel Qualifications:

603.19.1.6.1-General: Submit qualifications of supervisory personnel to the Engineer. The contractor will not begin construction until the qualifications of supervisory personnel, as set forth herein, have been approved by the Engineer.

603.19.1.6.2-Proof of License or Certification: Contractor personnel that are required to be registered as professional engineers as required herein, must submit a copy of the Professional Engineer license renewal notice/card issued by the licensing agency of the state from which they hold registration. The renewal notice/card must display the license number and must indicate that the license is in force and current. If not shown on the renewal notice/card, the telephone number and address of the licensing agency that issued the renewal notice shall be included with the copy of the renewal notice. Under certain circumstances a West Virginia registration may be required.

603.19.1.6.3-Experience Record: The Contractor shall provide for each project engineer, superintendent, manager, or foreman seeking approval as supervisors a notarized certificate attesting to the completeness and accuracy of the following information in order to substantiate their experience record:

1. Project owner’s name -such as the State of West Virginia- and telephone number of an owner’s representative, project identification number for the project as well as the following project location information: state, city, county, highway number and feature intersected.

2. Provide a detailed description of all bridge construction experience and the level of supervisory authority during that experience. Report the duration in weeks, as well as begin and end dates, for each experience period.

3. Provide the name, address and telephone number of an individual who can verify that the experience being reported is accurate. This individual should have been an immediate supervisor unless the supervisor cannot...
be contacted in which case another individual with direct knowledge of the experience is acceptable.

603.19.1.6.4-Concrete Post-Tensioning: The contractor shall ensure the following positions meet the requirements as follows:

603.19.1.6.4.1-Project Engineer: Ensure the Project Engineer is a registered Professional Engineer with a minimum of five (5) years of bridge construction experience. Ensure that a minimum of three (3) years of experience is in concrete post-tensioned box girder construction. Ensure that the three (3) years of experience includes, but is not limited to, erection, safe use of form traveler, design and stabilization of falsework required for concrete post-tensioned box girder construction, post-tensioning and grouting operations and a minimum of one (1) year as the Project Engineer in responsible charge of post-tensioning related operations.

603.19.1.6.4.2-Project Superintendent/Manager: Ensure the Project Superintendent/Manager has a minimum of ten (10) years of bridge construction experience or is a registered Professional Engineer with five (5) years of bridge construction experience. Ensure that the Project Superintendent/Manager has a minimum of three (3) years of supervisory experience in, but not limited to, erection, safe use of form traveler, design and stabilization of falsework required for concrete post-tensioned box girder construction, post-tensioning and grouting operations and a minimum of one (1) year as the Project Superintendent/Manager in responsible charge of post-tensioning related operations.

603.19.1.6.4.3-Foreman: Ensure the Foreman has a minimum of five (5) years of bridge construction experience with a minimum of two (2) years of experience in post-tensioning related construction and a minimum of one (1) year as the Foreman in responsible charge of post-tensioning related operations. Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist.

603.19.1.6.4.4-Crews for Tendon Installations and Post-Tensioning: Perform all tendon installation and stressing of post-tensioning tendons under the supervision of the Crew Foreman. The Crew Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist. In addition, the Crew Foreman shall have a minimum of three (3) years of job site experience in post-tensioning operations. In addition, the contractor shall provide a minimum of two (2) crew members who are certified PTI Level 2 Bonded PT Field Specialist, but need not necessarily have job-site experience. At least 25% of each crew shall be certified in PTI Level 1 Bonded PT – Field Installation.

603.19.1.6.4.5-Crews for Tendon Grouting: Perform all grouting operations after the stressing of tendons under the supervision of the Crew Foreman. The Crew Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician. In addition, the Crew Foreman shall have a minimum of three (3) years job-site experience in the grouting of post-tensioning tendons. In addition, the Contractor shall provide a minimum of two (2) crew members that shall be certified as PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician, but need not necessarily have
job-site experience. At least 25% of each crew shall be certified in PTI Level 1 Bonded PT – Field Installation.

603.19.2-Terms Used:

Anchorage Assembly: An assembly of various hardware components that secures a tendon at its ends after it has been stressed imparting the tendon force into the concrete.

Anchor Plate: Any hardware of the anchorage assembly that bears directly on the concrete and transfers the tendon force directly into a structure.

Anticipated Set: The set assumed to occur in the design calculation of the post-tensioning forces at the time of load transfer.

Bar: Post-tensioning bars are high strength steel bars, normally available from 5/8 to 2 1/2 inch diameter and usually threaded with very coarse thread.

Bleed: The autogenous flow of mixing water within or that which emerges from newly placed grout caused by the settlement of the solid materials within the mass.

Coupler: A device used to transfer the prestressing force from one partial length prestressing tendon to another. (Strand couplers are not allowed.)

Duct: Material forming a conduit to accommodate prestressing steel installation and provide an annular space for the grout, which protects the prestressing steel.

Family of Systems: Group of post-tensioning tendon assemblies of various sizes, which use common anchorage devices and design. All components within the family of systems shall be furnished by a single supplier and shall have a common design with varying sizes.

Fluidity: A measure of time, expressed in seconds, necessary for a stated quantity of grout to pass through the orifice of a flow cone.

Grout: A mixture of cementitious materials and water, with or without mineral additives or admixtures, proportioned to produce a pumpable consistency without segregation of the constituents, when injected into the duct to fill the space around the prestressing steel.

GUTS: Guaranteed Ultimate Tensile Strength: This is the tensile strength of the material that can be assured by the manufacturer. GUTS should not be confused with "f PU" the specified ultimate tensile strength (AASHTO LRFD 5.4.4.1).

Grout Cap: A device that contains the grout and forms a protective cover sealing the post-tensioning steel at the anchorage.

Inlet Vent: Tubing or duct used for injection of the grout into the duct.

Outlet Vent: Tubing or duct to allow the escape of air, water, grout and bleed water from the duct.

Post-tensioning: A method of prestressing where tensioning of the tendons occurs after the concrete has reached a specified strength.

Prestressing Steel: The steel element of a post-tensioning tendon which is elongated and anchored to provide the necessary permanent prestressing force.

Post-Tensioning Scheme or Layout: The pattern, size and locations of post-tensioning tendons provided by the Designer on the Contract Plans.

Post-tensioning System: An assembly of specific models of hardware, including but not limited to anchorage assembly, local zone reinforcement, wedge plate, wedges, inlet and outlet vents, couplers, duct, duct connections and grout cap used to construct a tendon of a particular size and type. The entire assembly must meet the system pressure testing requirement.
Pressure Rating: The estimated maximum pressure that water in a duct or duct component can exert continuously with a high degree of certainty that failure of the duct or duct component will not occur (commonly referred to as working pressure).

Set (Also Anchor Set or Wedge Set): Set is the total movement of a point on the strand just behind the anchoring wedges during load transfer from the jack to the permanent anchorages. Set movement is the sum of slippage of the wedges with respect to the anchorage head and the elastic deformation of the anchor components. For bars, set is the total movement of a point on the bar just behind the anchor nut at transfer and is the sum of slippage of the bar and the elastic deformation of the anchorage components.

Strand: An assembly of several high strength steel wires wound together. Strands usually have six outer wires helically wound around a single straight wire of a similar diameter.

Tendon: A single or group of prestressing steel elements and their anchorage assemblies imparting prestress forces to a structural member. Also included are ducts, grouting attachments, grout and corrosion protection filler materials or coatings.

Tendon Size: The number of individual strands of a certain strand diameter or the diameter of a bar.

Tendon Type: The relative location of the tendon to the concrete shape, either internal or external.

Thixotropic: The property of a material that enables it to stiffen in a short time while at rest, but also to acquire a lower viscosity when mechanically agitated.

Wedge Plate: The hardware that holds the wedges of a multi-strand tendon and transfers the tendon force to the anchorage assembly (commonly referred to as anchor head).

Wedge: A conically shaped device that anchors the strand in the wedge plate.

603.19.3-Materials: Meet the requirements of the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Strand</td>
<td>AASHTO M203</td>
</tr>
<tr>
<td>Bar</td>
<td>AASHTO M275</td>
</tr>
<tr>
<td>Water</td>
<td>Section 715, Subsection 715.7</td>
</tr>
</tbody>
</table>

603.19.3.1-Prestressing Material:

603.19.3.1.1-Prestressing Steel:

Strand: Unless otherwise noted on the Plans, strand shall be uncoated, Grade 270 (1860 MPa), low relaxation 7-wire strand conforming to the requirements of AASHTO M203.

Bar: Unless otherwise noted on the Plans, bar shall be uncoated, Grade 150 (1035 MPa), high strength, coarse thread bar conforming to the requirements of AASHTO M275, TYPE II.

603.19.3.1.2-Post-Tensioning System: Use only the approved post-tensioning system as stated in Section 603.19.1.5 of this Special Provision, and of the proper size and type to construct tendons as shown on the Contract Documents. The use of bar couplers on the project is subject to written approval by the Engineer. Substitution of components of an approved post-tensioning system is not allowed. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages and ducts. Systems that transfer prestress force by bonding the prestress steel strand directly to concrete are not allowed. Embedded anchors for bars are permitted. Systems utilizing formed, ungrouted voids or “diabolos” will be permitted for future post-tensioning only. Strand or tendon couplers are not permitted. Use bar couplers meeting the requirements of AASHTO LRFD Bridge Design.
and Bridge Construction Specifications. Test and provide certification that the couplers meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

603.19.3.1.3-Post-Tensioning Anchorages: The Contractor shall ensure that the anchorages develop at least 95% of the actual ultimate tensile strength of the prestressing steel, when tested in an unbonded state, without exceeding the anticipated set.

Anchorages shall be designed so that the average concrete bearing stress and local zone reinforcement complies with the “AASHTO LRFD Bridge Design Specifications”, Current Edition with all applicable Interims. Test and provide written certification that anchorages meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications. The design and furnishing of local zone reinforcement, in addition to the reinforcement shown in the plans, shall be the responsibility of the Contractor with no additional compensation.

The body of all future post-tensioning anchorages shall be galvanized in accordance with AASHTO M111. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage.

Extreme care shall be taken so that bends in deviators/diablos conform to the radii shown on the plans and that the deviators/diablos are properly positioned. The Contractor shall demonstrate to the Engineer that deviators/diablos are correctly positioned after concrete placement is complete by stringing lines along future tendon paths between anchorages and deviators. Improperly bent or positioned deviators/diablos shall be rejected and shall be repaired or replaced by the Contractor.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Place anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 3/8” diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages will be made of either ferrous metal or polypropylene plastic material conforming to the requirements stated in Section 603.19.3.1.6.4. The thickness of the trumpet at the transition location (choke point) will not be less than the thickness of the duct as established in Section 603.19.3.1.6.4. Alternately, the trumpet material may be a polyethylene or polyolefin containing antioxidant(s) with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

603.19.3.1.4-Inlets, Outlets, Valves and Plugs: Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A240, Type 316 stainless steel, nylon or
polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter of 3/4 inch (20 mm) for tendons of five or more strands and 3/8 inch (10 mm) for single bar tendons and four-strand tendons.

Provide dual mechanical shut-off valves when performing vertical grouting. Specifically designate temporary items, not part of the permanent structure, on the PT System drawings. Temporary items may be made of any suitable material.

603.19.3.1.5-Permanent Grout Caps: Use permanent grout caps made from fiber reinforced polymer or ASTM A240 Type 316L stainless steel. The resins used in the fiber-reinforced polymer shall be either nylon, Acrylonitrile Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Seal the cap with O-ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

603.19.3.1.6-Duct and Pipe:
603.19.3.1.6.1-General: Use only corrugated plastic duct for all internal tendons. Ensure that all connectors, connections and components of post-tensioning system hardware are air and water tight and pass the pressure test requirements herein. The use of diablos is allowed for future post-tensioning only. The Contractor shall provide connectors for the future tendon’s ducts at the diablos located at anchorages for future tendons.

Ducts and pipes shall be sufficiently rigid to withstand placement of concrete, grouting, and construction loads without damage or excessive deformation, and shall be air and watertight. Ducts shall bend without crimping or flattening, and shall have sufficient strength to maintain their shape and correct alignment during concrete placement. Also, ducts and all connections shall be capable of withstanding the pressure required for pre-grouting air pressure test.

603.19.3.1.6.2-Duct and Pipe Minimum Diameter: For prestressing bars, provide ducts with a minimum internal diameter of at least 1/2 inch larger than the outside diameter of the bar, measured across the deformations.

For multi-strand tendons, provide ducts with a minimum cross-sectional area 2 1/2 times the cross-sectional area of the prestressing steel.
**603.19.3.1.6.3-Steel Pipes:** Use galvanized schedule 40 steel pipes conforming to ASTM A-53, Grade B where shown in the plans. Ensure that steel pipes used in the tendon anchorage zones are equipped with shear transfer devices. Test and provide written certification that the shear transfer mechanism can resist at least 68% of the tendon GUTS in a shear transfer pull-out test described below:

Shear Transfer Mechanism Pullout Test Procedure:

1. Cast anchorage, shear transfer mechanism and duct in a test block of concrete with minimum dimensions of 2’-6” x 2’-6” x Required Diaphragm Length (6 ft. min.)
2. Stress tendon to 80% GUTS. Grout tendon.
3. Transfer force from wedge plate to shear transfer mechanism. Alternative procedures to safely obtain the required resistance force for the shear transfer mechanism may be used.
4. Measure tendon release force. (Must be greater than 68% of tendon GUTS)
5. Remove shim plates from behind anchor head and transfer tendon force through grout/shear transfer mechanism into test block.
6. Record lowest transfer force measured over a sustained period of one hour. Use tested shear transfer devices.

**603.19.3.1.6.4-Corrugated Plastic Duct:** Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from non-colored, unfilled polypropylene meeting the requirements of ASTM D4101 “Standard Specification for Polypropylene Injection and Extrusion Materials” with a cell classification range of PP0340B44544 to PP0340B65884. The duct shall be white in color containing antioxidant(s) with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of 20 minutes and containing a non-yellowing light stabilizer. Furnish duct with a minimum thickness as defined in the following table:

<table>
<thead>
<tr>
<th>Duct Shape</th>
<th>Duct Diameter</th>
<th>Duct Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>any size</td>
<td>0.08 inches (2.0 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>3.0 inches (76 mm)</td>
<td>0.10 inches (2.5 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>4.0 inches (100 mm)</td>
<td>0.12 inches (3.0 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>1 5/8 inches (47 mm)</td>
<td>0.12 inches (3.0 mm)</td>
</tr>
</tbody>
</table>

**603.19.3.1.6.4.1-Testing Requirements for Corrugated Plastic Duct:** Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning” as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows:

(a) Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. (667 N) for all sizes.
(b) Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 in (1.5 mm) for duct up to 3.35 inches in diameter and not less than 0.08 inch (2 mm) for duct greater than 3.35 inches in diameter.

(c) Bond length test (FIB 4.1.8) must achieve 40 % GUTS in a maximum length of 16 duct diameters.

603.19.3.1.6.4.2-Minimum Bending Radius for Corrugated Plastic Duct: In addition to the component testing stated herein, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The test consists of a modified duct wear test as described in Chapter 4, Article 4.1.7 of FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”. The test apparatus shall be identical to the wear test apparatus with the same clamping force as a function of the number of strands in the duct; however, modify the procedure as follows: do not move the sample along the strand to simulate wear; the test duration will be 7 days. Upon completion of the test duration, remove the duct. The minimum wall thickness along the strand path must not be less than 0.06 inch for duct up to 3.35 inches diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter.

603.19.3.1.6.4.3-Corrugated Duct Connections and Fittings: Make all splices, joints, couplings and connections to anchorages with devices or methods (i.e. mechanical couplers, plastic sleeves in conjunction with shrink sleeve) producing a smooth interior alignment with no lips or kinks. Design all connections and fittings to be airtight. Duct tape is not permitted to join or repair duct connections. Construct connections and fittings from polyolefin materials containing antioxidant stabilizer(s) meeting the requirements established in Section 603.19.3.1.4 or 603.19.3.1.6.4.

603.19.3.1.6.5-Corrugated Ferrous Metal Duct: Do not use corrugated ferrous metal ducts in any location.

603.19.3.1.6.6-Epoxy Coated Metal Duct: Do not use epoxy coated metal ducts in any location.

603.19.3.1.6.7-Shipping and Storage of Ducts: Furnish ducts with end caps to seal the duct interior from contamination. Ship in bundles which are capped and covered during shipping and storage. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove end caps supplied with the duct until the duct is incorporated into the bridge component. Store ducts in a location that is dry and protected from the sun. Storage must be on a raised platform and completely covered to prevent contamination. If necessary, wash only the outside surface of the duct before use to remove any contamination.

603.19.3.1.7-Internal Duct Mechanical Couplers, O-Ring Assemblies and Heat Shrink Sleeve Requirements:
**603.19.3.1.7.1-Mechanical Couplers:** Construct mechanical internal duct couplers with stainless steel, plastic or a combination of these materials. Use plastic resins meeting the requirements of Sections 603.19.3.1.4 or 603.19.3.1.6.4 to construct plastic couplers. Use ASTM A240 Type 316L stainless steel to make metallic components.

**603.19.3.1.7.2-O-Rings:** O-ring duct coupling shall be made from plastic resins meeting the requirements of Section 603.19.3.1.4 or 603.19.3.1.6.4.

All O-ring materials (diameter < or = 0.25 inch) shall conform to the following requirements:

**Mechanical Properties**
- Shore hardness, A (ASTM D2240): 50-75
- Ultimate elongation %, (ASTM D412) > 250
- Tension strength, Set @ 100%, 200% & ultimate elongation (ASTM D412) < 1400 psi

--- Tear Strength Die T, (ASTM D624): 110 pli

**Accelerated Testing**
- Thermal Deterioration 70 hours @ 257°F (ASTM D573)
  - Change in tensile strength + or – 30% < 3%
  - Change of elongation < -250%
  - Change of hardness + or - -15 points
  - Compression Set Method B 22 hours @ 257°F (ASTM D57395) < 250%
- Volume change due to absorption of H2O, Method D, for 70 hours @ 212°F, ASTM D471 +10%

**Environmental Resistance**
- Ozone Resistance Exposure Method B, ASTM D1171: Pass 70 hours @ 40°C & 50 MPa partial ozone pressure (ASTM D1149): No Cracks
  - Low Temp. Non-brittle after 3 Min. @ -240°F (ASTM D7462137): Not Brittle Pass

Furnish segment seal assemblies for large diameter compression seals, used to couple ducts at segment joints, which conform with the requirements stated above with the following additions and changes:

**Mechanical Properties**
- Shore hardness, A (ASTM D2240): 30-40
- Tensile strength, (ASTM D412): > 600 psi
- Compression Set Method B 22 hours @ 257°F, (ASTM D395): 60%

**Compression Force** – The maximum force to compress the O-ring to its final compressed position shall not be greater than 25 psi times the area encircled by the O-ring.
**Voided Area** – The seal shall be designed to accommodate the material flow within its own cross sectional area by using a hollow or voided design.

**Mounting Assemblies** – Assemblies holding the O-ring must mount to the form bulkhead and provide for duct alignment.

**603.19.3.1.7.3-Heat Shrink Sleeves:** Furnish and install heat shrink sleeves having a uni-directional circumferential recovery manufactured specifically for the size of the duct being coupled consisting of an irradiated and linear-density polyethylene for internal applications. Furnish adhesive having the same value to steel polyolefin applications. Ensure the heat shrink sleeves have an adhesive layer that will withstand 150°F operating temperature and meet the requirements of the following table:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Fully Recovered</td>
<td></td>
<td><strong>Internal Application</strong></td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td>92 to 126 mils</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>ASTM D 1000</td>
<td>29 pli</td>
</tr>
<tr>
<td>Softening Point</td>
<td>ASTM E 28</td>
<td>162°F</td>
</tr>
<tr>
<td>Lap Shear</td>
<td>DIN 30 672M</td>
<td>87 psi</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 638</td>
<td>2,900 to 3,480 psi</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D 2240</td>
<td>46 to 48 Shore D</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D 570</td>
<td>Less than 0.05%</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td>Yellow or Black</td>
</tr>
<tr>
<td>Minimum Recovery</td>
<td>Heat Recovery Test</td>
<td>33% to 58%</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td></td>
<td>125°F</td>
</tr>
</tbody>
</table>

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer’s recommendations.

**603.19.3.1.8-System Test Requirements:** For each family of post-tensioning systems, assemble systems and perform the pressure test defined herein. For each family of post-tensioning systems, test two assemblies (largest and smallest) from the family. The post-tensioning assembly includes at least one of each component required to make a tendon from grout cap to grout cap.

**603.19.3.1.8.1-Grouting Component Assembly Pressure Test:** Assemble anchorage and grout cap with all required grouting attachments (grout tube, plugs, etc.). Seal the opening in the anchorage where the duct connects. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five (5) minutes with no more than 15 psi reduction in pressure. For systems using the same anchorages, grout caps and grouting attachments as previously approved system, the Grouting Component Assembly Pressure Test may include documentation from a previous submittal with written certification that the same components are being utilized in both anchorages.
603.19.3.1.8.2-Internal Duct Systems: Perform a system test for the assembly for compliance with the requirements of Chapter 4, Article 4.2 Stage 1 and Stage 2 Testing contained in FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning.” For bar systems, modify the system test length to 15 feet.

Test the coupler for proper function by casting the coupler into a two part concrete test block using match cast techniques. Use blocks that are 12 inch x 12 inch x 12 inch (300 mm x 300 mm x 300 mm). After the concrete has hardened, pull the blocks apart and clean the surface of any bond breaker materials. Using an external apparatus, clamp the block together and maintain 40 psi pressure on the block cross-section during the pressure test. Do not apply epoxy between the blocks for this portion of the test. Pressurize the duct within the test block to 1.5 psi and lock off the outside air source. The assembly must sustain a 1.5 psi internal pressure for five (5) minutes with no more than 0.15 psi reduction in pressure. Separate the duct coupler blocks from the duct system, remove the clamping device, place a 1/16 inch layer of epoxy on the face of both blocks, and clamp the blocks together and maintain a pressure of 40 psi on the block cross-section for 24 hours. Upon removal of the clamping force, demolish the blocks. The coupler and attached ducts should be intact and free of epoxy, and properly attached without crushing, tearing or other signs of failure. This test will not be required if the Engineer approves prior test results performed for the same system submitted by the Contractor.

The grout cap to anchorage seal and the duct to pipe assembly must comply with the following test. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. The length of the test pipe assembly for this test is 15 feet.

Acceptance of the “duct system test data” will be a prerequisite for shop drawing submission of the duct system.

603.19.4-Grout:

A. Grouts shall be prebagged in plastic lined or coated bags. Stamp grout bags with date of manufacture, lot number, shelf life, and mixing instructions. Any change of materials or material sources requires retesting and certification of the conformance of the grout with the physical properties requirements. A copy of the Quality Control Data Sheet for each lot number and shipment sent to the job site shall be provided to the Contractor by the grout supplier and furnished to the Engineer.

B. Materials with a total time from manufacture to usage in excess of six months shall be retested and certified by the supplier before use or shall be removed and replaced.

C. Manufacturers of post-tensioning grout seeking evaluation of their product shall submit material to the WVDOT Materials Laboratory for testing and shall provide certified test reports from an audited and independent Cement and Concrete Reference Laboratory (CCRL), which shows the material meets all the requirements specified herein.

D. Grout shall be stored in a location that is waterproof and convenient to the work. Storage in the open must be on a raised platform and with an adequate waterproofing. On-site storage of grout is limited to a maximum period of one month.

E. The grout material shall be mixed in accordance with the manufacturer’s recommendations.
F. Grouts shall achieve a non-bleeding characteristic and shall maintain grout fluidity in strict compliance with the manufacturer’s recommendations.

G. Grouts shall contain no aluminum powder.

H. The water content shall be the minimum necessary for proper placement, and shall not exceed a water-cement ratio of 0.45.

I. Grouts and temporary corrosion protection methods shall not involve toxic substance.

J. Grout shall meet or exceed the specified physical properties stated herein as determined by the following standard and modified ASTM test methods.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Chloride Ions</td>
<td>Max. 0.08% by weight of cementitious material</td>
<td>ASTM C 1152</td>
</tr>
<tr>
<td><strong>Volume Change</strong></td>
<td><strong>Hardened Height Change @ 24 hours and 28 days</strong></td>
<td>0.0% to + 0.12% expansion at 24 hours and 0.0% to +0.2% expansion at 28 days</td>
</tr>
<tr>
<td>Expansion</td>
<td>&lt;= 2.0% for up to 3 hours</td>
<td>ASTM C 940</td>
</tr>
<tr>
<td>Fine Aggregate (if utilized)</td>
<td>99% percent passing the No. 50 Sieve (300 micron)</td>
<td>ASTM C 136**</td>
</tr>
<tr>
<td>Wet Density – Laboratory</td>
<td>Report maximum and minimum obtained test value lb/ft³ (kg/l)</td>
<td>ASTM C 185</td>
</tr>
<tr>
<td>Wet Density – Field</td>
<td>Report maximum and minimum obtained test value lb/ft³ (kg/l)</td>
<td>ASTM C 138</td>
</tr>
<tr>
<td>Compressive Strength @ 28 days (Average of 3 cubes)</td>
<td>&gt;= 76,000 psi (41.5 MPa)</td>
<td>ASTM C 942</td>
</tr>
<tr>
<td>Initial Set of Grout</td>
<td>Min. 3 hours, Max. 12 hours</td>
<td>ASTM C 953</td>
</tr>
</tbody>
</table>
| Fluidity Test *** | Efflux Time from Flow Cone | ASTM C 939
(a) Immediately after mixing | Min. 20 sec., Max. 30 sec. | ASTM C 939
Or Min. 9 sec., Max. 20 sec. | ASTM C 939 ****
(b) 30 minutes after mixing with remixing for 30 sec. | Max. 30 sec. | ASTM C 939 ****
<p>| Bleeding @ 3 hours | Max. 0.0% | ASTM C 940 ***** |
| Max. 4% at 20.3 psi (140 kPa) for Vertical Rise 0 ft. (0 m) &lt;= x &lt; 2 ft. (0.6 m) | Schupack ***** |
| Max. 2% at 31.9 psi (220 kPa) for Vertical Rise 2 ft. (0.6 m) &lt; x &lt;= 6 ft. (1.8 m) | Schupack ***** |
| Max. 0% at 52.2 psi (360 kPa) for Vertical Rise 6 ft. (1.8 m) &lt; x &lt;=100 ft (30 m) | Schupack ***** |
| Permeability @ 28 days | Max. 2500 coulombs | ASTM C 1202 |</p>
<table>
<thead>
<tr>
<th>API Mud Balance Test</th>
<th>Value &gt;= 1.9</th>
<th>Report maximum and minimum obtained test value</th>
</tr>
</thead>
</table>

* * Modify ASTM C 1090 to include verification at both 24 hours and 28 days.
** Use ASTM C117 procedure modified to use #50 sieve. Determine the percent passing the #50 sieve after washing the sieve.
*** Adjustments to flow rates will be achieved by strict compliance with the manufacturer’s recommendations. The time efflux is the time to fill a one liter container placed directly under the flow cone.
**** Modify the ASTM C 939 test by filling the cone to the top instead of the standard level. The efflux time is the time to fill one quart (one liter) container placed directly under the flow cone.
***** Modify ASTM C 940 to conform with the wick induced bleed test as follows:

(a) Use a wick made of a 20 inch length of AASHTO M203, Grade 270, seven wire 0.6 inch diameter strand. Wrap the strand with 2 inch wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning.
(b) Condition dry ingredients, mixing water, prestressing strand and test apparatus overnight at 65 to 75°F (18 to 24°C).
(c) Mix the conditioned dry ingredients with conditioned mixing water and place 800 ml of the resulting grout into the 1,000 ml graduated cylinder. Measure and record the level of the top of the grout. Insert 0.21 gal (800 ml) of mixed conditioned grout with conditioned water into the 0.26 gal (1,000 ml) graduated cylinder. Mark the level of the top of the grout.
(d) Completely insert the strand into graduated cylinder. Center and fasten the strand so it remains essentially parallel to the vertical axis of the cylinder. Measure and record the level of the top of the grout. Wrap the strand with 2 inch (50.8 mm) wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning. Insert completely a 20 inch (508 mm) length of conditioned, cleaned, AASHTO M203, Grade 270 (1860 MPa), seven wire strand (0.6 inch (13 mm) diameter) into the 0.26 gal (1,000 ml) graduated cylinder (possibly using a centralizer). Mark the level of the top of the grout.
(e) Store the mixed grout at the temperature range listed above in (ba).
(f) Measure the level of the bleed water every 15 minutes for the first hour and hourly for two successive readings thereafter afterward for three hours.
(g) Calculate the bleed water, if any, at the end of the three hour test period and the resulting expansion per the procedures outlined in ASTM C 940, with the quantity of bleed water expressed as a percent of the initial grout volume. Note if the bleed water remains above or below the top of the original grout height. Note if any of bleed water is absorbed into the specimen during the test.

****** API (American Petroleum Institute) Recommended Practice 13B-1, Standard Procedure for Testing Water-based Drilling Fluids. The mud balance apparatus is to be non-reactive with the grout. Report maximum and minimum values, when compared to water, obtained when using maximum w/c ratios as specified by the grout manufacturer.

Schupack Pressure Bleed Test Using the Gelman Filtration Funnel

(a) Grouts shall be mixed in accordance with the manufacturer’s instructions, and as approved by the engineer.
(b) Fill the filtration funnel with 0.053 gal (200 ml) of freshly mixed grout and screw cap on hand tight, while keeping funnel in upright position.
(c) Place funnel in frame.
(d) Connect air supply (air pressure at 0 psi (0 kpa)).
(e) Allow grout to rest in funnel for 10 minutes.
(f) Increase pressure to specified test pressure from table above.
(g) Hold at specified pressure for 5 minutes and record bleed volume to the nearest 0.00005 gal (0.2 ml) at the end of hold time.
(h) Bleed volume shall be reported as a percentage of the sample volume.

\[
\% \text{ bleed} = \frac{\text{bleed (gal)} \times 100}{0.053 \text{ gal}}
\]

If a loss of pressure occurs prior to completion of step (h), the test is considered to have failed for the given pressure level.

603.19.5-Samples for Testing and Identification:

603.19.5.1-General: Testing shall conform to the applicable AASHTO/ASTM Specifications for the prestressing material used. All material samples for testing shall be furnished by the Contractor at no cost to the Division. Consider job site or site referred to herein as the location where the prestressing steel is to be installed.

603.19.5.2-Testing of Prestressing Steel: Furnish samples for testing as described below for each manufacturer of prestressing strand or bar to be used on the project.

With each sample of prestressing steel strand or bar furnished for testing, submit a certification stating the manufacturer’s minimum guaranteed ultimate tensile strength of the sample furnished.

The Engineer will sample the following materials, at the plant, from the prestressing steel used for post-tensioning operations:

(a) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with minimum of one sample for every ten reels delivered.

(b) For bars: three randomly selected samples, 5 feet long, per manufacturer, per size of bar, per heat of steel, with minimum of one sample per shipment.

One of each of the samples furnished to represent a lot, will be tested. The remaining sample(s), properly identified and tagged, will be stored by the Engineer for future testing. In the event of loss or failure of the component, the stored sample will be utilized to evaluate for minimum strength requirements. For acceptance of the lot represented, test results must show 100% of guaranteed ultimate tensile strength (GUTS).

603.19.5.3-Lots and Identification: A lot is that parcel of components as described herein. All bars, of each size from each mill heat of steel, and all strand from each manufactured reel to be shipped to the site, must be assigned an individual lot number and must be tagged in such a manner that each such lot can be accurately identified at the job site. Submit records to the Engineer identifying assigned lot numbers with the heat or reel of material represented. All unidentified prestressing steel, or bars received at the site will be rejected. In addition, loss of positive identification of these items at any time will be cause for rejection.

603.19.5.4-Testing of Grout: The Contractor shall provide the current certified mill test reports for each lot of grout received from the manufacturer showing compliance with the requirements in Section 603.19.4. Any change of materials or material sources requires retesting and certification of the conformance of the grout with the physical properties requirements. A copy of the Quality Control Data Sheet for each lot number and shipment
sent to the job site shall be provided to the Contractor by the grout supplier and furnished
to the Engineer.

Materials with a total time from manufacture to usage in excess of either six months,
or the stated shelf-life, shall be re-tested and certified by the supplier before use, or shall
be removed and replaced. Materials stored at the job site more than one month will be
rejected and the Contractor shall remove them from the job site.

603.19.5.5-Approval of Materials: The approval of any material by the Engineer shall
not preclude subsequent rejection if the material is damaged in transit or later damaged or
found to be defective.

603.19.6-Testing by the Contractor:

603.19.6.1-Tendon Modulus of Elasticity Test: For this project, the Contractor shall
perform a tendon modulus of elasticity test in accordance with the following procedure.

For the purpose of accurately determining the tendon elongations while stressing,
bench test two (2) samples of each size of tendon to determine the modulus of elasticity
prior to stressing the initial tendon.

For the purpose of this test, the bench length between anchorages must be at least 40
feet and the tendon duct at least 2 inches clear of the tendon all around. The test procedure
must consist of stressing the tendon at the anchor assembly with a load cell at the dead end.
Tension the test specimen to 80% of ultimate in ten equal increments and the detension
from 80% of ultimate to zero in ten equal decrements. For each increment and decrement,
record the gauge pressure, elongation and load cell force. Note elongations of the tendon
for both ends and the central 30 feet, measured to accuracy of ± 1/32 inch. Correct the
elongations for the actual anchorage set of the dead end.

Calculate the modulus as follows:

\[ E = \frac{PL}{Adl} \]

Where:

- \( P \) = force in tendon
- \( L \) = distance between pulling wedges and dead wedges or
  exact length in center 30 feet of the tendon.
- \( A \) = cross sectional area of the tendon based on nominal area.
- \( dl \) = strand elongation for load \( P \).

If the bench test result varies from the modulus of elasticity used for shop drawings by
more than 1%, submit revisions to the theoretical elongations to the Engineer for approval.

When the observed elongations of the tendon in the erected structure fall outside the
acceptable tolerances, or to otherwise settle disputes, additional Tendon Modulus of
Elasticity Tests may be required to the satisfaction of the Engineer.

If the source of the prestressing steel changes during the course of the project,
additional test series or substantiations from previous projects, not to exceed two per
source, will be required.

The apparatus and methods used to perform the test must be submitted to the Engineer
for approval. Test must be conducted in the Engineer’s presence.
603.19.6.2-In Place Friction Test: This test is intended to demonstrate that the friction characteristics, losses, and resulting tendon forces are in agreement with the design assumptions. This test is only required if authorized by the Engineer in order to resolve discrepancies between actual and theoretical elongations in excess of ± 5% percent.

The test procedure shall consist of stressing the tendon at an anchor assembly with a load cell at the dead end. The test specimen shall be tensioned to 80 percent of ultimate tendon tensile strength in eight equal increments and de-tensioned in eight equal decrements. For each increment and decrement, the gauge pressure, elongations, and load cell force shall be recorded. Account shall be taken of any wedge seating in both the live end (i.e., back of jack) and the dead end (i.e., back of load cell) and of any friction within the anchorages, wedge plates, and jack as a result of slight deviations of the strands through these assemblies. For long tendons requiring multiple jack pulls with intermediate temporary anchoring, care shall be taken to keep an accurate account of the elongation at the jacking end allowing for intermediate wedge seating and slip of the jack’s wedges.

When friction is to be reduced, only graphite is to be used as a lubricant subject to the approval of the Engineer. The ducts shall be blown dry with oil free air to remove any excess graphite.

If the elongation falls outside the ± 5% range compared to the anticipated elongations, investigate the reason and make detailed calculations confirming the final tendon forces are in agreement with the approved Plans.

Significant shortfall in elongations is indicative of poor duct alignments and/or obstructions. Correct or compensate for such elongations in a manner proposed by the Contractor and reviewed and approved by the Engineer at no additional cost to the Department.

If, for the Contractor's expected friction coefficients, the elongations fall outside the plus or minus 5 percent range, the Contractor shall investigate the reason and make revisions to his post-tensioning operations such that the final tendon forces are in agreement with the Plans.

The apparatus and methods used to perform the test must be submitted to the Engineer for approval. Tests must be conducted in the Engineer’s presence.

603.19.6.3-Grout Fluidity: Contractor shall perform a grout fluidity test in accordance with Section 603.19.4, prior to the beginning of the injection process and after grouting each tendon. The test shall be performed on a sample taken from the end of the pump hose before grouting and at the outlet end of the tendon after the tendon has been properly grouted. The testing shall be repeated for each two hours of grouting operations. The efflux time shall be within 5 seconds of the values established during laboratory testing.

603.19.6.4-Tests Reports Required: Submit two copies of the “Tendon Modulus of Elasticity Test” reports to the Engineer at least 30 days prior to installing the tendons.

Submit two copies of the “In Place Friction Test” reports to the Engineer within two (2) weeks after successful installation of the tested tendon.

Two copies of the grout fluidity test per tendon shall be submitted to the Engineer within three days after performing the test.
603.19.6.5-Payment for Testing: Testing by the Contractor will not be paid for separately but shall be incidental to the price paid for the post-tensioning.

603.19.6.6-Application of Test Results: Re-evaluate the theoretical elongation shown on the post-tensioning shop drawing or working drawings using the results for the Tendon Modulus of Elasticity Test and In Place Friction Test as appropriate and correct as necessary. Submit revisions to the theoretical elongations to the Engineer for approval. No work shall proceed on grouting the tendons until the Engineer has reviewed and approved the revisions to the theoretical elongations.

603.19.7-Protection of Prestressing Steel:

603.19.7.1-Shipping, Handling, and Storage: Protect all prestressing steel against physical damage and corrosion at all times, from manufacture to final grouting or encasing in the concrete. The Engineer will reject prestressing steel that has sustained physical damage. Carefully inspect any reel that is found to contain broken wires during use. Remove and discard lengths of strand containing broken wires. The wire must be bright and uniformly colored when installed, having no foreign matter or pitting on its surface.

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust or other results of corrosion, shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel, concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specification MIL-P-3420. Packaging or forms damaged by any cause shall be immediately replaced or restored to the original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, the care to be used in handling, and the type, kind, and amount of corrosion inhibitor used, including the date when placed, safety orders, and instructions for use. Low relaxation (stabilized) strand shall be specifically designated per requirements of AASHTO M203. All such strand not so designated shall be rejected.

603.19.7.2-During Installation in the Structure: The time between the first installation of the post-tensioning steel in the duct and the completion of the stressing and grouting operations shall not exceed twenty (20) calendar days unless the use of a corrosion inhibitor is approved by the Engineer. The corrosion inhibitor shall not reduce the bond between the post-tensioning steel and the grout or the grout and the ducts, and the removal of the corrosion inhibitor shall not introduce remnant moisture into the ducts or annular spaces between the wires of the post-tensioning strand. Any light surface corrosion forming during this period will not be cause for rejection of the post-tensioning steel. These twenty calendar days shall also apply to the post-tensioning steel used for the In-Place Friction Test, if it is to be used as a production tendon.

Flushing of grout is not permitted and vacuum grouting is required to repair all voids as defined in Section 603.19.12.6.7. Flushing of ducts is only permitted as defined in Section 603.19.10. When flushing is permitted, use flush water containing slack lime (calcium hydroxide) or quicklime (calcium oxide) in the amount of 0.17 lb/gal.
Except when approved by the Engineer in writing, failure to grout tendons within sixty (60) calendar days will result in stoppage of the affected work.

603.19.8-Fabrication of Post-Tensioning Ducts and Anchorages in the Final Structure:

603.19.8.1-General: Accurately and securely fasten all post-tensioning anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedded items at the locations shown on the plans or on the approved Shop or Working Drawings or as otherwise approved by the Engineer. Construct tendons using the minimum number of duct splices possible.

603.19.8.2-Ducts: Accurately align and position ducts at the locations shown on the Plans, according to the approved Shop or Working Drawings, or as otherwise approved by the Engineer. Securely fasten all internal ducts in position at regular intervals not exceeding two feet (0.6 meter) for round plastic ducts, and one foot (0.3 meter) for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations. Show the method and spacing of duct supports on appropriate Shop Drawings.

Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents.

Carefully check all ducts and repair as necessary before the placing of any concrete commences. The tolerance on the location of the ducts for the tendons shall be as specified below in Section 603.19.8.5.

After installing the ducts and until grouting is complete, ensure that all ends of ducts, connections to anchorages, splices, inlets and outlets are sealed at all times. Provide an absolute seal of anchorage and duct termination locations by using plumber’s plugs or equal. Grout inlets and outlets will be installed with plugs or valves in the closed position. Leave low point outlets open. The use of duct tape is not permitted.

603.19.8.3-Splices and Joints: All splices, joint couplings, and connections (inlet and outlet) and valves shall be part of the approved post-tensioning system. Approved shrink sleeve material may be used to repair duct. The use of any tape to repair or seal the duct is not permitted.

603.19.8.4-Location of Grout Inlets and Outlets: Place grout inlets and outlets at locations as shown on the plans or approved shop drawings. Equip all grout inlets and outlets with positive shut-off devices. At a minimum, grout inlets and outlets will be placed in the following positions:

(a) Top of the tendon anchorage,
(b) Top of the grout cap,
(c) At the high points of the duct when the vertical distance between the highest and lowest point is more than 20 inches;
(d) At a location 3 feet past high points of the duct on the down stream side opposite the direction of grouting,
(e) At all low-points,
(f) At major changes in the cross section of the duct,
(g) At intermediate point(s) for tendons longer than 150 feet,
(h) At other locations required by the Engineer.

Extend grout tubes a sufficient distance out of the concrete member to allow for proper closing of the valves.
All grout caps used must be installed to prevent entrapment of air or water voids and must provide 100 percent coverage of all tendons, wedges and wedge plates in the anchorage.

603.19.8.5-Tolerances: Position post-tensioning ducts within the tolerances given below:

<table>
<thead>
<tr>
<th>Tolerances in Inches For:</th>
<th>Vertical Position</th>
<th>Lateral Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse Deck Tendons in Slab</td>
<td>± ¼</td>
<td>± ½</td>
</tr>
<tr>
<td>Longitudinal Tendons</td>
<td>± ¼</td>
<td>± ½</td>
</tr>
<tr>
<td>All Other Cases or in Cases of Doubt</td>
<td>± ¼</td>
<td>± ¼</td>
</tr>
</tbody>
</table>

In all other cases, ensure that tendons are not out of position by more than ± 1/4 inch in any direction.
Ensure entrance and exit angles of tendon paths at anchorages and/or at faces of concrete are within ± 3 degrees [± 5%] of desired angle measured in any direction and any deviations in the alignment are accomplished with smooth transitions without any kinks.
Angle changes at duct joints must not be greater than ± 3 degrees [± 5%] in any direction and must be accomplished with smooth transitions without any kinks.
Locate anchorages within ± 1/4 inch of desired position laterally and ± 1 inch along the tendon except that minimum cover requirements must be maintained.
Position anchorage confinement reinforcement in the form of spirals, multiple U shaped bars or links, properly centered around the duct and start within 1/2 inch of the back of the main anchor plate.
If conflicts exist between the reinforcement and post-tensioning duct, the position of the post-tensioning duct shall prevail and the reinforcement shall be adjusted locally with the Engineer’s approval.

603.19.8.6-Internal Duct Pressure Test: Pressure test all internal ducts, before casting concrete. Seal the tendon at the anchorage duct at the termini and test with compressed air to determine if the duct connections require repair. In the presence of the Engineer, pressurize the duct to 1.5 psi and lock-off the outside air source. Record the pressure loss over one (1) minute. If the pressure loss exceeds 0.15 psi, repair the leaks in the duct using methods approved by the Engineer. Upon completion of repairs approved by the engineer, the duct shall be retested to the requirements specified above.

603.19.8.7-Post-Tensioning System Field Certification: Post-Tensioning System supplier shall furnish the engineer with a certification that the post-tensioning system chosen for this project has been installed without modification as indicated in the approved shop drawings.
603.19.9 Placing Concrete

603.19.9.1 - Precautions: The Contractor shall exercise great care when placing and consolidating concrete so as not to displace or damage any of the post-tensioning ducts, anchorage assemblies, splices and connections, reinforcement, or other embeddings. Fabricate all duct splices to prevent duct kinks during concrete placement. Use mandrels at joints as needed to maintain duct alignment and shape.

The Contractor shall ensure that ducts located within mass concrete pours have the capacity to withstand the concrete temperature expected according to the thermal control plan as per Section 601.12.4.1 of the Special Provisions. For mass concrete pours, the contractor may propose to use galvanize rigid steel pipe ducts for Engineer’s approval, at no additional cost to the Division.

603.19.9.2 - Proving of Post-Tensioning Ducts: Upon completion of concrete placement, prove that the post-tensioning ducts are free and clear of any obstructions or damage and are able to accept the intended post-tensioning tendons by passing a torpedo through the new joints in the ducts. Use a torpedo having the same cross-sectional shape as the duct and that is a 1/4 inch smaller all around than the clear, nominal inside dimensions of the duct. Make no deductions to the torpedo section dimensions for tolerances allowed in the manufacture or fixing of the ducts. For straight ducts, use a torpedo at least 2 feet long. For curved ducts, determine the length so that when both ends touch the outermost wall of the duct, the torpedo is 1/4 inch clear of the innermost wall. If the torpedo will not travel completely through the duct, the Engineer will reject the member, unless a workable repair can be made to clear the duct. The torpedo must pass through the duct easily, by hand, without resorting to excessive effort or mechanical assistance.

603.19.9.3 - Problems and Remedies: The Engineer will reject ducts or any part of the work found to be deficient. Perform no remedial or repair work without the Engineer’s approval. Any remedial work will be completed at no additional cost to the Division.

603.19.10 - Installing Tendons: For tendons subjected to contamination with chlorides, flush the duct before placing the prestressing strands, with lime treated potable water and test for presence of chlorides and oils. Chlorides in the water must be less than 600 ppm. If chloride levels are in excess of 600 ppm, continue to flush the duct until the chloride level is below 250 ppm. Blow oil-free compressed air through the duct to remove any excess water in the duct.

Post-tensioning strands may be pushed or pulled through the ducts to make up a tendon using methods which will not snag on any lips or joints or damage the duct. Strands which are pushed shall be rounded off at the end of the strand or fitted with a smooth protective cap. During the installation of the post-tensioning strand in to the duct, the strand shall not be intentionally rotated by any mechanical device.

Alternatively, strands may be assembled into the tendon, which then may be pulled through the duct together using a special steel wire sock ("Chinese finger") or other device attached to the end. If the ends of the strands are welded or brazed, they shall be cut back 18 inches from the weld or braze. Round the end of the pre-assembled tendon for smooth passage through the duct. Cutting shall be done with an abrasive saw or equal. Flame cutting shall not be allowed.
In accordance with this Special Provision, the time requirements for corrosion protection shall commence from the time the strands were first placed in the ducts and not from the time of concrete placement. Do not install permanent tendons before the completion of testing as required by this Special Provision and plans. As a sole exception, the tendon to be tested in the “In Place Friction Test” may be installed for the test.

603.19.11-Post-Tensioning Operations:

603.19.11.1-General: Do not apply post-tensioning forces unless the concrete has attained the specified compressive strength as determined by cylinder tests. The stressing of post-tensioning tendons shall be under the immediate supervision of the qualified project personnel as described in Section 603.19.1.7. In addition, a qualified representative of the post-tensioning Specialty Contractor, who shall exercise rigid control of the operations as necessary for full compliance with all requirements stated in this Section (603.19.11) shall be present. As a minimum, the representative shall be present at the beginning of each different type of post-tensioning operation. If the representative determines that the Contractor’s crew is thoroughly familiar with one type of operation, he shall deliver a signed statement of competence for the crew to the Engineer for review. Upon approval by the Engineer of the statement of competence, the presence of the representative shall not be required again until a different type of post-tensioning operation occurs. The statement shall list the names of the Contractor’s crew and crew leader who will be responsible for the post-tensioning operations. The stressing operations shall be overseen by the Contractor’s crew leader who shall demonstrate competence in supervising the stressing operations and performing elongation measurements and calculations; this crew leader shall preferably be an Engineer. No stressing operations shall be performed without direct supervision of the representative or the Contractor’s approved project personnel.

603.19.11.2-Stressing Tendons: All post-tensioning steel shall be tensioned by means of hydraulic jacks so that the post-tensioning force shall not be less than that required by the Plans, or by approved Shop Drawings, or as otherwise required or approved by the Engineer. Do not utilize monostrand jacks to stress tendons with five or more strands. Monostrand jacks will be allowed for stressing tendons only when specifically approved by the Engineer, or when strand tendons are housed in flat ducts that preclude intertwining of strands. Monostrand jacking is permitted provided the elongation of individual strands is kept within a tolerance of ±10% of the calculated value. In addition, the average elongation of the group of strands in the duct shall be within ± 5% of the calculated elongation.

The maximum temporary stress (jacking stress) in the post-tensioning steel shall not exceed 80 percent of its specified minimum ultimate tensile strength. Tendons shall not be overstressed to achieve the expected elongation.

The post-tensioning steel shall be anchored at initial stresses that will result in the long term retention of permanent stresses or forces of not less than those shown on the Plans or the approved Shop Drawings. Unless otherwise approved by the Engineer, the initial stress after anchor set shall not exceed 70 percent of the specified ultimate tensile strength of the post-tensioning steel.

Permanent stress and permanent force are the stress and force remaining in the post-tensioning steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in the post-tensioning steel from the
sequence of stressing, friction and unintentional wobble of the ducts, anchor set, friction in the anchorages, and all other losses peculiar to the post-tensioning system.

603.19.11.3-Stressing Sequence: The Contractor shall follow the sequence, the phase and the end from which tendons must be stressed shown in the plans or required by the Engineer. The Contractor shall not modify the stressing sequence shown on the Plans or the approved Construction Manual without approval from the Engineer.

603.19.11.4-Stressing Equipment: Only use equipment furnished by the supplier of the post-tensioning system (tendons, hardware, anchorages, etc.).

603.19.11.4.1-Stressing Jacks and Gauges: Each jack must be equipped with a pressure gauge for determining the jacking pressure. The pressure gauge must have an accurate reading gage with a dial at least 6 inches in diameter.

603.19.11.4.2-Calibration of Jacks and Gauges: Calibrate each jack and its gauge(s) as a unit. The calibration must consist of three test cycles with the cylinder extension of the jack in various positions (i.e. 2-inch, 4 inch, 8 inch stroke). At each pressure increment, average the forces from each test cycle to obtain an average force. Perform the calibration with the equipment (jack, pump, hoses, etc.) setup in the same configuration that is intended to be used at the job site. The post-tensioning supplier or an independent laboratory shall perform initial calibration of jacks and gauge(s). Use load cells calibrated within the past 12 months to calibrate stressing equipment. For each jack and gauge unit used on the project, furnish certified calibration charts and curves to the Engineer prior to stressing. Supply documentation denoting the load cell(s) calibration date and tractability to NIST (National Institute of Standards and Technology) along with the jack/gauge calibration.

Provide the Engineer with certified calibration charts and curves prior to the start of the work and every six months thereafter, or as requested by the Engineer. Calibrations subsequent to the initial calibration with a load cell may be accomplished by the use of a master gauge. Supply the master gauge to the Engineer in a protective waterproof container capable of protecting the calibration of the master gauge during shipment to a laboratory. Provide a quick-attach hydraulic manifold to enable quick and easy installation of the master gauge to verify the permanent gauge readings. The master gauge will be calibrated and provided to the Engineer. The master gauge will remain in the possession of the Engineer for the duration of the project.

Any jack repair, such as replacing seals or changing the length of the hydraulic lines, is cause for recalibration using a load cell.

No extra compensation will be allowed for the initial or subsequent calibrations or for the use and required calibrations of the master gauge.

603.19.11.5-Elongations and Agreement with Forces: Ensure that the forces being applied to the tendon and the elongation of the post-tensioning tendon can be measured at all times.

Measure tendon elongations to the nearest 1/16 inch.
For the required tendon force, the observed elongation must agree within 5% of the theoretical elongation or the entire operation must be checked and the source of error determined and remedied to the satisfaction of the Engineer before proceeding further. Do not overstress the tendon to achieve the theoretical elongation.

In the event that agreement between the observed and theoretical elongations at the required force falls outside the acceptable tolerances, the Engineer may, at his discretion and without additional compensation to the Contractor, require additional tests for “In-Place Friction” in accordance with Section 603.19.6.2.

603.19.11.6 Friction: The Contract Plans were prepared based on the assumed friction and wobble coefficients and anchor set noted on the Plans. The Contractor shall submit calculations and show a typical tendon force diagram, after friction, wobble, and anchor set losses on the Shop Drawings based upon the expected actual coefficients and values for the post-tensioning system to be used. These coefficients and values shall be given on the Shop Drawings.

If, in the opinion of the Engineer, the actual friction significantly varies from the expected friction, the Contractor shall revise his post-tensioning operation such that the final tendon force is in agreement with the Plans.

When friction is to be reduced, only graphite is to be used as a lubricant subject to the approval of the Engineer. The ducts shall be blown dry with oil free air to remove any excess graphite.

603.19.11.7 Wire Failures in Post-Tensioning Tendons: Multi-strand post-tensioning tendons having wires, which failed by breaking or slippage during stressing, may be accepted provided the following conditions are met:

(a) The completed structure shall have a final post-tensioning force of at least 98 percent of the design total post-tensioning force.

(b) Any single tendon shall have no more than a five percent reduction in cross-sectional area of post-tensioning steel due to wire failure.

As an exception, any of the above conditions may be waived as approved by the Engineer when conditions permit the Contractor to propose acceptable alternative means of restoring the post-tensioning force lost due to wire failure.

603.19.11.8 Cutting of Post-Tensioning Steel: Post-tensioning steel shall be cut by an abrasive saw within ¾ to 1½ inches away from the anchoring device. Flame cutting of post-tensioning steel is not allowed.

603.19.11.9 Record of Stressing Operations: The Contractor shall keep a record of the following post-tensioning operations for each tendon installed:

(a) Project name, number.
(b) Contractor and/or subcontractor.
(c) Tendon location, size, and type.
(d) Date tendon was first installed in ducts.
(e) Reel number for strands and heat number for bars.
(f) Nominal and minimum cross-sectional area.
(g) Assumed Modulus of elasticity.
(h) Date Stressed.
(i) Jack and Gauge serial numbers per stressing operation.
(j) Required jacking force.
(k) Gauge pressures.
(l) Elongations (anticipated and actual).
(m) Anchor sets (anticipated and actual).
(n) Stressing sequence.
(o) Stressing mode (one end/ two ends/ simultaneous).
(p) Witnesses to stressing operation (Contractor and inspector).
(q) Date grouted, days from stressing to grouting, grouting pressure applied, and injection end.

Any other relevant information, including but not limited to the application of approved corrosion inhibitors onto the tendon, shall also be recorded. The Contractor shall provide the Engineer with a complete copy of all stressing and grouting operations.

603.19.11.10-Duct Pressure Field Test: After stressing and before grouting internal tendons, install all grout caps, inlets and outlets and test the tendon with compressed air to determine if duct connections require repair. In the presence of the Engineer, pressurize the tendon to 50 psi and lock-off the outside air source. Record the pressure loss for one minute. A pressure loss of 25 psi is acceptable. If the pressure loss exceeds 25 psi, repair leaking connections using methods approved by the Engineer. Upon completion of repairs approved by the engineer, retest the duct to the requirements specified above.

603.19.11.11-Tendon Protection: Within four hours after stressing, the ends of the tendon shall be cut and the tendon shall be protected against corrosion or harmful effects of debris by temporarily plugging or sealing all openings and vents until the tendon is grouted. Grout caps shall be placed over the tendon end and anchorage plate. If tendon contamination occurs, remove and replace the tendon.

603.19.12-Grouting Operations:

603.19.12.1-General: Prior to grouting, clean ducts with oil-free compressed air to remove water that may interfere with the grout injection. The flushing of ducts with water during grouting operation will not be permitted. Check all inlets and outlets to ensure they are capable of accepting injection of the grout by blowing through the system and proving that each inlet and outlet is free and capable of accepting the grout.

Either install an approved corrosion inhibitor or grout ducts within twenty (20) calendar days from the date of the post-tensioning steel installation except when the Engineer approves in writing.

Grouting operations shall be supervised and conducted by qualified crew members, technician(s) and/or engineer(s) in accordance with Section 603.19.1.7, Project Personnel Qualifications.

Grouting shall be injected from the lowest point on the tendon profile. The location of all grout injection locations must clearly be shown on the Shop Drawings.
603.19.12.2-Grouting Operations Plan: Submit a grouting operations plan for approval at least thirty (30) working days in advance of any scheduled grouting operations. Written approval of the grouting operations plan by the Engineer is required prior to commencement of grouting of the permanent structure. At a minimum, the plan will address and provide procedures for the following items:

1. Names and proof of experience and training for the grouting crew and the crew supervisor in conformance with Section 603.19.1.7 of this Special Provision;
2. Type, quantity, and brand of materials used in grouting including all certifications required;
3. Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;
4. General grouting procedure;
5. Duct pressure test and repair procedures;
6. Proposed method to control the rate of flow within ducts;
7. Theoretical grout volume calculations;
8. Mixing and pumping procedures;
9. Direction of grouting;
10. Sequence of use of the inlets and outlet pipes;
11. Procedures for handling blockages;
13. The Contractor shall provide additional temporary corrosion protection measures to be used when tendons are left ungrouted for more than twenty (20) calendar days, including methods by which to expel moisture or to remove any contamination if induced as a part of the corrosion protective measures.

A joint meeting of the Contractor, grouting crew and the Engineer will be required five (5) working days prior to the commencement of grouting operations. At the meeting the grouting operation plan, required testing, corrective procedures and any other relevant issues shall be discussed.

603.19.12.3-Grout Inlets and Outlets: Ensure the connections from the grout pump hose to inlets are free of dirt and are airtight. Inspect valves to be sure that they can be opened and closed properly.

603.19.12.4-Supplies: Before grouting operations start, provide an adequate supply of water and compressed air for clearing and testing the ducts, mixing and pumping the grout. Where public water supply is not available, provide a water storage tank of sufficient capacity.

603.19.12.5-Equipment:

603.19.12.5.1-General: Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (holding reservoir) and a pump with all the necessary connecting hoses, valves, and pressure gauge. Provide
pumping equipment with sufficient capacity to ensure that the post-tensioning ducts to be grouted can be filled and vented without interruption at the required rate of injection in not more than 30 minutes. Any material not placed within 30 minutes shall be retested for conformance with Section 603.19.4. Grout failing to meet these requirements shall be rejected.

Provide an air compressor and hoses with sufficient output to perform the required functions.

Provide vacuum grouting equipment (volumetric measuring type) prior to the start of grouting operations and retain the equipment on the job during the duration of tendon grouting operations.

603.19.12.5.2-Mixer, Storage Hopper: Provide a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and undispersed cement. The colloidal grout machinery will have a charging tank for blending and a holding tank. The blending tank must be equipped with a high shear colloidal mixer. The holding tank must be kept agitated and at least partially full at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Add water during the initial mixing by use of a flow meter or calibrated water reservoir with a measuring accuracy equal to one percent of the total water volume.

603.19.12.5.3-Grout Pumping Equipment: Provide pumping equipment capable of continuous operation which will include a system for circulating the grout when actual grouting is not in progress.

The equipment shall be capable of maintaining pressure when ducts are completely grouted and have a valve that can be closed off without loss of pressure in the duct.

Grout pumps shall be positive displacement type, capable of providing a continuous grout flow and maintaining a discharge pressure of at least 145 psi.

Pumps shall be constructed to have seals adequate to prevent oil, air or other foreign substances from entering the grout and to prevent loss of grout or water. The capacity will be such that an optimal rate of grouting can be achieved.

A pressure gauge having a full scale reading of no more than 300 psi will be placed at the duct inlet. If long hoses (in excess of 100 ft) are used, place two gauges, one at the pump and one at the inlet. The diameter and rated pressure capacity of the grout hoses must be compatible with the pump output.

603.19.12.5.4-Vacuum Grouting Equipment: Provide vacuum grouting equipment for backup at the job site, concurrently with all pressure grouting operations, consisting of the following:

(a) Volumeter for the measurement of void volume.
(b) Vacuum pump with a minimum capacity of 10 cfm (0.283 cmm) and equipped with flow-meter capable of measuring amount of grout being injected.
(c) Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 20 liters in volume.
(d) Standard colloidal mixers, for voids 20 liters and greater in volume.
603.19.12.5.5-Stand-by Equipment: During grouting operations, provide a stand-by grout mixer and pump.

603.19.12.6-Grouting:

603.19.12.6.1-General: Perform test to confirm the accuracy of the volume-measuring component of the vacuum grouting equipment each day before performing any vacuum grouting operation. Use either water or grout for testing using standard testing devices with volumes of 0.5 gal and 6.5 gal and an accuracy of equal to or less than 4 ounces. Perform one test with each device. The results must verify the accuracy of the void volume-measuring component of the vacuum grouting equipment within 1% of the test device volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test device volume. Ensure the Engineer is present when any test is performed.

Grout tendons in accordance with the procedures set forth in the approved grouting operation plan. Grout all empty ducts.

603.19.12.6.2-Temperature Considerations: Maximum grout temperature must not exceed 90°F at the grout inlet. Use chilled water and/or pre-cooling of the bagged material to maintain mixed grout temperature below the maximum allowed temperature. Grouting operations are prohibited when the ambient temperature is below 40°F or is 40°F and falling.

603.19.12.6.3-Mixing and Pumping: Mix the grout with a metered amount of water. The materials will be mixed to produce a homogeneous grout. Continuously agitate the grout until grouting is complete.

603.19.12.6.4-Grout Production Test: During grouting operations the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer’s representative, based on ambient weather conditions. The manufacturer’s representative shall be on-site at all times during this testing. Determine grout fluidity by use of either test method found in Section 603.19.4. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

Prior to grouting empty ducts, condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. Prior to performing repair grouting operations, condition the grout materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.

At the beginning of each day’s grouting operation, perform a Shupack Pressure Bleed Test in accordance with Section 603.19.4. If zero bleed is not achieved at the end of the required time period, do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.
603.19.12.6.5-Grout Operations: Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the Grouting Operations Plan.

Unless approved otherwise by the Engineer, pump grout at a rate of 16 feet to 50 feet of duct per minute. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at the grout inlet. Do not exceed the maximum pumping pressure of 145 psi at the grout inlet.

Use grout pumping methods which will ensure complete filling of the ducts and complete encasement of the steel. Grout must flow from the first and subsequent outlets until any residual water or entrapped air has been removed prior to closing the outlet.

Pump grout through the duct and continuously discharge it at the anchorage and grout cap outlets until all free water and air are discharged and the consistency of the grout is equivalent to that of the grout being pumped into the inlet. Close the anchorage outlet and discharge a minimum of 2 gallons of grout from the grout cap outlet into a clean receptacle. Close the grout cap outlet.

For each tendon, immediately after uncontaminated uniform discharge begins, perform a fluidity test using the flow cone on the grout discharged from all grout outlets. Discharge a minimum of one gallon of grout for the fluidity test. The measured grout efflux time will not be less than the efflux time measured at the pump or minimum acceptable efflux time as established in Section 603.19.4. Perform fluidity test for each tendon to be grouted and maintain the correct water to cement ratio. Alternately, check the grout fluidity using the Wet Density method contained in Section 603.19.4. The measured density must fall within the values established in Section 603.19.4. The density at the final outlet must not be less than the grout density at the inlet. If the grout fluidity is not acceptable, discharge additional grout from the anchorage outlet and test the grout fluidity.

Continue this cycle until an acceptable grout fluidity is achieved. Discard grout used for testing fluidity. After all outlets have been bled and sealed, elevate the grout pressure to 75 psi, seal the inlet valve and wait two minutes to determine if any leaks exist. If leaks are present, fix the leaks using methods approved by the Engineer. Repeat the above stated process until no leaks are present. If no leaks are present, bleed the pressure to 5 psi and wait a minimum of ten minutes for any entrapped air to flow to the high points. After the minimum ten minute period has expired, increase the pressure as needed and discharge grout at each high point outlet to eliminate any entrapped air or water. Complete the process by locking a pressure of 30 psi into the tendon.

If the actual grouting pressure exceeds the maximum allowed, the inlet will be closed and the grout will be pumped at the next outlet, which has just been, or is ready to be closed as long as a one-way flow is maintained. Grout will not be pumped into a succeeding outlet from which grout has not yet flowed. If this procedure is used, the outlet/inlet, which is to be used for pumping will be fitted with a positive shut-off and pressure gage.

When complete grouting of the tendon cannot be achieved by the steps stated herein, stop the grouting operation. After waiting 48 hours, fill the tendon with grout in accordance with the procedure outlined in 603.19.12.6.8.

603.19.12.6.6-Construction Traffic and Operations Causing Vibrations: During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from all sources of construction activities such as moving construction vehicles, jackhammers, compressors, generators, pile driving operations, soil compaction, etc., that are operating
within 300 feet down-station and 300 feet up-station of the ends of the span in which grouting is taking place.

603.19.12.6.7-Post-Grouting Operations and Inspection: Do not remove or open inlets and outlets until the grout has cured for 24 to 48 hours. Perform inspections within one hour after the removal of the inlet/outlet. After the grout has cured, remove all outlets located at anchorages and high points along the tendon to facilitate inspection. Inspect all high points along the tendon as well as the inlets or outlets located at the anchorages. Depending on the geometry of the grout inlets, drilling may be required to penetrate to the inner surface of the trumpet or duct. Use drilling equipment that will automatically shut-off when steel is encountered. Unless grout caps are determined to have voids by sounding, do not drill into the cap. Perform inspections in the presence of the Engineer using endoscopes or probes. Within four hours of completion of the inspections, fill all duct and anchorage voids using the volumetric measuring vacuum grouting process.

Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes as specified in Section 603.19.13.2. Remove the inlet/outlet to a minimum depth of 2 inches. Use an injection tube to extend to the bottom of the drilled holes for backfilling with epoxy.

Post grouting inspection of tendons having a length of less than 150 feet may utilize the following statistical frequency for inspection:

1. For the first 20 tendons, inspect all outlets located at anchors and tendon high points by drilling and probing with an endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), continue testing all tendons until 20 consecutive tendons have been inspected and no voids have been found.
2. When no defects are detected as defined in No. 1 above, the frequency of inspection can be reduced to inspect every other tendon (50%). If a defect is located, inspect the last five tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

If tendon grouting operations were prematurely terminated prior to completely filling the tendon, drill into the duct and explore the voided areas with an endoscope. Probing is not allowed. Determine the location and extent of all voided areas. Install grout inlets as needed and fill the voids using volumetric measuring vacuum grouting equipment.

603.19.12.6.8-Vacuum Grouting: If vacuum grouting is required to repair voids in ducts, the following procedure shall be used:

1. Pressurize void and check for leaks
2. Seal leaks by a method approved by the Engineer
3. Measure the volume of the void to determine the necessary amount of grout
4. Mix sufficient amount of grout for use and for testing, record quantity of mixed grout
5. Test the grout using the flow-cone or the modified flow-cone method in accordance with Subsection 603.19.4
6. Evacuate air from the voids
7. Switch valve and inject grout into voids under pressure
8. Record quantity of grout remaining and calculate the amount injected
9. Seal all grout injection inlets
10. Clean equipment, area of operations on structure and properly discard unused grout
11. Record and report all vacuum grouting operations

603.19.12.6.9-Grouting Report: Provide a grouting report signed by the Contractor and/or the Subcontractor within 72 hours of each grouting operation for review by the Engineer.

Report the theoretical quantity of grout anticipated as compared to the actual quantity of grout used to fill the duct. Notify the Engineer immediately of shortages or overages.

Information to be noted in the records must include but not necessarily be limited to the following: identification of the tendon; date grouted; number of days from tendon installation to grouting; type of grout; injection end and applied grouting pressure, ratio of actual to theoretical grout quantity; summary of any problems encountered and corrective action taken.

603.19.13-Forming and Repairs of Holes and Block-Outs:

603.19.13.1-Repair of Holes and Block-Outs: Repair all holes and block-outs by filling with a non-shrink epoxy grout used to protect the post-tensioning anchorages. This non-shrink epoxy grout may be Embeco, Chem-Comp, Five Star or approved equal.

603.19.13.2-Repair of Grout Inlets and Outlets: Place threaded plastic caps in all intermediate grout inlet and outlet pipes and threaded plastic plugs to be installed at anchorages and grout caps shown on the Shop Drawings. Repair all intermediate grout inlets and outlet pipes shown on the Shop Drawings using a non-shrink epoxy grout (fluid or gel type) approved by the Engineer. Prepare the surface to receive the non-shrink epoxy grout in strict compliance with the manufacturer’s recommendations.

603.19.14-Protection of Post-Tensioning Anchorages: Within seven days upon completion of the grouting, protect the anchorage of post-tensioning bars and strands as indicated here. Clean all exposed surfaces of laitance, grease, curing compounds, surface treatments, misplaced mortar, grout, coating and oils by grit blasting or water blasting. After cleaning of all surfaces and acceptance by the Engineer, place a heavy unbroken coating of an epoxy bonding compound to all such surfaces. The epoxy bonding compound shall conform to AASHTO M 235, Type III.

Immediately upon the completion of the epoxy bonding compound application, install tight fitting forms securely against the previously placed concrete. Mix and place and fill forms with non-shrink epoxy grout in accordance with the manufacturer’s current standard technical guidelines. The non-shrink epoxy grout shall be placed within the “tack time” period of the epoxy bonding compound. Construct all pour-backs in leak proof forms creating neat lines. The non-shrink epoxy grout may require pumping for proper installation. Construct forms to maintain a liquid head to insure intimate contact with the concrete surface. Use vents as needed to provide for the escape of air to insure complete filling of the forms.
After anchorage material has properly cured in accordance with the manufacturer’s recommendations, the forms may be removed. After the pour-backs are a minimum of 28 days old, clean the surface of laitance, grease, curing compounds, surface treatments, oils and coatings, if any, by methods approved by the Engineer. Apply to all surfaces of pour-backs a coating in accordance with the Section 601.13 of the Supplemental Specifications.

603.19.15-Method of Measurement: The quantity of post-tensioning tendons to be paid for under this Section shall be the computed weight, in pounds (kilograms), of permanent post-tensioning steel tendons entered into the completed structure and accepted. Measurement shall be the theoretical plan length measured from anchor plate bearing face to anchor plate bearing face with no allowance made for waste or extension past the anchor plate faces. No measurement will be made for temporary post-tensioning, which shall be considered incidental to the item "Post Tensioning Strands" and the item "Post Tensioning Bars".

For quantity determination the following unit weights shall be used:

<table>
<thead>
<tr>
<th>Prestressing System</th>
<th>Weight per Unit Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 inch diameter seven wire strand</td>
<td>0.521 plf</td>
</tr>
<tr>
<td>0.60 inch diameter seven wire strand</td>
<td>0.740 plf</td>
</tr>
<tr>
<td>1 inch high strength deformed bar</td>
<td>3.010 plf</td>
</tr>
<tr>
<td>1-1/4 inch high strength deformed bar</td>
<td>4.395 plf</td>
</tr>
<tr>
<td>1-3/8 inch high strength deformed bar</td>
<td>5.564 plf</td>
</tr>
</tbody>
</table>

603.19.16-Basis of Payment: Post-tensioning tendons will be paid for at the contract unit price per pound of steel strand and per pound of steel bar, complete and in place. Payment shall be full compensation for furnishing, installing, stressing, grouting all post-tensioning tendons, and probing and inspecting grouted anchorages. Payment shall also include anchorage assemblies and post-tensioning system hardware which is not embedded in concrete, grout and grouting, all testing, anchorage protection systems, and all labor, materials, tools, equipment, and incidentals necessary for completing the work in accordance with these Special Provisions and the plans. This payment shall also include lubricant in the tendon ducts for friction control. No separate measurement and payment will be made for anchorage components, including anchoring assemblies and anchorages for future tendons and spare ducts, local anchorage zone reinforcement supplied as an integral part of a proprietary anchorage system, nor ducts for similar post-tensioning system hardware. Anchorage components, ducts, and similar items of post-tensioning system hardware, which are embedded within the cast-in-place concrete, shall be deemed to be included in the cost of the cast-in-place concrete.

In the event that the Contractor constructs the structure with an accepted alternative not detailed on the Plans, the payment shall be based on the unit price bid extended by either the quantities shown on the Plans or the actual quantities used and accepted, whichever is less.

603.19.17-Pay Items:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 603003-001</td>
<td>Post Tensioning Strands</td>
<td>per pound (kilogram)</td>
</tr>
<tr>
<td>Item 603004-001</td>
<td>Post Tensioning Bars</td>
<td>per pound (kilogram)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: __________________________
FEDERAL PROJECT NUMBER: _______________________

SECTION 604
PIPE CULVERTS

601.1-DESCRIPTION:

ADD THE FOLLOWING TO THE SECTION:

604.1.1-Cured-In-Place Pipe Liner: The purpose of this special provision is to describe the work and material required to line an existing pipe with a new cured-in-place (CIP) pipe liner.

604.2-MATERIALS:

ADD THE FOLLOWING TO THE SECTION:

604.2.5-Materials: The CIP pipe liner must be a continuous system (jointless) and must provide for complete structural integrity, independent of the load bearing capacity of the existing host pipe. The CIP pipe liner shall conform to ASTM D5813 and be designed according to ASTM F1216 as a fully deteriorated gravity pipe. Design the structural spray liner rehabilitation system to support the dead load and live load. Use the following AASHTO HL-93 live loads for calculations:

<table>
<thead>
<tr>
<th>Cover</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ft.</td>
<td>30.8 psi</td>
</tr>
<tr>
<td>2 ft.</td>
<td>13.4 psi</td>
</tr>
<tr>
<td>3 ft.</td>
<td>7.3 psi</td>
</tr>
<tr>
<td>4 ft.</td>
<td>4.6 psi</td>
</tr>
<tr>
<td>5 ft.</td>
<td>3.1 psi</td>
</tr>
<tr>
<td>6 ft.</td>
<td>2.2 psi</td>
</tr>
<tr>
<td>7 ft.</td>
<td>1.6 psi</td>
</tr>
<tr>
<td>8 ft.</td>
<td>1.2 psi</td>
</tr>
<tr>
<td>9 ft+</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Use the following minimum design parameters:
1. ground water level will be top of the existing pipe unless site conditions indicate a higher value
2. soil density of 120 pcf
3. soil modulus of reaction of 2000 psi
4. factor of safety of 2

604.6-LAYING AND JOINING:

ADD THE FOLLOWING TO THE SECTION:

604.6.4-Cured-In-Place Pipe Liner: Installation of the CIP pipe liner shall meet the following requirements.

   604.6.4.1-Installation: The Contractor shall provide a CIP pipe liner that is able to mold itself or fit tightly to the shape of the existing pipe. The CIP pipe liner must be capable of conforming to the pipeline bends in the existing pipe without splitting, rupturing, or wrinkling of the CIP pipe liner material. The CIP pipe liner must provide a flow capacity equal to, or greater than, that of the existing pipe prior to rehabilitation. Submit a written installation plan for the conduit renewal to the Engineer for acceptance at least ten days before beginning work. Provide design calculations performed and stamped by a Professional Engineer registered in West Virginia.

   Installation shall be per ASTM F1216, ASTM F1743, ASTM F2019 and per the manufacturer’s recommendations. All process water and condensate from steam used in the installation and curing process shall be managed per 107.21 through 107.24, inclusive, as a liquid waste.

   The work covered under this section includes furnishing all labor, materials and equipment required for installing a new CIP pipe liner system within an existing pipe. Minor work may be required to prepare the existing pipe for installation of the new CIP pipe liner and to complete the installation of the CIP pipe liner. Inspect the existing pipe using experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry before and after installation of the CIP pipe liner. Clean, remove debris, and repair conduit walls and joints prior to installing the CIP pipe liner. Restore active service connections after installation of the pipe liner.

604.14-PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>604125-*</td>
<td>&quot;size&quot;, Cured-In-Place Pipe Liner</td>
<td>Linear Foot (Meter)</td>
</tr>
</tbody>
</table>

“size” - Normal
* Sequence Number
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 601
STRUCTURAL CONCRETE

601.13-PROTECTIVE SURFACE TREATMENT:

601.13.3-Field Application of Concrete Protective Coatings:

DELETE ENTIRE SUBSECTION 601.13.3 AND REPLACE WITH THE FOLLOWING:

601.13.3-Concrete Protective Coating: This section covers requirements for materials to be used as surface finishes for designated surfaces of concrete structures. The concrete protective coatings must hide form marks, patches, and other minor irregularities and prevent deterioration, spalling, and other damage to the concrete due to the action of the weather and deicing chemicals. The Engineer will inspect all concrete surfaces to be coated as stated in the plans and/or contract documents. The field painting (coating) of concrete structures shall follow the provided requirements set forth in this specification unless otherwise noted in the Contract. This specification shall apply to surface preparation, coating application, contractor responsibilities, environmental and worker protection, and waste handling/disposal. All structures shall be pre-cleaned and washed in accordance with Section 685 of the Standard Specifications. The Engineer will ensure a satisfactory ordinary surface finish prior to coating operations. This section shall apply only when the pay item for concrete protective coating is included in the plans.

601.13.3.1-Physical Requirements of Coating: Physical requirements shall conform to Section 711.5.2.

601.13.3.2-Concrete Surface Preparation: All concrete surfaces to receive a protective coating shall be prepared in accordance with SSPC-SP 13, Surface Preparation of Concrete, SSPC-The Fundamentals of Cleaning and Coating Concrete, ASTM D4258-Standard Practice for Surface Cleaning Concrete for Coating. All surfaces to receive a protective coating shall be thoroughly cleaned and kept free of oil, form oil, grease, dust, dirt, mud, curing compound, release agents, loose patching mortar, or any other substances that may prevent bonding.
601.13.3.3-Coating Paint Application Requirements: The following surfaces shall be coated, including all beveled edges.

1) Bridge Abutments and Wingwalls – Every exposed surface above a point six inches below ground or fill line. Exclude where epoxy coating is applied.
2) Bridge Pier Caps – The tops (including exposed surfaces of pads, pedestals, and keys), sides and ends. Do not apply the coating to bearing areas. Exclude where epoxy coating is applied.
3) Bridge Superstructure – The tops, inside and outside faces, and ends of all barrier walls, parapets, curbs, and points that will be exposed. Do not apply the coating to the riding surface of the bridge deck.
4) Exposed Surfaces of Substructure and the Superstructure – all surfaces identified in 1), 2), and 3) above and the underneath surfaces of slab overhangs that are outside of exterior girders and the exterior side and bottom of exterior beams or girders, the interior windows of barriers, and all exposed surfaces of piers and abutments. Extend the concrete masonry-coating from a point six inches below ground line to the top of the exposed surface.
5) Any other area as designated within the contract plans not mentioned above.

601.13.3.3.1-Weather Conditions: Coating application shall not be performed while done when the ambient temperature is below 40° F (5° C) or above 100° F (38° C), or the relative humidity above 90 percent. Coating application shall only be permitted between the dates of April 15th through October 15th. There will be no painting permitted to occur in a heated containment. Heated containment shall not be permitted.

601.13.3.3.2-Coating Paint Storage: Coatings and thinners shall be stored in a temperature controlled environment between 40° F (5° C) and 100° F (38° C) in accordance to coating manufacturers recommendations. At no time will the coatings be used beyond the manufacturer’s shelf life.

601.13.3.3.3-Coating Paint Application: The coating shall be applied by spray, brush or roller methods. Brushes or rollers, when used, shall have sufficient body and length of bristle or roller nap to spread a uniform coat. Small touch-up areas may be brushed or rolled, if approved by the Engineer.

Use of an agitated pot shall be mandatory in spray application. The agitator or stirring rod shall reach within 1 inch (25 mm), of the bottom of the pot and shall remain in motion at all times during coating application. Coatings shall be mixed in strict accordance with the coating manufacturer’s written instructions. Under certain conditions, it may be necessary to thin or adjust the solvent balance of the paint. The type and amount of solvent to be used shall be that listed on the coating manufacturer’s product data sheet for that material. Upon thinning, the dry film thickness requirement shall still be met by appropriately increasing the wet film thickness.

Application requirements and drying times between coats shall be in accordance with the coating manufacturer’s recommendations.

Spray guns must be equipped with the recommended size tip for the coating being applied and shall be held perpendicular (90 degrees) to, and at, the
proper distance from the receiving surface. Complete protection shall be provided by the contractor against paint spatter, spillage, overspray, wind blown paint, or similar releases.

Appropriate containment shall be placed around the work area to protect public and private property. Staging must be adequate to provide access to all areas being coated painted. Violation of these requirements causing excessive paint waste will be justification for the WVDOH Engineer to order the Contractor to cease all work on the project until corrective action has been taken. The method of cleaning and/or replacement shall be submitted to the Engineer in advance for approval.

Coating application shall be suspended any time the ambient temperature or the temperature of the concrete does not comply with the coating manufacturer’s recommendations.

Prior to application of the materials, the contractor shall furnish the Engineer with copies of the coating material manufacturer’s brochures, or booklets, and product data sheets. Apply protective coating materials in strict conformity with the coating manufacturer’s written instructions and apply the material at a uniform rate of at least 50± 10 ft²/gal (1.75± 0.35 m²/L).

Satisfactorily repair or remove any portions of the coating that are not clean, uniform in color, texture, thickness, tightly bonded, or that are damaged before final acceptance of the project and replace them with an acceptable finish and coating.

Provide a neat uniform appearance, and prevent the coating from being dripped, sprayed, or otherwise deposited upon concrete and surfaces not designated to receive the coating. Remove any objectionable deposits or material and repair the surfaces to the Engineer’s satisfaction.

601.13.3.4-Environmental, Worker Protection, And Waste Handling:

601.13.3.4.1-General: Environmental protection shall be used when cleaning, coating painting, welding—or cutting an existing bridge. The containment class, emission assessment methods and levels as defined by the current revision of SSPC Guide 6 shall be as stated in the contract documents. The specific pollution control system which is proposed for the complete capture, containment, collection, and disposal of the “spent material” generated by the work shall be included in the plan.

601.13.3.4.2-“Spent Material”: This shall include material generated by surface preparation operations, and shall be disposed of in accordance with Section 7 of SSPC SP-13. The Contractor shall, at the Contractor’s expense, select a laboratory that will sample and analyze the “spent materials”. The laboratory must be certified by the WVDEP, EPA or by another state’s DEP-equivalent. Certification will be provided to the Engineer prior to the beginning of work. The waste transporter for both hazardous and non-hazardous waste will be listed on the Contractor’s Containment/Disposal Control Plan.

601.13.3.4.3–Permits for Disposal of “Spent Material”: Shall be in accordance with Section 107.2, Permits, Licenses, and Taxes or any other applicable sections of Section 107. The “spent material” shall not be disposed of until authorized by the Engineer and in no case shall “spent material” be allowed to accumulate longer than 90 days prior to transport.
601.13.3.4.4-Additional requirements for all classes of containment: Contractor will provide ground covers beneath the containment area and all equipment where spills are possible to capture inadvertent spills or leaks of debris. Extend the covers a minimum of 5 feet beyond the area to be covered. Debris shall be removed from the covers at least once per shift, or as directed by the Engineer. If the ground beneath the structure serves as the base of the containment, install and maintain air and dust impenetrable materials such as solid plywood panels or flexible materials such as tarpaulins. Provide explosion-proof lighting inside containment for all paint application. Maintain a minimum of 10 foot-candles for surface.

601.13.3.5-Contractor Responsibilities:

601.13.3.5.1-Concrete Protective Coating Materials: Select concrete masonry coatings from the Department’s List of Approved Materials. Use a material that is readily recognizable by its name, trademark, container, or other feature. All materials shall conform to 711.5.3.

601.13.3.6-Inspection Requirements:

601.13.3.6.1-Inspection of Applied Coating Paint: If in the opinion of the Engineer the coating has flaws other than deficiencies in the prescribed dry film thickness, the material shall be repaired or shall be removed and replaced. Defects in the film, including but not limited to runs, sags, mud-cracking, or lifting, overspray, and dry spray, shall be corrected until a continuous uniform film has been applied.

Excessive film thickness shall be reduced, and insufficient film thickness shall be increased. If the thickness of the finish coat is reduced, a thin coat of the finish shall be reapplied to seal the surface and to blend the area into the surrounding coating. Depending on the defect, total removal and replacement of the effected coating may be required. Dry film thickness readings shall be in accordance with the coating manufacturer recommendations. No unsightly runs or sags shall be visible. All "mud-cracking" and/or "dry overspray" in the paint film coating shall be removed. Calibration of the ultrasonic thickness gage shall be in accordance with ASTM D6132 and dry film thickness measurements shall be in accordance with MP 708.40.00 SSPC PA-9.

601.13.3.6.2-Access for Inspection: The Contractor shall furnish suitable safe access and shall provide a time mutually agreed to for inspecting the structural concrete prior to and after each coating. The Division’s inspector shall approve all repairs. When providing suitable safe access, rubber rollers or other protective devices shall be used. Metal rollers or clamps and other types of fastenings that will mar or damage freshly coated surfaces shall not be used. No temporary attachments, supports for access, or forms, shall damage the coating system. Any damage that occurs from such devices shall be repaired to the satisfaction of the Engineer at the Contractor’s expense.

601.13.3.6.3-Repair Procedures for Field Paint Coating Deficiencies: All field repairs to the coating shall be made in strict accordance with the coating manufacturer's recommendations, except where the requirements listed in this specification are more stringent. Any products used during repairs to the coating deficiencies shall be from the same manufacturer as the coating being repaired. Surfaces that will be inaccessible for...
coating after erection shall be repaired and/or recoated prior to erection. The Engineer is to review and accept a repair plan before deficient areas are repaired. The requirements specified herein for provisions for inspection, mixing, thinning, temperature and humidity, and application shall govern the coating of the repaired areas. In order to avoid abrupt changes in paint coating thickness, the area adjacent to repair areas shall transition from zero paintfilm thickness to full system film thickness within not less than 3 inches (75 mm) of the repair area by means of sanding the transition area. The requirements for the dry film thickness of the repair coats are the same as those specified for the coating paint system.

**601.13.3.7-Submittals:** Submittals shall be forwarded through the Prime Contractor and be accepted by the Engineer prior to commencement of the subject work. This is the responsibility of both the Fabricator and the Field Contractor. Electronic submittals will be accepted.

**601.13.3.7.1-Quality Control Plan for Painting:** Minimum requirements and document form are set forth in MP 688.02.20.

**601.13.3.7.2-Containment/Disposal Environmental Control Plan for Existing Concrete Structures:** Minimum requirements and document form are set forth in MP 688.03.20.

**601.16-PAY ITEMS:**

DELETE ITEM 601019 FROM THE TABLE AND REPLACE WITH THE FOLLOWING:

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
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<td>Square Foot</td>
</tr>
<tr>
<td>601019-005</td>
<td>Concrete Protective Coating – Rehabilitation</td>
<td>Square Foot</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 711
PAINTS, COATING, OILS, AND INKS

DELETE THE INTRODUCTION AND SUBSECTIONS 711.1 THROUGH 711.22
AND REPLACE WITH THE FOLLOWING:

All shall consist of pigments and vehicles conforming to the general requirements of these
specifications, proportioned and treated to produce materials possessing the detailed composition
and physical properties.

711.1-711.4: BLANK

711.5-CONCRETE PROTECTIVE COATINGS AND STAIN:

711.5.1-General: This specification provides the requirements for concrete protective
coatings and stains. Concrete coatings and stain may be used as surface finishes for designated
surfaces of cement concrete structures. The protective coatings and stains must hide form
marks, patches, and other minor irregularities and prevent deterioration, spalling, and other
damage to the concrete due to the action of the weather and deicing chemicals. These materials
must have protective and corrosion resistance properties. The storage life will be based on
manufacturer recommendations.

711.5.2-Physical Requirements: An independent testing laboratory acceptable to the
Division shall perform the tests described herein on representative samples of the material.
Tests listed herein are the minimum testing requirements to be met. When requested in writing,
the Engineer may accept materials based on conformance to the same type of test but differing
on minor procedural points. Attach copies of test procedures which differ from those stated
herein.

i. Freeze-Thaw Test: Cast and cure 3 concrete specimens no less than 4 by 6 by 6 inches
(100 by 150 by 150 mm). Moist cure specimens for 14 days and then dry in room air
at 60° to 80° F (15° to 27° C) for 24 hours before applying protective coating. Ensure
that there is no excessive oil on specimen forms. Coat sides of specimens (brush
permitted) according to the manufacturer’s directions at a rate of 50± 10ft2/gal (1.75±
0.35 m2/L) and cure at room temperature for 48 hours, after which:

1. Immerse in water at room temperature 60° to 80° F (15° to 27° C) for 3 hours
2. Place in cold storage at 5° F (-15° C) for one hour and remove.
3. Thaw at room temperature, 60° to 80° F (15° to 27° C) for one hour.
4. Repeat steps 1), 2) and 3) to complete a total of 50 cycles. At the end of 50 cycles of the Freeze/Thaw Test, ensure that the coated specimens show no visible defects.

ii. **Salt Fog**: Apply the masonry coating to concrete at a rate of 50± 10ft2/gal (1.75± 0.35 m2/L) and test the coating according to ASTM B 117. Expose the coating to a 5 percent sodium (salt) solution for 300 hours and maintain it at 194° ± 4° F (90± 2° C) during the period of exposure. Ensure that it shows no loss of adhesion or deterioration at the end of the 300 hours.

iii. **Fungus Growth**: Ensure that like protective coatings passes a fungus resistance test as described by federal specifications TT-P-29. After a minimum incubation period of 21 days, ensure that no growth is exhibited on the coatings.

iv. **Color**: The color choices permissible shall conform to SAE International AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standard Numbers- 37925, 36650, 37925, 36622

**711.5.3-Approval**: For approval, the manufacturer shall submit copies of certified test reports to Materials Control, Soils and Testing (MCS&T) Division for review and approval. An independent testing laboratory acceptable to the Division shall perform the tests described herein on representative samples of the material. Tests listed herein are the minimum testing requirements to be met. Attach copies of test procedures which differ from those stated herein. In addition, provide brochures or booklets containing detailed instructions and explanatory remarks about surface preparation, application procedures, and other pertinent operations. The Division may also choose approved products materials from the National Transportation Product Evaluation Program (NTPEP) and/or the North East Protective Coating Committee (NEPCOAT) tested materials.

**711.6-ZINC PRIMERS:**

**711.6.1-ORGANIC ZINC PRIMER:**

**711.6.1.1-General**: This specification provides the requirements for an organic zinc rich primer. The Organic Zinc Primer may be used in the shop on new steel or in the field on existing steel. The steel shall be capable of being blast cleaned to a near-white finish, meeting SSPC-SP-10 requirements for new steel, and SSPC-SP-6, for existing steel. When used as a shop primer, the material shall have a minimum slip coefficient of 0.50 (Class B) when tested in accordance with “Test Method to Determine the Slip Coefficient for Coatings used in Bolted Joints” as adapted by the Research Council on Structural Connections. Acceptance for field painting will be based on batch testing of materials that do not meet the minimum of 0.50 (Class B) slip coefficient. Initial approval of all materials will may be based on complete Division testing, or may be chosen from the National Transportation Product Evaluation Program (NTPEP) and/or the North East Protective Coating Committee (NEPCOAT) tested materials to assure specification compliance. The primer may be top coated with materials meeting the requirements of Subsections 711.22.3 and 711.22.4. The dry film thickness requirement will be based on manufacturer recommendations. The paint storage life will be based on manufacturer recommendations.
711.6.1.2-Physical Requirements: Shall be as per SSPC Paint 20, Type II with the following exceptions:
   i. The VOC shall not exceed 3.5 lbs/gal (420 g/l).
   ii. Viscosity of the mixed paint shall be in accordance with ASTM D 562. Variance shall be within ±10 Krebs Units of the viscosity of the previously qualified paint.
   iii. Weight per gallon of the mixed paint shall be in accordance with ASTM D 1475. Variance shall be within ±0.5 pounds (225 g) of the weight per gallon of the previously qualified paint.

711.6.2-Inorganic Zinc Primer:
   711.6.2.1-General: This specification provides the requirements for an inorganic zinc rich primer. The Inorganic Zinc Primer shall be shop applied only, over a near white blasted surface, meeting SSPC – SP-10 requirements. The primer shall have a minimum slip coefficient of 0.50 (Class B) when tested in accordance with "Test Method to Determine the Slip Coefficient for Coatings used in Bolted Joints" as adapted by the Research Council on Structural Connections. The paint storage life will be based on manufacturer recommendations.

   711.6.2.2-Physical Requirements: This primer shall meet the requirements set forth in AASHTO M 300 with the following exceptions:
   i. The VOC shall not exceed 3.5 lbs/gal (420 g/l).
   ii. The adhesion shall be a minimum of 4B when tested in accordance with ASTM D3359, Method B.
   iii. Viscosity of the mixed paint shall be in accordance with ASTM D 562. Variance shall be within ±10 Krebs Units of the viscosity of the previously qualified paint.
   iv. Weight per gallon of the mixed paint shall be in accordance with ASTM D1475. Variance shall be within ±0.5 pounds (225 g) of the weight per gallon of the previously qualified paint.

711.7-711.11: BLANK

711.12-EPOXY COATINGS:
   711.12.1-General: This specification provides the requirements for a two component, modified epoxy coating for use as a spot primer or a one coat system for use on poorly prepared surfaces on most existing structures. The coating may be used as a primer over steel that has been cleaned to a minimum of SSPC-SP-2. If it is used as a primer, it may then be coated with the manufacturer’s recommended intermediate and/or top coat from the Division’s approved list of Zinc Rich Low VOC Systems (711.22). This coating shall also be suitable for use over zinc rich primers. All ingredients are not specified; however, the finished product shall comply with the requirements prescribed. The paint storage life will be based on manufacturer recommendations.
711.12.2-Composition: The pigment shall not react with the vehicle or interfere with the cure. The pigment may be aluminum flake powder or paste. The metallic aluminum pigment may be replaced by other pigments and coloring agents necessary to provide the specified color. The vehicle shall be modified epoxy resin and curing agent. The vehicle shall be formulated to permit trouble free application during normal humidity conditions.

i. Color – The color choices permissible shall conform to SAE International AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standard Numbers- 20062, 26373

ii. Gloss @ 60° shall be 30-50 for semi-gloss and 51 or greater for gloss finishes.

iii. Flat finishes shall have a gloss of 29 or less.

711.12.3-Physical Requirements: Steel panels shall meet the requirements of ASTM D609, Type III. Steel panels shall be sandblasted to a white metal blast finish in accordance with SSPC-SP-5, exposed to the atmosphere for 30 days so uniform rusting occurs, and then hand cleaned with a wire brush in accordance with SSPC-SP-2. The panel shall then be spray applied with epoxy maintenance coating according to manufacturers’ recommendations.

i. Dry to touch @ 5 mils, (125 μm) dry, 24 Hours Maximum

ii. Dry hard @ 5 mils, (125 μm) dry, 72 Hours Maximum

iii. Weight per gallon, 10.5 Lbs. Minimum

iv. Accelerated Weathering: Panels shall be tested in accordance with ASTM G 154. After 1,000 hours exposure, the coating shall show no rusting, blistering, or loss of adhesion to the test panel.

v. Salt Fog: Panels shall be scribed to the base metal with an X of at least two inch (50 mm) legs. The test panels shall then be tested in accordance with ASTM B 117. After 1,000 hours of continuous exposure, the coating shall show no loss of bond, nor shall it show rusting or blistering beyond 1/16 inch (2 mm) from the center of the scribe mark.

711.12.4-Application Properties: The mixed paint, when thinned in accordance with manufacturer’s recommendations, shall be capable of being sprayed in one coat at a wet film thickness of 10 mils (250 μm) without runs or sags. The properly thinned paint shall be capable of brush and roller application. The manufacturer's current printed instructions for application of the epoxy maintenance coating shall be submitted to the Division for review and approval prior to application. The paint storage life will be based on manufacturer recommendations.

714.13 through 711.20: BLANK

711.21-REPAIR OF DAMAGED GALVANIZED SURFACES:

Repair of damaged galvanized surfaces will be done using a primer meeting the requirements Section 711.6.

711.22-ZINC RICH LOW VOC SYSTEM:

711.22.1-General: Initial approval of the system will may be based on testing of the complete system by the Division for specification compliance or chosen from the NTPEP or NEPCOAT tested materials for specification compliance. Each product in the system shall be from the same paint manufacturer. Each coat shall be a contrasting color to the one previously
applied. The use of the intermediate coat meeting 711.22.3, shall be at the option of the paint manufacturer. In either case, the adhesion of the system shall be a minimum of 4A when tested in accordance with ASTM D3359, Method A. The adhesion test shall be conducted approximately 14 days after application of the top coat. All products shall have a maximum VOC of 2.8 lbs / gallon (336 g/l) with exception of the primer, which shall have a maximum VOC of 3.5 lbs / gallon (420 g/l). The paint storage life will be based on manufacturer recommendations. The prime fabricator is responsible for choosing the paint system when shop applied.

711.22.2-Primer: The primer shall meet the requirements of 711.6.

711.22.3-Intermediate Coat: This material shall meet the manufacturer's specification and shall be compatible with a primer (711.6) and the top coat (711.22.4).

711.22.4-Top Coat: This material shall meet the manufacturer’s specification and shall meet the requirements of 711.22.4.1. After system approval, all topcoat material shall be batch tested for color and dry time.

711.22.4.1-Physical Requirements:
   i. **Dry Hard**-24 Hours Maximum
   ii. **Color**—The color choices permissible shall conform to SAE International AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standards Numbers- 20062, 26373
   iii. **Gloss @ 60°** shall be 30-50 for semi-gloss and 51 or greater for gloss finishes. Flat finishes shall have a gloss of 29 or less.

711.22.5-System: The system shall be composed of a primer and topcoat. Application and dry film thickness shall be based on the manufacturer recommendations. The use of the intermediate coat shall be at the option of the paint manufacturer.

711.22.5.1-System Requirements:
   i. **Intercoat Adhesion**-The adhesion of the system shall be a minimum of 4B when tested in accordance with ASTM D3359, Method B.
   ii. **Accelerated Weathering**-After cycling 1000 hours there shall be no evidence of checking, cracking, rusting, or blistering. The degree of chalking shall not be less than No. 6 when tested according to ASTM G 154. The color difference after 1000 hours shall be no more than five ΔE units.
   iii. **Salt Fog**-Testing shall be in accordance with ASTM B117. After 1000 hours of continuous exposure, there shall be no evidence of checking, cracking, rusting, or blistering.
711.23- SAMPLE SUBMISSION AND APPROVAL:

711.23.1: All samples for approval testing and all supporting documentation shall be shipped to the address provided below:

   West Virginia Division of Highways
   Materials Control, Soils and Testing
   Paint Laboratory
   190 Dry Branch Drive
   Charleston, West Virginia, 25306

711.23.2: Paints and coatings submitted for approval testing shall be furnished to the MCS&T Division in appropriate containers not holding more than one gallon (3.79 liters) of material. Each component shall be labeled appropriately, and the following information shall be provided with the sample.

   i. Name and address of Manufacturer
   ii. Trade Name or Trade Mark
   iii. Type of Paint
   iv. Lot or Batch number
   v. Date of manufacturing
   vi. All SDS/PDS information pertaining to the material
   vii. Reference to the Division’s Standard Specifications

711.23.3: Acceptance Procedure: The Division will develop an approved list of products meeting this specification. This list will be placed on the Division’s website. The list shall be based upon testing performed by the Division, or the Division may choose materials from the National Transportation Product Evaluation Program (NTPEP) and/or the North East Protective Coating Committee (NEPCOA) tested materials. Upon approval by the Division, further testing will not be required unless random samples tested by the Division show non-compliance with any of the specification requirements. The manufacturer shall supply the MCS&T Division the following for each product:

   i. One, one gallon kit of the product
   ii. One gallon thinner
   iii. Instructions for mixing, thinning and application
   iv. Materials Safety Data Sheet for both the paint and thinner
   v. Product data sheet
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ___________________________
FEDERAL PROJECT NUMBER: ___________________________

SECTION 604
PIPE CULVERTS

604.1—DESCRIPTION:

ADD THE FOLLOWING TO THE SUBSECTION:

604.1.1—High Density Polyethylene (HDPE) Pipe Liner: The purpose of this special provision is to describe the work and material required to line an existing pipe with a new high density polyethylene (HDPE) pipe liner.

604.2—MATERIALS:

ADD THE FOLLOWING TO THE SUBSECTION:

604.2.5—Materials: The liner pipe shall be solid wall HDPE in accordance with AASHTO M 326 having a Standard Dimension Ratio (SDR) of 32.5 or structural profile wall polyethylene pipe in accordance with ASTM F894 having a minimum ring stiffness constant (RSC) of 100.

604.6 – LAYING AND JOINING:

ADD THE FOLLOWING TO THE SUBSECTION:

604.6.4—High Density Polyethylene Pipe Liner: Installation of high density polyethylene (HDPE) pipe liner shall meet the following requirements.
604.6.4.1–Installation: The Contractor shall verify that the “Lining Pipe Culvert” will fit inside the culvert being lined prior to ordering materials. The Contractor shall adhere to the manufacturer and ASTM F585 installation requirements. The work covered under this section includes furnishing all labor, materials and equipment required for installing a new HDPE liner within an existing pipe. Minor work may be required to prepare the existing pipe for insertion of the new HDPE liner pipe. Remove all objects from the existing pipe that could damage the new pipe or obstruct the flow of grout within the annular space between the existing and new pipes. Blocking may be required to prevent the lining pipe from floating during grouting stage.

604.14–PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
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<tbody>
<tr>
<td>604055-*</td>
<td>“size”, Lining Pipe Culverts</td>
<td>Linear Foot (Meter)</td>
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</tbody>
</table>

“size” — Nominal Size of Pipe
* Sequence number
## APPENDIX 604A

| Lining-Pipe Culvert Nominal Size | Equivalent-Pipe Sizes |  |  
|---|---|---|---|
| | AASHTO-M326 Outside-Diameter Pipe | ASTM-F894 Inside-Diameter Pipe |  
| Inches | Inches | Inches |  
| 14-Inch | 14-Inch | 12-Inch |  
| 16-Inch | 16-Inch | 15-Inch |  
| 18-Inch | 18-Inch | NA |  
| 20-Inch | 20-Inch | 18-Inch |  
| 22-Inch | 22-Inch | 20-Inch |  
| 24-Inch | 24-Inch | 21-Inch |  
| 28-Inch | 28-Inch | 24-Inch |  
| 30-Inch | 30-Inch | 27-Inch |  
| 32-Inch | 32-Inch | 28-Inch |  
| 34-Inch | 34-Inch | 30-Inch |  
| 36-Inch | 36-Inch | 34-Inch |  
| 42-Inch | 42-Inch | 40-Inch |  
| 48-Inch | 48-Inch | 42-Inch |  
| 54-Inch | 54-Inch | 48-Inch |  
| 60-Inch | 60-Inch | 54-Inch |  
| 72-Inch | NA | 66-Inch |  
| 84-Inch | NA | 78-Inch |  
| 96-Inch | NA | 90-Inch |  
| 108-Inch | NA | 96-Inch |  
| 120-Inch | NA | 108-Inch |  
| 132-Inch | NA | 120-Inch |  
| 144-Inch | NA | 132-Inch |  

Page 3 of 4
## APPENDIX 604A

<table>
<thead>
<tr>
<th>Lining Pipe Culvert Size</th>
<th>Approximate Equivalent Pipe Size (See Note)</th>
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<td></td>
<td>AASHTO M326</td>
<td>ASTM F894</td>
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<td>Inside Diameter</td>
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<td>RSC 100, minimum Inside Diameter</td>
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<td>18</td>
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<td>18.77</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>22.4</td>
<td>20.646</td>
<td>22</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>25.4</td>
<td>22.524</td>
<td>24</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>31.4</td>
<td>30.03</td>
<td>32</td>
</tr>
<tr>
<td>33</td>
<td>33</td>
<td>34.9</td>
<td>33.784</td>
<td>36</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>38.1</td>
<td>39.416</td>
<td>42</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>44.3</td>
<td>45.046</td>
<td>48</td>
</tr>
<tr>
<td>48</td>
<td>48</td>
<td>50.5</td>
<td>50.676</td>
<td>54</td>
</tr>
<tr>
<td>54</td>
<td>54</td>
<td>56.5</td>
<td>59.124</td>
<td>63</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td>62.6</td>
<td>59.124</td>
<td>63</td>
</tr>
<tr>
<td>66</td>
<td>66</td>
<td>68.6</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>78</td>
<td>78</td>
<td>74.6</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>90</td>
<td>90</td>
<td>86.7</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>96</td>
<td>96</td>
<td>98.7</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>108</td>
<td>108</td>
<td>110.7</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>120</td>
<td>120</td>
<td>122.7</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>132</td>
<td>132</td>
<td>134.7</td>
<td>NA</td>
<td>--</td>
</tr>
</tbody>
</table>

**NOTE:**

1. This information is provided for informational purposes only.
2. Contractor shall obtain actual pipe material specifications from pipe supplier/manufacture for the specific pipe product installed.
3. Contractor should verify lining pipe will fit accordance with 604.6.4.1.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: __________________________
FEDERAL PROJECT NUMBER: _______________________

FOR

SECTION 616
PILING

616.1–DESCRIPTION:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

This work shall consist of furnishing steel bearing piles of the kind and dimensions designated in the plans to the required bearing or penetration in accordance with this Special Provision and in reasonably close conformity with the lines and spacing shown on the Plans or established by the Engineer.

All piles shall be predrilled into rock and backfilled with concrete. Pile Driving is prohibited, unless called for in the Plans.

616.3–PREPARATION FOR DRIVING:

DELETE THE ENTIRE CONTENTS OF THE SUBSECTION

616.4–EQUIPMENT FOR DRIVING:

DELETE THE ENTIRE CONTENTS OF THE SUBSECTION
616.12-PREDRILLED PILING:

DELETE THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

The piles shall be predrilled into bedrock and concrete tremied around the piles to the top of rock socket elevation as indicated in the plans.

The bottom of the drilled boreholes shall be cleaned to the satisfaction of the Engineer prior to placement of concrete. Mini-Sid Inspection and CSL testing are waived.

Pile alignment shall meet the criteria as defined in Section 616.6.

Temporary Casing shall be used to keep the drill hole open during pile installation. The temporary casing shall be installed to the top of bedrock. The Rock Socket for the pile shall be a minimum diameter of three (3) feet. Shear studs, when required in the plans, shall be welded onto all piles.

The boreholes shall be drilled to the elevation specified in the plans and concrete shall be tremied in the annular space around the pile to the elevation specified in the plans from the bottom of the hole. The annular space around the piles shall be backfilled with Class DC Concrete (4,500 psi) or modified Class B (w/ 4500 psi strength). The Concrete shall be tremied according to Section 625 – Drilled Caisson Foundations.

The zone above the top of concrete shall be as specified in the plans and backfilled with clean, dry sand to the bottom of the pile cap elevation.

616.15-BASIS OF PAYMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:

“Steel Piling, Predrilled and Backfilled with Concrete” of the size specified shall be paid for the actual length of piles remaining in the finished structure. The cost of temporary casing, concrete and sand for backfilling, and incidentals necessary to complete the work will be included in the bid price for piling.

616.16-PAY ITEMS:

ADD THE FOLLOWING ITEM TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>616001-001</td>
<td>Steel Piling, Predrilled and Backfilled with Concrete,</td>
<td>Linear Foot</td>
</tr>
<tr>
<td></td>
<td>“size”</td>
<td>(Meter)</td>
</tr>
</tbody>
</table>

“size” = Piling Size
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 108
PROSECUTION AND PROGRESS

108.7-COMPLETION DATES:
108.7.1-Failure to Complete on Time and Liquidated Damages:

DELETE THE CONTENTS OF SUBSECTION 108.7.1 AND REPLACE THE FOLLOWING:

Time is an essential element of the Contract, and it is important that the work be completed within the time specified. The cost to the Division for the administration of the Contract, including engineering, inspection, and supervision, will increase as the time required to complete the work is increased.

Therefore, for each calendar day the project is deemed not to be Substantially Complete after the Contract Time specified for completion of the work, subject to such extensions of contract time required or permitted in 108.6, the Division will assess liquidated damages against the Contractor. Daily charges will be deducted for each calendar day, as defined in 101.2, on all contracts, except daily charges will not be deducted between November 30 and April 1. The total amount of daily charges will be deducted from any monies due the Contractor, not as a penalty but as liquidated damages. Unless specified elsewhere in the Contract, the amount of the daily charge will be calculated from the table posted at the WVDOH Contract Administration’s Specifications and Documents website: http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/LiquidDatedDamages.aspx. Table 108.7.1 on the date the project is first advertised.

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>For More Than $0 To and Including $500,000</td>
<td>$300</td>
</tr>
<tr>
<td>$500,000 To and Including $2,000,000</td>
<td>$600</td>
</tr>
<tr>
<td>$2,000,000 To and Including $10,000,000</td>
<td>$1,500</td>
</tr>
<tr>
<td>$10,000,000 To and Including $25,000,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>$25,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>
### Current WVDOH Liquidated Damages Schedule:

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$25,000</td>
</tr>
<tr>
<td>$25,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>$100,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>$40</td>
</tr>
</tbody>
</table>

### Surrounding State's Liquidated Damage Schedules:

**Kentucky - 108.09 (2012)**

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$500,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$1,000,000</td>
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<tr>
<td>$1,000,000</td>
<td>$2,000,000</td>
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<tr>
<td>$5,000,000</td>
<td>$10,000,000</td>
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<td>$10,000,000</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>$20,000,000</td>
<td>$40</td>
</tr>
</tbody>
</table>

**Pennsylvania - 108.07 (2016)**

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$500,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>$10,000,000</td>
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<tr>
<td>$10,000,000</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>$20,000,000</td>
<td>$40</td>
</tr>
</tbody>
</table>

**Virginia - 108.06 (2016)**

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$500,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$2,000,000</td>
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<tr>
<td>$5,000,000</td>
<td>$10,000,000</td>
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<tr>
<td>$10,000,000</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>$25,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

**Ohio - 108.07 (2016)**

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$500,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$2,000,000</td>
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<tr>
<td>$5,000,000</td>
<td>$10,000,000</td>
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<tr>
<td>$10,000,000</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>$25,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

### Markup showing the proposed changes to Liquidated Damages Schedule:

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$25,000</td>
</tr>
<tr>
<td>$25,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>$100,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>$25,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

### Proposed Liquidated Damages Schedule:

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$25,000</td>
</tr>
<tr>
<td>$25,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>$100,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

### If we used a 4% inflation factor over a 9 year period, the existing daily charges would be the following:

<table>
<thead>
<tr>
<th>Original Contract Amount</th>
<th>Daily Charges Per Calendar Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>$25,000</td>
</tr>
<tr>
<td>$25,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>$100,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$500,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>$1,000,000</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>
492.1-DIscRIPTION:
This work shall consist of a mixture of sized Reclaimed Asphalt Pavement, RAP, millings from existing asphalt pavement or existing stockpiles, asphalt emulsion, water and other additives. The mixture shall be produced at a nearby location, then placed and compacted to produce a recycled asphalt layer to the approved design properties in accordance with 105.03.

492.2-JUST-IN-TIME TRAINING, JITT:
The Engineer and Contractor are required to attend a just-in-time training, JITT, course regarding CCPR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CCPR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CCPR operations.

The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized CCPR. A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five working days before the course is to be taught.

492.3-QUALITY CONTROL:
A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed CCPR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods and procedures applied to the CCPR. All QC test results shall be maintained during the duration of the contract and made available to the Engineer upon request, within 2 business days.

The following table provides the type and minimum frequency for tests:
TABLE 492.3.2
Quality Control Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Frequency 1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Laydown</td>
<td>1 per 500 linear feet</td>
</tr>
<tr>
<td>Pulverized Material Gradation</td>
<td>1 per 1,000 tons of production</td>
</tr>
<tr>
<td>Pulverized Material Moisture Content 3</td>
<td>1 per 500 tons of production</td>
</tr>
<tr>
<td>Asphalt Emulsion Content 3</td>
<td>1 per 500 tons of production</td>
</tr>
<tr>
<td>Water Content 3</td>
<td>1 per 500 tons of production</td>
</tr>
<tr>
<td>Compacted In-Place Field Density</td>
<td>1 per 1,000 linear feet</td>
</tr>
<tr>
<td>Field Moisture Content for Curing</td>
<td>1 per each day of production</td>
</tr>
</tbody>
</table>

Note 1: The Contractor shall perform all quality control tests within the first 500 ft after startup and after any change in the mix design.
Note 2: Testing frequency is based upon either linear foot of CCPR laydown or tons of CCPR mixture processing.
Note 3: Asphalt emulsion content and water content shall be taken from the readings of the control settings of the mixing unit.

492.4-MATERIALS:
CCPR shall consist of a homogenous blend of RAP combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CCPR may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the CCPR mix design and project requirements. Cement used must be supplied from an approved source.

492.4.1: Materials for use in CCPR shall be in accordance with the following:
- Asphalt Emulsion........................................................................................................See Table 492.4.1
- Corrective Aggregate to adjust gradation or supplement material volume:
  1. Coarse or Dense Graded Aggregate, Class C or Higher......................704.03
  2. Fine Aggregate........................................................................................................704.02
  3. RAP shall be the product resulting from the cold milling or crushing of existing asphalt pavement and processed so that 100% passes the 1 ¼ in. (31.5 mm) sieve.
- Portland Cement, Type I..........................................................................................701.01(b)
- Water............................................................................................................................713.01

TABLE 492.4.1
CCPR Asphalt Emulsion (1)(3)

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol, @ 77°F (25°C), SFS</td>
<td>AASHTO T 59</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Sieve Test, No. 20 (850 µm), retained on sieve, %</td>
<td>AASHTO T 59</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Storage Stability Test, 24 hr, %</td>
<td>AASHTO T 59</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Distillation Test, Residue by distillation, %</td>
<td>AASHTO T 59</td>
<td>64.0</td>
<td></td>
</tr>
<tr>
<td>Oil Distillate by volume, %</td>
<td>AASHTO T 59</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Penetration, 77°F (25°C), 100 g, 5 s, dmm</td>
<td>AASHTO T 49</td>
<td>50</td>
<td>200</td>
</tr>
</tbody>
</table>

(1) The asphalt emulsion shall be selected for the project by the asphalt emulsion supplier based on the Contractor’s mixture design. The penetration of the supplied asphalt emulsion shall be within ±25 dmm of the penetration
of the design asphalt emulsion. The asphalt emulsion shall be received on the job site at a temperature no greater than 120°F.

(2) Modified AASHTO T 59 – distillation temperature of 350 ± 9°F (177 ± 5°C) with a 20-minute hold.

(3) Type A certification shall be required to be furnished by the asphalt emulsion supplier.

492.5-MIX DESIGN:

CCPR mix designs shall be in accordance with Materials Procedure (MP) xxx.05.01 and compromised of existing RAP, asphalt emulsion and recycling additives, if necessary. The mix design and all associated testing shall be performed using samples of each proposed material. RAP samples shall either be collected from the existing pavement at the project site representing the milling depth or from the RAP stockpile to be used during construction. The mix design shall be completed by a design laboratory that is AASHTO Re:source accredited in asphalt mixtures and asphalt emulsion. Additional mix designs shall be performed when the proposed material changes significantly in order to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CCPR shall be the minimum sampling frequency for mix design preparation.

The Contractor shall provide a mix design or designs for approval at least five calendar days prior to the JITT. The mix design shall include all test results performed. If new materials are added, a new mix design, including the updated test results, shall be submitted at least one day prior to implementation.

CONSTRUCTION REQUIREMENTS

492.6-ROADWAY PREPARATION:

1. Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to CCPR operations.
2. Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized asphalt material during milling operation.
3. All areas of soft or yielding subgrade shall be corrected prior to CCPR operations.
4. If the CCPR mix is to be placed on a prepared subgrade or aggregate base, ensure the subgrade soils and base have been properly prepared, moisture treated and compacted to the minimum density according to plans or specifications, immediately prior to placement of the CCPR mix, so as to create an evenly graded, unyielding surface.

492.7-PAVEMENT REMOVAL:

The existing asphalt pavement shall be milled in accordance with Section 415 to the length, depth and width as shown on the plans or specifications. The RAP shall be free of contamination of dirt, base, concrete or other deleterious materials such as silt and clay.

When a paving fabric, is encountered during pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the CCPR does not affect the performance parameters or inhibit placement or compaction of the CCPR. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments or operations so that the shredded fabric in the recycled material is no more than 5 sq. in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be removed as observed from the roadway. Residual materials that cannot be
completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mix shall be appropriately sized and blended so as not to adversely affect the strength of the recycled pavement.

492.8-EQUIPMENT:

The equipment shall consist of the following major components:

492.8.1-Milling Machine/Pavement Cold Planer: Milling equipment shall be in accordance with Section 415.2.2.1. The equipment shall be capable of pulverizing the existing asphalt material in a single pass to the depth shown on the plans. The machine shall have automatic depth controls to maintain the cutting depth to within ± ¼ in. of that shown on the plans. The milling operation shall not disturb or damage the underlying material. The use of a heating device to soften the pavement will not be allowed.

492.8.2-Additive Slurry Storage and Supply Equipment: Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

492.8.3-Sizing Equipment: A material sizing unit shall be capable of sizing using a scalping screen or crushing capabilities to reduce RAP to a maximum size of 1 ¼ in. (31.5 mm) or to the maximum size requirements specified prior to mixing with the asphalt emulsion.

492.8.4-Mixing and Proportioning Equipment: The equipment shall be capable of processing sized RAP, asphalt emulsion, water and any additives stipulated in the mix design to a homogenous and uniformly coated CCPR mixture.

The mixing plant shall be of sufficient capacity and coordination to adequately handle the proposed Cold Mix Asphalt (CMA) construction. The mixing unit shall be a twin shaft pugmill or other approved mixer, including the drum type capable of producing a consistent uniform mixture. The outlet of the mixer shall be such that it prevents segregation of the material when discharged.

A HMA mixing plant in accordance with Section 401 may be utilized as a CMA mixing plant.

The equipment/plant shall display automatic digital readings shall be displayed for flow rate of both the RAP and asphalt emulsion in appropriate units of weight and time.

The mixing apparatus shall have cold feed hopper equipped with vibrators on the hopper’s walls to assist the free flow of materials to a variable speed belt conveyor. Control of the RAP shall be by mechanically adjustable gate valves at the point of discharge or a RAP belt scale for the continuous weighing of the RAP. The variable speed belt conveyor or RAP belt scale shall be interlocked to the asphalt emulsion metering device.

The asphalt emulsion metering device shall be capable of automatically adjusting the flow of asphalt emulsion to compensate for any variation of RAP introduced into the mixing apparatus. Asphalt emulsion shall be metered by weight of RAP using a calibrated meter that will accurately measure the amount of asphalt emulsion to within a tolerance of ± 2.0% of the specified rate.
492.8.5-Hauling Equipment: Hauling equipment shall be in accordance with Section 401.9.7.

492.8.6-Laydown Equipment: Laydown equipment shall be in accordance with 401.9.9. The paver screed shall be controlled by electronic grade and cross-slope control. Heating of the screed shall not be allowed.

CCPR material shall either be loaded directly into the paver hopper from transport trucks or loaded a materials transfer vehicle. If utilizing a materials transfer device, a hopper insert shall be used and heating of the mixture shall not be allowed.

492.8.7-Compaction Equipment: Compaction equipment shall be in accordance with 401.9.10. The number, weight, and types of rollers shall be necessary to obtain required compaction. At a minimum, the following rollers shall be used:
1. At least one pneumatic tired roller in accordance with 401.9.10 with a minimum weight of not less than 20 tons.
2. At least one double drum vibratory roller in accordance with 401.9.10 with a minimum weight of not less than 10 tons.

492.9-WEATHER RESTRICTIONS:

CCPR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50°F with ambient temperatures above 35°F for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The CCPR shall not be performed before May 1st or after October 1st.

492.10-MATERIAL SIZING AND STOCKPILING:

The gradation of the RAP shall have 100% passing the 1 ¼ in. (31.5 mm) sieve, or to be sized to meet specific contract requirements.

RAP that has been crushed and screened shall be stockpiled and maintained to prevent reconsolidation. Water may be added to RAP as it is screened and crushed to abate dust and mitigate reconsolidation.

Corrective aggregate, if required, shall either be mixed with RAP to create a homogenous mixture during stockpiling or fed into the mixing apparatus at the rate determined by the mix design.

492.11-PROCESSING AND MIXING OPERATION:

The sized RAP shall be processed through a mixing unit capable of combining the sized RAP, asphalt emulsion, and any additives to produce a homogenous recycled mixture.

An additive used in asphalt emulsion stabilized CCPR may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

The asphalt emulsion shall be injected into the CCPR materials at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

The asphalt emulsion shall have an application tolerance determined by adding ± 0.25% to the percent total asphalt emulsion content.
The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

492.12-PLACEMENT:

The depth of CCPR shall be as indicated on the plans. The hauling equipment shall deliver the blended CCPR material into the paver within one hour of mixing or before the asphalt emulsion begins to break and set. CCPR single lift thickness shall be a minimum compacted depth of 3 in. and not exceed a maximum compacted depth of 6 in. A minimum lift thickness of 2 in. can be utilized if the crushed RAP has a maximum size of 3/4 in.

492.13-CONTROL STRIP AND COMPACTION:

A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

1. Demonstrate the equipment, materials and processes proposed to produce a CCPR layer in accordance with specification requirements
2. Determine the optimal rates for the asphalt emulsion, water and any additives recommended for the material
3. Determine the sequence and manner of rolling necessary to obtain specified density requirements in one uniformly compacted layer.

The CCPR density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment or construction methods.

A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart that shows the progress of densification from initial lay down through optimum field density using a properly calibrated nuclear gauge in accordance to AASHTO T 310. Production may continue after approval of the control strip.

The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.

The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved and approved by the Engineer.

Rollers shall not be started or stopped on recycled material unless when changing direction during the compaction process.

All tests shall be conducted at the stated QC testing frequencies throughout CCPR operations.
492.14-OPENING TO TRAFFIC:
Opening to traffic shall occur after sufficient cure time has been applied to the CCPR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with Section 405. After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

492.15-MAINTENANCE:
The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed. Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with the WV DOH Maintenance Manual. The excavated patch areas shall be filled and compacted with HMA or CCPR material as directed by the Engineer. No direct payment will be made for damage repair unless approved by the Engineer.

492.16-CURING:
Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:
1. There is less than 3.0% moisture remaining in the mixture, or;
2. The material has remained in-place for a minimum of 10 days without rainfall.

The planned method and duration of curing of CCPR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CCPR final cure, but no later than November 1.

492.17-PAVEMENT SMOOTHNESS:
Pavement smoothness of the cured CCPR mat shall meet the requirements of Section 720. The Contractor shall correct humps or depressions exceeding the tolerances in accordance with Section 720.

492.18-CCPR SURFACE COURSE:
The CCPR shall be swept of all loose material and standing water with a rotary power broom in accordance with Section 405 immediately prior to placing the tack coat. A tack coat shall be required and shall be applied to the CCPR in accordance with Section 408.

492.19-METHOD OF MEASUREMENT:
The CCPR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the gallon. Aggregate to adjust the CCPR gradation will be measured by the ton of material used. HMA Patching will be measured by the ton.

492.20-BASIS OF PAYMENT:
CCPR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per gallon, complete in place. Aggregate used to adjust the CCPR gradation will be paid for at the contract unit price per ton, complete in place.
The costs associated with the CCPR mix design and quality control testing shall be included in the cost of the cold central plant recycling.

The costs associated with the removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the cold central plant recycling.

The cost associated with pulverizing, stabilizing, compacting, curing and maintenance of the CCPR not related to failing subgrade shall be included in the cost of the cold central plant recycling.

The cost associated with mixing water for cold central plant material shall be included in the cost of the cold central plant recycling.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the cold central plant recycling.

The cost associated with the use of Portland cement when used as an additive shall be included in the cost of the cold central plant recycling.

The cost associated with aggregate when used to adjust the CCPR gradation shall be included in the cost of the corrective aggregate pay item.

The costs of the asphalt emulsion stabilizing material shall be included in the cost of stabilizing material pay item.

In the locations of failing subgrade, removal of the CCPR shall be included in the cost of subgrade treatment.

492.21- PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>492001-001</td>
<td>Cold Central Plant Recycling (CCPR) Pavement</td>
<td>Square Yard</td>
</tr>
<tr>
<td>492001-002</td>
<td>Corrective Aggregate, CCPR</td>
<td>Ton</td>
</tr>
<tr>
<td>492001-003</td>
<td>Asphalt Material, Emulsion</td>
<td>Gallon</td>
</tr>
<tr>
<td>492001-004</td>
<td>Asphalt Mixture, Patching</td>
<td>Ton</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ______________________________
FEDERAL PROJECT NUMBER: ______________________________

SECTION 601
STRUCTURAL CONCRETE

601.1-DESCRIPTION:

ADD THE FOLLOWING TO THE END OF THE SECTION:

601.1.1-Embedded Galvanic Anodes:  This work consists of installing embedded galvanic anodes in conjunction with Patching Concrete Structures (removing all loose, disintegrated and delaminated concrete; preparing the surface; furnishing and placing reinforcing steel as required; placing forms; and placing concrete patches, including curing of same).

601.2–MATERIALS:

ADD THE FOLLOWING TO THE END OF THE SECTION:

Furnish pre-manufactured galvanic anodes designed for cathodic protection when embedded in concrete and tied to steel reinforcing. The core of the anode shall consist of a minimum of 100 grams of electrolytic high grade zinc in compliance with ASTM B 418 Type II cast around a pair of steel tie wires and encased in a highly alkaline cementitious shell with a pH of 14, or encased in a material that uses activation methods to assure performance. The anodes shall have one side that is less than 1½-inches in height.

Furnish galvanic anodes in accordance with these specifications. Supply a certification of compliance to the engineer before starting work. Deliver, store, and handle all materials according to the manufacturer’s instructions.

Repair concrete shall be hydraulic cement-based material with a 28-day moist cured electrical resistivity less than 15,000 ohm-cm according to ASTM C 1760. Concrete mixes
containing high levels of supplementary cementitious materials such as silica fume, ground-granulated blast furnace slag, fly ash or metakaolin may not meet the resistivity requirement.

601.10-PLACING CONCRETE:

DELETE THE SECTION AND REPLACE WITH THE FOLLOWING:

601.10-GALVANIC ANODE INSTALLATION:

Install embedded galvanic anodes in accordance with manufacturer’s recommendations, as shown on the plans, and as listed in this specification.

1. Install galvanic anodes to existing reinforcement along the perimeter of the repair at spacing as specified on the plans. In no case shall the distance between anodes exceed 30 inches nor shall the distance between the anode and the edge of the repair exceed 6 inches.

2. Provide a 1-inch clearance between anodes and substrate to allow repair material to encase anode. If necessary, increase the size of the repair cavity to accommodate the anodes.

3. Secure the galvanic anodes as close as possible to the patch edge using the anode tie wires (bare wire). Wrap tie wires around the cleaned and uncoated reinforcing steel at least one full turn in opposite directions and then tighten the tie wires to allow little or no free movement. If the anode is to be tied onto a single bar, or if less than 1½-inch of concrete cover is expected, place anode beneath the uncoated bar and secure to reinforcing steel. If 1½-inch concrete cover will exist over the anode, the anode may be placed at the intersection between two bars and secured to each bar.

Confirm electrical connection between every anode tie wire and uncoated reinforcing steel with a multi-meter. The maximum DC resistance shall be 1 Ohm. Confirm electrical continuity of every exposed uncoated reinforcing steel within the repair area. Steel reinforcement shall be considered continuous when the DC resistance is 1 Ohm or less. If necessary, establish the electrical continuity with uncoated steel tie wire.

Provide the Engineer a report documenting the resistance measurement for every reinforcing bar in each repair area. The report shall be signed by the contractor’s employee responsible for supervision of the repair work.

601.14-METHOD OF MEASUREMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:

There will be no separate pay item for this work.

601.15-BASIS OF PAYMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:
This work is incidental to Item 601030-001 Patching Concrete Structures.
No additional payment shall be made for furnishing and installing the Galvanic Anodes.
Payment for furnishing and installing Galvanic Anodes shall be included in the price bid for the concrete patching.

**NOTE:**
Do not use this specification for patch areas less than 5 ft\textsuperscript{2}. Anode spacing shall be specified by the designer. Anode spacing is dependent upon the reinforcing steel density; chloride content; and amount of zinc per anode. The density of the reinforcing steel is the total surface area of the bar (ft\textsuperscript{2}) within a square foot of concrete (regardless of depth). Corrosion levels in the concrete can be broken into three measurable categories based on ASTM C 1152 Acid-Soluble Chloride of Mortar and Concrete: Light corrosion levels: < 4 lb/yd\textsuperscript{3}, Moderate corrosion levels 4 to 8 lb/yd\textsuperscript{3} and High corrosion levels: > 8 lb/yd\textsuperscript{3}. In lieu of coring to determine chloride thresholds, the following general guidelines may be considered: Light corrosion for concrete aged 0-15 years and exposed to deicing salt or concrete of any age not directly exposed to deicing salt; Moderate corrosion for concrete aged 16-30 years and exposed to deicing salt; High corrosion for concrete 31 years and older and exposed to deicing salt. The following anode spacing guidelines are based a minimum zinc content of 100 grams per anode and to mitigate the initiation of new corrosion activity:

<table>
<thead>
<tr>
<th>Steel Density Ratio</th>
<th>Anode Spacing (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light Corrosion Levels</td>
</tr>
<tr>
<td>&lt; 0.3</td>
<td>30</td>
</tr>
<tr>
<td>0.31 – 0.6</td>
<td>28</td>
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<tr>
<td>0.61 – 0.9</td>
<td>26</td>
</tr>
<tr>
<td>0.91 – 1.2</td>
<td>22</td>
</tr>
<tr>
<td>1.21 – 1.5</td>
<td>20</td>
</tr>
<tr>
<td>1.51 – 1.8</td>
<td>18</td>
</tr>
<tr>
<td>1.81 – 2.1</td>
<td>17</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: _________________________

SECTION 601
STRUCTURAL CONCRETE

601.1-DESCRIPTION:

ADD THE FOLLOWING SUBSECTION:

601.1.1-Epoxy Bonding Compound: This specification describes the Epoxy Bonding Compound to be used for this contract as required when Patching Concrete Structures is necessary.

601.2-MATERIALS:

ADD THE FOLLOWING TO THE END OF THE SECTION:

Provide an Epoxy Bonding Compound conforming to ASTM C881 Type V, Grade 2 and of a class chosen based on the temperatures expected during application. Submit a copy of the manufacturer’s recommendations for proper application to the Engineer. Apply the compound according to the manufacturer’s recommendations.

Epoxy Bonding Compound shall be used neat with no aggregate added.

601.10-PLACING CONCRETE:

DELETE SUBSECTION 601.10 AND REPLACE WITH THE FOLLOWING:

601.10-EPOXY BONDING COMPOUND CONSTRUCTION REQUIREMENTS:

Surfaces to which the compound is to bond shall be clean and sound. They may be dry, damp or wet (without standing water). Dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles and disintegrated material shall be removed. Temperature of concrete surfaces shall be 40°F or higher.
When the work requiring the Epoxy Bonding Compound is to be accomplished during periods of temperatures below 40°F, the proposed material to be used shall be submitted to the Engineer for approval.

The mix proportions of the epoxy system shall be as specified by the manufacturer. To insure intimate blending of the components, the Contractor shall use a 1/2 inch low-speed portable electric drill (400-600 rpm) fitted with a suitable mixing paddle. The mixing time shall be not less than three minutes and not more than five minutes. These times shall be carefully adhered to since a period shorter than the minimum can result in inadequate mixing; while a prolonged mixing time may result in premature gelation of the material.

Epoxy Bonding Compound shall be applied by spray with approved spray equipment. New concrete must be placed while bonding compound is still tacky. If bonding compound becomes glossy and loses tackiness, it shall be recoated.

601.14-METHOD OF MEASUREMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:

There will be no separate pay item for this work. The epoxy bonding compound will be applied to existing concrete surfaces where new patching material will be applied.

601.15-BASIS OF PAYMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:

This work is incidental to Item 601030-001 Patching Concrete Structures. No additional payment shall be made for furnishing and installing the Epoxy Bonding Compound. Payment for furnishing and installing Epoxy Bonding Compound shall be included in the price bid for the concrete patching.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: __________________________
FEDERAL PROJECT NUMBER: __________________________

SECTION 601
STRUCTURAL CONCRETE

601.1-DESCRIPTION:

ADD THE FOLLOWING SUBSECTION:

601.1.2-Epoxy Resin Injection: This work shall consist of sealing cracks in the existing concrete members as required with a pressure injected epoxy resin.

601.2-MATERIALS:

ADD THE FOLLOWING TO THE END OF THE SECTION:

Material to be injected shall be a high-modulus, low viscosity, high-strength epoxy conforming to ASTM C881 Type IV, Grade 1 and classes B or C. Submit a copy of the manufacturer’s recommendations for proper installation to the Engineer. Perform injection in accordance with the manufacturer’s recommendations. Other materials such as crack surface sealing material and injection entry ports shall be as recommended by the manufacturer and approved by the Engineer. Such material shall be compatible with the material to be used for crack injection.

601.10-PLACING CONCRETE:

DELETE SUBSECTION 601.10 AND REPLACE WITH THE FOLLOWING:

601.10-EPOXY INJECTION CRACK REPAIR CONSTRUCTION REQUIREMENTS:

1. Delineation—All cracks to be sealed shall be delineated by the Engineer. Approximate locations and crack lengths are shown on the contract drawings.
2. **Preparation for Repairs**—The surfaces shall be prepared before application of epoxy injection resin. The adjacent areas surrounding the cracks shall be cleaned of efflorescence, deteriorated concrete, petroleum, rubber deposits and other contaminants considered detrimental to adhesion. Large cracks may be rutted or "veed" to accommodate insertion of injection ports of entry. All cracks may be slotted to facilitate installation of injection ports. Injection ports shall be glued in place at spacings recommended by the manufacturer. The surface of the crack and the areas surrounding the entry ports shall be sealed with a compatible epoxy mortar or gel. The seal shall be applied in such a manner that the epoxy injection resin shall be sealed until initial cure.

3. **Making Epoxy Resin System**—The epoxy resin system shall be mixed as per manufacturer's instruction with a minimum three (3) minute mixing time using a low speed (400-600 RPM) electric drill with an approved mixing paddle. The mixing may also be accomplished by an injection machine capable of metering and mixing the specific proportions of components within a tolerance of ±5 percent.

4. **Injection Procedure**—The crack shall not be injected until after the surface sealer had hardened. The epoxy may be injected by means of a hand gun, pressure pot or injection machine or as recommended by the manufacturer. Injection should start at the lowest point on the crack. When material begins to flow from the next higher entry port, the nozzle is removed, the port plugged, and the nozzle inserted in the next higher entry port. The operation is continued until the crack is completely filled. After the epoxy material has achieved an initial cure the entry ports shall be removed and, if required, the area patched with the same material used to seal the rest of the crack surface.

5. **Application Limitations**—Epoxy materials shall not be applied or injected if the ambient temperatures are below 40°F.

6. **Disposal**—All packaging debris, injection ports, etc. used during the crack repair procedure shall be properly disposed of by the Contractor.

**601.14-METHOD OF MEASUREMENT:**

ADD THE FOLLOWING TO THE END OF THE SECTION:

The designated cracks to be repaired by this procedure will be measured in place in linear feet.

**601.15-BASIS OF PAYMENT:**

ADD THE FOLLOWING TO THE END OF THE SECTION:

Epoxy injection crack repair will be paid for at the contract unit price per linear foot, complete in place, which price shall include all preparation; furnishing, mixing and injecting the epoxy resin; and doing all the work herein prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, scaffolding, supplies, and incidentals necessary to complete the work.

**601.16–PAY ITEM:**
ADD THE FOLLOWING ITEM TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>601031-001</td>
<td>Epoxy Injection Crack Repair</td>
<td>Linear Foot (Meter)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ________________________________
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SECTION 601
STRUCTURAL CONCRETE

601.1-DESCRIPTION:

ADD THE FOLLOWING TO THE END OF THE SECTION:

This specification describes additional requirements for the Shotcrete method of performing Patching Concrete Structures. Coordinate the work described with the requirements for installing galvanic anodes as required. The maximum depth of repair for which shotcrete can be utilized is 6 inches.

601.2–MATERIALS:

ADD THE FOLLOWING TO THE END OF THE SECTION:

a. Cement. Section 701.1
b. Fine Aggregate. Section 702.1
c. Water. Section 715.7
d. Reinforcement Bars. Section 709.1
e. Fabric Reinforcement. Section 709.4. Use fabric reinforcement, consisting of galvanized, welded straight-line fabric, conforming to one of the following:
   1. No. 12 gage wire, spaced 2 inches in each direction;
   2. No. 10 gage wire, spaced 3 inches in each direction;
   3. or approved alternative.
f. Burlap. Section 707.7
g. Liquid Membrane-Forming Curing Compound, Clear. Section 707.9
h. Expansion Bolts. Submit manufacturer and type for approval.
601.10–PLACING CONCRETE:

ADD THE FOLLOWING TO THE END OF THE SECTION:

(a) **Preparation of Structure.** Thoroughly clean the surfaces and voids of rust, scale, grease, loose and disintegrated particles, and material that might impair the bond between the surfaces to be covered and the shotcrete mortar mixture. Remove unsound concrete, as directed. Clean by means of compressed air and waterblasting, by handscraping, and by sandblasting, if necessary.

(b) **Placing Reinforcement.** Lap adjacent sheets of fabric at least 4 inches for 2-inch mesh and at least 6 inches for 3-inch mesh. Fasten fabric together with wire ties at intervals of not more than 18 inches. In areas of buildup for the replacement of disintegrated material, unless otherwise indicated or directed, place a layer of fabric for each 3-inch layer of shotcrete mortar or fraction thereof. More than one layer of fabric may be attached to an anchor bolt, provided the bolt is long enough. Hold the fabric in place by means of lead-collared expansion bolts, either 1/4 inch by 3 inches, or 3/8 inch by 4 inches. Use longer bolts, where necessary. Space 1/4-inch diameter bolts approximately 20 inches center-to-center in each direction, starting 3 inches from the outside edges of the areas to be shotcreted. Space 3/8-inch diameter bolts approximately 30 inches center-to-center in each direction, starting 6 inches from the outside edges of the areas to be shotcreted. Fasten the fabric to the expansion bolts away from the prepared surface, with 1 inch clear below the finished surface of the repair. Where existing reinforcement is exposed due to removal of deteriorated concrete, fabric may be tied to this reinforcement at 18-inch intervals, to form a cage to position and support the fabric within 1 inch of the finished surface of repair. Avoid excessive fabric layers, which may create planes of weakness or internal stresses.

(c) **Mixing Shotcrete Mortar (Mortar).** Mix the mortar of one part cement and 3 1/2 parts fine aggregate. Thoroughly dry-mix the mortar in a batch mixer. Screen the dry-mix and remove material retained on a No. 4 sieve, before placing the mixture in the hopper of the mortar pressure gun. Do not mix more than 1 hour's supply of mortar at a time. Keep the mixture in the gun bin thoroughly stirred.

(d) **Pressures.** At the gun, supply air pressure of at least 35 pounds per square inch when shooting the mixture. Increase the air pressure, as necessary, when the lift is greater than 25 feet, or when using more than 100 feet of hose. Maintain uniform air pressure. At the nozzle, maintain a uniform water pressure of at least 15 pounds per square inch greater than the air pressure at the gun. Supply pressure in the lower gun chamber to produce a nozzle velocity of 375 feet per second to 450 feet per second, with a 1 1/4-inch tip opening. Vary these pressures and velocities only when directed. Determine the nozzle pressure and velocity from the nozzle velocity meter attached to the gun.

(e) **Moisture Content of Mortar.** Use approximately 8% to 10% moisture, by weight, when shooting, of approximately 3 1/2 gallons of water per bag of cement. Do not use a greater quantity of water than necessary to produce a proper mixture. When using reinforcement fabric, supply a moisture content of approximately 8%, for mortar below the fabric, and approximately 9% to 10% above the fabric.

(f) **Air Content of Mortar.** The As-Shot air content of the mortar shall be between 3% and 5%.
(g) **Application.** Perform work under the continuous supervision of an experienced pressure gun foreperson, using only experienced personnel as gun and nozzle operators. Saturate the surfaces with clean water before applying mortar. Use guide strips at corners and other places, where necessary, to ensure true lines, corners, and the placement of specified thickness, dimensions, and designs. Bring mortared surfaces to a reasonably true plane, then finish the entire mortared area with a pressure-gun finish. Apply the mortar in at least two coats. Apply bottom surfaces in at least two coats to obtain proper adhesion and to avoid sagging. Bring the last main coat to within 1/8 inch of the proposed surface, then correct irregularities and remove high spots with trowels. Give the entire surface a thin coat of mortar, but do not trowel or float. If directed, give the final surfaces a finish using a long-bristled brush, saturated with clean water, then dragged over the surfaces. Do not work the surfaces with the brush. Fill voids with mortar, making the surface flush with the adjacent face of the structure. Shoot mortar at right angles to the surface, holding the gun nozzle approximately 3 feet from the surface, when using a 3/4-inch or a 1-inch nozzle, or 4 feet from the surface, when using a 1 1/4-inch nozzle. Use a shorter distance only where working space requires closer shooting. Remove deposits of loose fine aggregate. If any deposit of loose, fine aggregate is covered by succeeding layers of mortar, remove the surfacing and replace with suitable mortar. At the end of a day's work or at other required stopping periods, slope off the mortar to a thin edge. Do not use square joints. Before shooting the adjacent section, joining new work to old work, or placing additional coats, clean this sloped portion, old work, or previous coat. Saturate the previous coat by a combination of air and water blasting. Do not place mortar unless the air temperature or the surface on which it is placed is 50 degrees F or higher.

(h) **Curing.** Immediately after initial hardening, saturate mortar and keep wet for a period of at least 96 hours. Protect placed surfaces with burlap. Keep burlap wet during this curing period. If allowed as an alternative to burlap curing, apply Liquid Membrane Forming Curing Compound. Cure in cool and cold weather, as specified in Section 601.9.1.

(i) **Backfilling.** For spaces excavated around areas being surfaced, backfill with acceptable embankment material in layers no more than 4 inches in depth. Thoroughly compact mechanically.

### 601.14–METHOD OF MEASUREMENT:

ADD THE FOLLOWING TO THE END OF THE SECTION:

This work is a method of performing concrete placement for Item 601030-001 Patching Concrete Structures. This work is included in that item which is measured by square feet.

### 601.15–BASIS OF PAYMENT:

This work is a method of performing concrete placement for Item 601030-001 Patching Concrete Structures, and payment will be included in that item.