Meeting Date
Wednesday, August 2, 2017 @ 9:00am
Building 5, Room 855

Approved Permanent Specification changes from last Committee meeting (6/7/17)
- 601.7-Mixing Limits the amount of water added to concrete mix to w/c established in mix design.
- 603.6.2-Mix Design Updates references from ACI 318 to ACI 301.

Approved Project Specific Special Provisions (SP) from last Committee meeting (6/7/17)
- SP607 - Guardrail ZAM coating
- SP670 - Waterline Installation Horizontal Directional Drilling
- SP607 - Bullnose Terminal & Thrie Beam Guardrail
- SP663 - Route Shield
- Recall Striping Contract
  - SP204-Mobilization
  - SP663-Pavement Markings
  - SP711-Paints, Coatings, Oils and Ink

Items removed from Committee Agenda
- None

Old Business - Provisions discussed at last Committee meeting

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<th>TITLE</th>
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<td>104</td>
<td>SP's for High Tension Cable Barrier System</td>
<td>Project Specific Special Provisions (SP) for High Tension Cable Barrier System.</td>
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<td>211</td>
<td>High Tension Cable Barrier System</td>
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<td>607</td>
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<td>Project Specifics SP's:</td>
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<tr>
<td>609</td>
<td></td>
<td>1. SP104 - Value Engineering Change Proposal and Practical Design Change Proposal (1st time to committee)</td>
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<tr>
<td>639</td>
<td></td>
<td>2. SP211 - Borrow Excavation by Modeling Surface (3rd time to committee)</td>
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<td>3. SP607 - Guardrail and High Tension Cable Barrier System (5th time to committee)</td>
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<td>4. SP607 - Guardrail and High Tension Cable Barrier System MASH (3rd time to committee... same SP607 as #2 above, but for MASH testing requirements... redline copy showing changes from SP607 #2 above)</td>
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<td>5. SP609 - Concrete Mow Strip (4th time to committee)</td>
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<td>6. SP639 - Construction Layout Stakes for Electronic Data (4th time to committee)</td>
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</table>

A redline copy, showing the proposed changes/updates to the provision (from what was presented at last meeting) is included.

Please expedite your review of these. They will start showing up in
<table>
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<th></th>
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<th>proposals and anticipate their approval at the next spec committee meeting (in October).</th>
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</thead>
</table>
| 405 | SP 405 - Scrub Seal Surface Treatment | 4th time to Committee; discussed in February, April, & June.  
Project Specific special provision for Scrub Seal asphalt surface treatment.  
A redline copy, showing the proposed changes/updates to the provision (from what was presented at last meeting) is included. |
| 421 | SP 421 - Intelligent Compaction | 4th time to Committee; discussed in February, April, & June.  
Project Specific special provision for Intelligent Compaction of asphalt pavement.  
A redline copy, showing the proposed changes/updates to the provision (from what was presented at last meeting) is included. |
| 405 | 405 - Chip Seal | 3rd time to Committee; discussed in April & June.  
Proposed specification change is a complete section re-write.  
Provision has been updated, per comments at the June meeting. A redline copy, showing the changes/updates to the provision (from what was presented at last meeting) is included. |
| 679 | 679.3.7.1 - General  
679.5.1 - Straightedge Test  
679.5.2 - Finished Deck Grooving | 3rd time to Committee; discussed in April & June.  
Proposed specification change to Section 679 - Overlaying of Portland Cement; with revision to the 679.3.7.1, 679.5.1, and 679.5.2 subsections. The proposed specification change is a redline copy showing the changes to the provision.  
No update to the provisions.  
Approval expected in August. |
| 668 | SP668 - CCTV | 3rd time to Committee; discussed in April & June.  
Project Specific Special Provision (SP) for Closed Circuit Television.  
No update to the provisions.  
Approval expected in August. |
| 705 | 705.5 - Performance Graded Binders | 3rd time to Committee; discussed in April & June.  
Proposed specification change to Section 705 - Asphalt Materials; with revision to the 705.5 subsection.  
Subsection has been re-written from what was shown at prior meetings. A redline copy, showing the current & proposed spec is included. |
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<tr>
<th>Section</th>
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<th>Status</th>
<th>Notes</th>
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<tbody>
<tr>
<td>107.21.2</td>
<td>Pollution</td>
<td>2nd time to Committee, discussed in June</td>
<td>Proposed specification change, removing reference to WVDOH BMP manual for bridge cleaning and painting, as the manual is outdated and not currently used. No updated to the provision. A redline copy, showing the changes to the spec is included. Approval expected in August.</td>
</tr>
<tr>
<td>204.5</td>
<td>Basis of Payment</td>
<td>2nd time to Committee, discussed in June</td>
<td>Proposed specification change to Section 204 - Mobilization; with revision to the 204.5 subsection. The change would facilitate mobilization payment on projects that are only going to last a short time. The provision has been updated. A redline copy, showing the changes to the spec is included.</td>
</tr>
<tr>
<td>601</td>
<td>SP 601 - Ultra High Performance Concrete</td>
<td>2nd time to Committee, discussed in June.</td>
<td>Project Specific Special Provision (SP) for Ultra High Performance Concrete (UHPC). No updated to the provision.</td>
</tr>
<tr>
<td>614</td>
<td>614.5 - Corrosion Protection</td>
<td>2nd time to Committee, discussed in June.</td>
<td>Proposed specification change to Section 614 - Piling Walls; with revision to the 617.5 subsection. The proposed specification changes the equation for price reduction penalty for piles grouted with grout strength less than 1600 psi compressive strength. Provision has been updated, per discussion at the June meeting. A redline copy, showing the changes to the spec is included.</td>
</tr>
<tr>
<td>614</td>
<td>614.7 - Lagging and Backfilling</td>
<td>2nd time to Committee, discussed in June</td>
<td>The six proposed specification change adds reference to MP 604.02.40, which outlines the process for precast concrete fabrication and inspection requirements for precast items. A redline copy showing the changes to the spec is included. Approval expected in August.</td>
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<tr>
<td>620.3.2</td>
<td>Precast Three Sided Bridge/Culverts</td>
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<td>626.5.1.1</td>
<td>Reinforced Concrete Facing Elements</td>
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<td>714</td>
<td>714.23 - Precast Reinforced Concrete Box Culvert</td>
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<td>715</td>
<td>715.19 - Precast Concrete Units for Manhole and Inlets</td>
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<tr>
<td>715</td>
<td>715.42.11.2 - Type H (Heavy Duty)</td>
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<td>636</td>
<td>636.9 - Traffic Control Devices</td>
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<td></td>
<td>63.14.1 - Materials</td>
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<td></td>
<td>636.14.2 - Installation</td>
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<td>2nd time to Committee, discussed in June</td>
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<td>Proposed specification change to Section 636 - Maintaining Traffic with revision to the 636.9, 636.14.1, and 636.14.2 subsections. The revision adds MASH requirements for temporary work zone devices &amp; barriers.</td>
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<td>Provision has been updated. A redline copy showing the changes to the specs is included.</td>
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<td>636</td>
<td>636.2 - Material Certification</td>
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<td>2nd time to Committee, discussed in June</td>
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<td>Proposed specification change to Section 636 - Maintaining Traffic; with addition of 636.2.1 subsection. It is for the certification of various traffic control items associated with the section.</td>
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<td>No update to the provision.</td>
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<td>Approval expected in August.</td>
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<td>642</td>
<td>SP642 - Flocculant Block</td>
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<td>2nd time to Committee, discussed in June</td>
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<td></td>
<td>Project Specific Special Provision (SP) for Flocculant Block.</td>
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<td>Provision updated per comments at the June meeting; a redline copy showing the changes is included.</td>
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<tr>
<td>667</td>
<td>SP667 - LED Dynamic Message Sign</td>
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<td>2nd time to Committee, discussed in June</td>
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<td>Project Specific Special Provision (SP) for Dynamic Message Sign system (DMS).</td>
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<td>Provision updated per comments at the June meeting; a redline copy showing the changes is included.</td>
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<td>669</td>
<td>SP669 - Road Weather Information Systems</td>
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<td>2nd time to Committee, discussed in June</td>
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<td></td>
<td>Project Specific Special Provision (SP) for Road Weather Information Systems (RWIS).</td>
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<td>No update to the provision.</td>
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New Business - New Provisions for Spec Committee

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<thead>
<tr>
<th>SECTION</th>
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</thead>
<tbody>
<tr>
<td>601</td>
<td>601.7-Mixing</td>
<td>1st time to Committee. Permanent Specification change to 601.7 - Mixing. It eliminates reference to form that no longer exists and provides clarification on what exactly needs to be included on batch tickets provided at the job site. A redline copy showing the changes to the spec is included.</td>
</tr>
<tr>
<td>603</td>
<td>603.2.1 - Inspection and Testing</td>
<td>1st time to Committee. The proposed specification change adds reference to MP 603.10.40 (Inspection and Acceptance Procedures for Prestressed Concrete Bridge Members). A redline copy showing the changes to the spec is included.</td>
</tr>
<tr>
<td>401 501 601 679 720</td>
<td>Specification changes related to Ride Quality</td>
<td>1st time to Committee. Proposed specifications changes for ride quality. 1. 401.7.2 - Surface Tolerance 2. 501.13 - Surface Test 3. 601.11.43-Straightedge Testing of Hardened Bridge Decks &amp; 601.15.2 - Price Adjustment 4. 679.5.1 - Straightedge Test 5. Section 720 - Smoothness Testing A redline copy, showing the changes/updates to the proposed specifications is included.</td>
</tr>
<tr>
<td>619</td>
<td>SP619 - Waterproofing</td>
<td>1st time to Committee. Project Specific Special Provision (SP) for high-strength drainage composite. The SP is intended to be used on a tunnel liner project.</td>
</tr>
<tr>
<td>619</td>
<td>SP619 - Waterproofing</td>
<td>1st time to Committee. Project Specific Special Provision (SP) for geocomposite wall drain; intended to be used behind the abutment walls on a bridge project.</td>
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</tbody>
</table>

Comments

Comments are requested on these Specification Changes and Project Specific Special Provisions. Please share your comments by July 31, 2017, they help in the decision making process.

Please Send Comments to: DOHSpecifications@wv.gov

Deadline for new items & updates to these provisions is September 5, 2017

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 minor per comments and discussion in Spec Committee.. Failure to submit updates may result in removal of item and/or delays.
**Next Meeting**
Wednesday, October 4, 2017 at 9am (tentative)
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**

**Electronic Copy (pdf):** The 2017 Standard Specifications Roads and Bridges can be viewed, printed, or downloaded from the Specifications Website. A link to the Specifications pages is here:
[http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx](http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx)

**Print Version:** Hard copies of the 2017 Standard Specifications Roads and Bridges are available thru Contract Administration.
An order form for the new book is on Specifications Website. A link to the Specifications pages is here:
[http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx](http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx)

**2017 Specifications Committee**
The Specification Committee typically meet every other month; 2017 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://www.transportation.wv.gov/highways/contractadmin/specifications/SpecComit/Pages/default.aspx](http://www.transportation.wv.gov/highways/contractadmin/specifications/SpecComit/Pages/default.aspx)

**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](mailto:DOHSpecifications@wv.gov)

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**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** – Are 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:
  2. Project Specific Special Provisions (SP) – Will be shown in all black.
  3. Updates to approved SP – Shown as red-line copy

Each items 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, than 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.
SPECIAL PROVISION
FOR
HIGH TENSION CABLE BARRIER SYSTEM

STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________

SECTION 104
SCOPE OF WORK

104.12 – VALUE ENGINEERING CHANGE PROPOSAL AND PRACTICAL DESIGN CHANGE PROPOSAL:

ADD THE FOLLOWING TO THE SUBSECTION:

The following Pay Items will not be considered for modification by Value Engineering Change Proposal (VECP) or Practical Design Change Proposal (PDCP) on the project:
1. Item 211001-* Unclassified Borrow
2. Item 607018-001 High Tension Cable Barrier
3. Item 607018-005 Cable End Terminal
4. Item 607018-010 Cable End Terminal Foundation
5. Item 607018-050 HTCB Installation & Maintenance Training
6. Item 609020-001 Concrete Mow Strip
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

FOR

SECTION 211
BORROW EXCAVATION

211.7-METHOD OF MEASUREMENT:
211.7.1-Cubic Yard (Meter) Measurement:

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

The quantity of work done will be measured in cubic yards (cubic meters) actually obtained and incorporated in the work; determined by a volume computation using based on a surface to surface computation between the “Existing Terrain Model” and the “Final Plan Constructed Terrain Model” as described in Special Provision 639. No shrink or swell factor will be applied to the volume computation.

The Existing Terrain Model and the Plan Terrain Model will be provided by the Division. The Constructed Terrain Model and the Final Constructed Terrain Model shall be provided by the Contractor. The Constructed Terrain Model and the Final Constructed Terrain Model shall be subject to review and acceptance by the Division prior to payment for said work. Other means of calculating the quantity of work performed for progress payment may be proposed by the Contractor for consideration by the Division.

All costs for the Contractor to provide the Constructed Terrain Model and the Final Constructed Terrain Model shall be included in Item 211001 *, “Unclassified Borrow Excavation”.

It is the intent of the contract documents that the grading shall be performed to the limits as defined. Under no circumstances shall the volume computation between the Final Constructed Terrain Model and The Existing Terrain Model be lower than the volume computation between the Plan Terrain Model and Existing Terrain Model.
211.8-BASIS OF PAYMENT:

ADD THE FOLLOWING TO THE SUBSECTION:

The Constructed Terrain Model and Final Constructed Terrain Model are required deliverables with the earthwork as defined above. All submissions of Constructed Terrain Models and the Final Constructed Terrain Model shall include cross sections at 100 Feet Intervals. These submissions shall include an electronic surface and cross section files with a hardcopy of cross sections at 1” = 10’ horizontal and vertical scales. The cross sections shall be generated from the modeled surface.

The terrain models described above shall be developed from mapping meeting the requirements as follows:

Data Collection for Mobile LiDAR and Reduction

Mapping services for this project require conducting mobile LiDAR collection of roadway and median. Other means of data collection may be submitted for approval prior to performing.

The contractor shall deliver triangulated surfaces and planimetric in a computer aided drafting format compatible with Division standards. The criteria will adhere to the following protocols:

Project Datum

- NAD83 West Virginia State Plane (GRID)
- NAVD88 Elevations
- All data shall be referenced to the WV DOT Real Time Network

Data Collection

- Minimum of two passes, one on each of the inside lanes
- No collection with snow on the median

Deliverables

- Five Mile Maximum file sizes
- Digital Terrain Model of bare earth surface (Outside Edge to Outside Edge)
- Scan data in .las file type
- All digital calibrated photos (if applicable)
- Delivered on external hard drive

All costs for the Contractor to provide the Constructed Terrain Model and the Final Constructed Terrain Model shall be included in Item 211001-*, “Unclassified Borrow Excavation”.

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WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

SPECIAL PROVISION
FOR
HIGH TENSION CABLE BARRIER SYSTEM

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 607
GUARDRAIL

DELETE THE HEADING AND CHANGE TO THE FOLLOWING:

SECTION 607
GUARDRAIL AND HIGH TENSION CABLE BARRIER SYSTEM

607.1-DESCRIPTION:

ADD THE FOLLOWING TO THE SUBSECTION:

The work includes furnishing and erecting a 4 wire rope High Tension Cable Barrier (HTCB) system meeting the requirements of National Cooperative Highway Research Program (NCHRP) 350 or Manual for Assessing Safety Hardware (MASH) for the cable barrier system, terminals and all appurtenances. The system shall have a letter of eligibility from FHWA for Test Level 4 (TL4) for 6:0:1 side slopes.

The work shall conform to the lines, grades, and locations shown on the Plans or as directed by the Engineer. The cable barrier shall be placed in accordance with the cable system manufacturer’s instructions and in accordance with the Division approved shop drawings and submittals prepared by the manufacturer of the cable barrier system.

Unless provided for on the plans, the work covered by this special provision includes only work necessary to install the cable barrier system and appurtenances. It includes the following:

1. Furnishing and placement of concrete foundations for the anchors, line posts and the end terminals.
2. Providing and installing the cable system and all hardware and appurtenances for a complete and functional cable barrier system by one manufacture. All components are to be of the same type.
3. Conducting installation training prior to the installation of the barrier system and maintenance training after installation of the system.
4. No Value Engineering Change Proposals for alternative barrier types will be considered.

**607.2 MATERIALS:**

ADD THE FOLLOWING TO THE SUBSECTION:

**607.2.1 HTCB Materials:** The wire rope shall be galvanized, 3/4”-3x7 meeting requirements of AASHTO M30-92 Type I, Class A coating with minimum breaking strength of 39,000 pounds. Wire rope shall be pre-tensioned. Provide a Certificate of Quality from the wire rope manufacturer with each cable spool specifying breaking strength, modulus of elasticity and the amount of force used to elongate the wire rope.

Provide factory swaged threaded terminals for connecting the wire ropes at the turnbuckles. A maximum of two wedge-type connections that secure the wire rope by compression may be used per wire rope per segment.

Threaded terminals, turnbuckles and fittings shall be galvanized after threading and meet the requirements of ASTM A-153. The fittings shall be designed for the cable arrangement used and fully fitted connections shall have minimum breaking strength of 36,800 pounds, certified by test reports that shall be submitted to the Engineer. Turnbuckles shall be of the solid or closed body type with two holes to determine cable stud thread penetration. Turnbuckles shall be installed at a maximum spacing of 1000 Feet intervals.

The line posts shall meet the manufacturer’s specifications and be consistent with the post size specified in the FHWA NCHRP-350 or MASH acceptance letter. Furnish steel posts meeting the requirements of ASTM A-36 galvanized to ASTM A-123 requirements following fabrication. The posts shall be designed to hold the wire at the design height. The posts shall be inserted in galvanized metal sockets or sleeves conforming to the manufacturer’s design. Provide a low density polyethylene (or similar type material) excluder profiled to fit tightly around the post to prevent debris from entering the sockets.

The line post shall foundation shall be compatible with the concrete mow strip as shown in the plans.

The line post shall have retroreflective sheeting on every fourth post or 50 feet, whichever is less. The sheeting shall be Type XI, Fluorescent-yellow meeting the requirements of Section 715.9.2.4 with a minimum surface area of 9 square inches. Place Fluorescent-yellow sheeting applied directly on both sides of the post. A post cap method of sheeting attachment that may detach upon impact to the line post, shall not be permitted. The retroreflective sheeting shall be placed as high as possible on the line post.

All materials including wire rope, fittings, posts, reflectorized spacers or post caps, and terminals shall meet the approved manufacturer’s specifications and details and shall be approved by the Engineer prior to installation.

“Open wedge” connections as allowed on GR-3 low tension cable systems shall not be used. Swaged fittings shall be required. Connections at anchorages needed to field adjust the cables may be “closed wedge” compression type fittings.
Any damage (break in the coating) to exposed steel or metal that is required to be galvanized shall be repaired or retouched to the satisfaction of the Engineer or shall be replaced with fittings or materials with the factory coating intact.

The End Terminals shall have a minimum of 120 square inches of Type XI retroreflective sheeting meeting the requirements of Section 715.9.2.4 affixed to each of the terminal posts.

607.2.2 Geotechnical Data: The known soil data to the Division is made part of the Contract documents. Any additional soil data required, shall be the responsibility of the Contractor.

It is the Contractor’s responsibility to supply the cable barrier manufacturer with any soil information needed to design the End Terminal Foundations.

All soil information gathering shall be considered incidental to construction of the cable system at no additional cost to the contract.

The existing median shall be graded to a proposed 6:0:1 or flatter side slope where shown in the plans. The proposed grading and drainage work required shall not be part of this provision and shall be paid for separately per the appropriate items in this contract.

The cable barrier system described below requires side slopes of 6:0:1 or flatter. The steepening or elimination of the 6:1 grading and related drainage work by Value Engineering Proposal, Practical Design Change Proposal or other contract revisions shall not be considered applicable to this contract.

607.2.3 Submittals: Submittals listed below shall be provided at least 30 days prior to initiating work and submitted electronically.

1. Provide an FHWA Eligibility Letter for National Cooperative Highway Research Program (NCHRP) 350 or Manual for Assessing Safety Hardware (MASH) FHWA Eligibility Letter for the cable barrier system, terminals and all appurtenances. The system shall be approved for Test Level 4 (TL4) for 6:1 side slopes.
2. The cable system manufacturer shall be responsible for the design of any transitions between existing or proposed guardrail and the cable system that is not compatible by the manufacturer of the proposed HTCB system as shown on the plans. This design shall be submitted to the Division at least 30 days prior to beginning work and must be approved by the Engineer prior to beginning work on the barrier. The cable may not be tied to any guardrail or bridge structure but must be “overlapped” in a manner approved by the Engineer.
3. Provide manufacturer’s drawings, general notes, specifications and installation manuals for all components proposed for installation.
4. Provide manufacturer’s guidelines and instructions for repairs that may be required to the cable system and all appurtenances following a vehicle hit.
5. Submit material specifications and technical data information on all materials proposed for use on the project.
6. The design of the cable system termini, depth and size of line posts, concrete footings, and the concrete end-anchors shall bear the seal of a Registered Professional Engineer currently licensed in West Virginia.
7. Provide an Installation Plan, with schedule, for the barrier. The Installation Plan shall be linked to the Transportation Management Plan for the project and shall be subject to the approval of the Engineer.
8. Detailed drawings of all post and hardware including a post with all four (4) cable heights defined and construction tolerances to be met.
9. Two (2) sets of As-Built plans shall be submitted showing the locations of the turnbuckles and spice locations of the complete project.
10. The complete foundation design for all Cable End Terminal Foundations shall be submitted to the Engineer. The design shall provide detailed reinforcement layout, dimensions and material properties defined as a minimum. Plans must be sealed by a Registered Professional Engineer licensed in West Virginia.
11. Line Post Foundation shall be designed when geotechnical soil conditions are not met as required by the HTCB manufacturer’s standard criteria.
12. Blank Sample of the proposed Cable Tension Log are to be submitted upon completion.

607.2.4-Design Criteria: Base the minimum design load for the Cable End Terminal to cable connections on the theoretical cumulative tension expected at -20 degrees Fahrenheit.
Limit Cable End Terminal foundation lateral deflection to 1 inch at the proposed ground surface using a minimum factor of safety of 2.0.

607.2.5-Preconstruction Conference: A Preconstruction Conference with all parties shall be held at least 30 days prior to commencement of the work to install the barrier system. At that time, all materials and methods must have been approved by the Engineer.

607.4-ERECTING RAIL ELEMENTS:

ADD THE FOLLOWING TO THE SUBSECTION:

607.4.1-High Tension Cable Barrier System: The cable barrier system and end terminals shall consist of pre-tensioned wire rope (cable), steel line posts set in steel sockets in concrete footings, end-anchors and all fittings meeting National Cooperative Highway Research Program (NCHRP) Report 350 or MASH for Test Level 4 for approach slopes of 6H:1V.

The cable barrier system shall be 4 wire ropes with post spacing at 12 feet or less as approved by the Engineer. The dynamic deflection shall be less than 8 feet using NCHRP 350 or MASH testing requirements. In locations where a dynamic deflection distance of 8 feet is not attainable between a fixed object, the post spacing shall be decreased per manufacturer’s engineering calculations to reduce the deflection to achieve the required deflection.

The specified maximum dynamic deflection of 8 feet shall be met along the entire length of each cable barrier segment between end anchors. In addition to meeting the NCHRP 350 or MASH testing requirements, the manufacturer shall provide documentation demonstrating that the proposed system meets the dynamic deflection requirements at the maximum distance between anchors that the system will be installed as specified in the plans. The documentation may be in the form of field testing results and/or computer simulations. Any testing or study supporting the claims shall either be done by the manufacturer and accepted by appropriate governmental entities or done by reputable and recognized testing or evaluation entities using the manufacturer’s materials and system design. If the manufacturer cannot adequately demonstrate the ability of their system to meet the dynamic deflection requirements at the maximum distance between anchors specified in the plans, they shall be required, at the
sole discretion of Division, to reduce post spacing and/or add additional anchors until the requirements are met and approved by the Engineer. Any additional cost associated with reducing the post spacing and adding anchors shall be considered incidental to construction and included in price bid for this item.

The manufacturer of the cable system must have been in operation for at least 3 years and must have successfully installed a minimum of 50 miles of high tension cable systems in the United States. The manufacturer shall present evidence of such to the Engineer at the barrier system preconstruction conference.

The cable barrier system shall be designed so that line post repairs following a vehicle hit can be made quickly by two maintenance technicians using readily available hand tools. In addition, the cable barrier manufacturer shall provide written repair instructions for all elements of the cable system including the cables, anchors, and connections. All repair instructions shall be provided in an electronic version and in a printed and bound version (minimum 2 copies).

607.4.2-Construction Methods:

607.4.2.1-Installation of the Cable Barrier Line Posts: Any grading and excavation shall be completed to finished line and grade prior to installation of the line posts.

Excavate for line posts in accordance with the approved manufacturer’s drawings. Each post shall be at the proper location, elevation, alignment and depth as proposed and approved. Excavation of line post footings shall be performed to place concrete, as required by the manufacturer, in undisturbed soil for the bottom and sides. In the event backfill is necessary, specification procedures must be followed to achieve the proper backfill method and compaction. Size and depth of footings shall be as approved by the Engineer but shall not be less than 14” diameter and 36” deep (14”x36”) unless larger sizes are recommended by the manufacturer and approved by the Engineer.

The galvanized steel line post sleeves shall be placed in concrete footings in accordance with the approved manufacturer’s drawings. Footings shall have reinforcing bars in accordance with the manufacturer’s approved shop drawings.

The line post footings shall be compatible with a concrete mow strip, as called for in the plans, and shall be separated by expansion material sufficient to protect both from cracking.

The line posts shall be set in the line post sleeves paying close attention to the horizontal and vertical alignment of the posts. It is critical that the posts be set to achieve the proper wire rope height. Line posts shall be set to achieve the vertical and horizontal tolerances set by the manufacturer in the approved shop drawings and installation manuals. Posts and foundations not set at the proper line and grade shall be replaced prior to the installation of the wire rope.

607.4.2.2-Installation of End Terminals: Install terminals in conformance with the requirements of the cable system manufacturer’s instructions and as approved by the Engineer.

End terminals shall be placed in excavations of natural, undisturbed ground, to size and shape required by the manufacturer based on soil types and ground conditions. If over-excavation is unavoidable as verified by the Engineer prior to installation of the concrete,
the sides must be vertical and additional concrete shall be used to fill completely the excavated area.

Provide an end terminal for each separate connection for each separate run of cable. Cables shall not be tied to anything but an approved terminal and shall not be tied to any proposed or existing guardrail, bridge structure or other unapproved object.

No incomplete runs subject to traffic shall be left overnight or unprotected. At the end of each working day, any section started shall be completed by the end of the day if the roadway is under traffic.

Any end-anchor movement exceeding 1 inch within twelve (12) months of complete installation will require re-construction and re-tensioning of the system by the Contractor at their cost as directed by the Engineer.

607.4.2.3-Installation of Wire Rope: The wire rope shall be installed at the elevation and proper height as approved in the manufacturer’s design and approved drawings.

Tension shall be applied meeting manufacturer’s recommendations. Check the tension per manufacturer’s recommendations.

Three weeks following the initial tensioning, check and adjust the tension as necessary. No additional compensation will be provided for any subsequent tensioning required.

Maintain a tension log showing time, date, location, cable temperature, ambient air temperature and final tension reading, signed by the person performing the tension testing. The log will be reviewed to verify that the measured tension matches the temperature/tension chart provided by the manufacturer and is within the stated variance. The log shall be provided to the Engineer after tensioning is complete.

The number and location of splices will be subject to the approval of the Engineer. Splices shall be staggered in accordance with the manufacturer’s recommendations. Cable splices shall be made in accordance with the recommendations of the cable manufacturer.

607.4.3-Maintenance During Construction: Once the cable system has been erected the cable and that section of roadway returned to traffic, the Contractor is responsible for maintaining and repair of the cable barrier system until final acceptance of the entire project. Should the cable barrier be damaged by the traveling public, Contractor shall repair the barrier within 24 hours. The cable barrier posts shall be replaced and the cable reinstalled to the post. If that section of cable has been inspected and certified to by the manufacturer, the cable will be re-inspected and recertified as with the initial installation.

All repairs made to the cable barrier or terminals, no matter the cause of the repair, prior to final acceptance, shall be considered incidental to construction at no additional cost to the contract.

607.4.4-Cable System Installation Training and Certification:

607.4.4.1-Manufacturer’s Certification: A manufacturer’s representative shall be present during the installation of the first section of the cable barrier system and shall supervise installation of all components (i.e. posts, anchors, tensioning). Upon completion of the entire system, a manufacturer’s representative shall inspect and certify in writing that the cable system was installed in accordance with the manufacturer’s design and requirements.
607.4.4.2-On-Site Installation Training: All training shall be provided by the cable system manufacturer. Provide a minimum of 2 hours of classroom training on the installation of the system. This training shall be provided at the WVDOH District Office responsible for the construction of the system. The location and time of this training shall be subject to the approval of the Engineer.

Provide on-site field instruction using a minimum 2000-foot section of the system. The amount of training will be as necessary to provide the field training on all aspects of system installation, line post installation, wire rope installation and tensioning and testing, and terminal installation.

Provide Certification by the manufacturer of the system for the participants of the training. This certification shall require participants to pass a written examination prepared and given by the system manufacturer. The Contractor shall have certified personnel on the site at all times during the installation of all elements of the system.

The training and certification instruction described above shall be provided for a minimum of twenty participants to include the Contractor, WVDOH (Construction, Maintenance and Traffic Operations personnel) and FHWA. Twelve slots shall be reserved for WVDOH and FHWA and the remainder for the Contractor.

607.4.4.3-Training Following Installation: Provide a minimum of two hours of classroom instruction on the maintenance and repair of the cable system. This training shall be provided at the WVDOH District Office responsible for maintenance. The scheduling and location of this training shall be as approved by the Engineer.

Provide a minimum of one hour of on-site instruction on the maintenance and repair of the system.

A training session of two hours shall be provided to address the needs of emergency response personnel involved in extricating vehicles from the cables and the safety of the responders with techniques in minimizing damage to the system.

The training shall be for a maximum of 20 participants including WVDOH (Construction, Maintenance, and Traffic Operations), FHWA and representatives of local fire and rescue services.

607.6-METHOD OF MEASUREMENT:

ADD THE FOLLOWING TO THE END OF THE SUBSECTION:

The quantity of HTCB will be measured in feet along the top cable constructed, tested and accepted. Each segment of HTCB shall be between Length of Need (LON) points as shown on the plans. The measured length between LON points shall pay for all 4 cables of the system, line post, line post foundation and appurtenances. The length of the End Terminals outside of the LON shall not be included in this measurement. The approved shop drawings shall define the location of the LON point of the system.

The Cable End Terminals will be measured separately and will be the actual number constructed and accepted.

The Cable End Terminal Foundations will be measured separately and will be the actual number constructed and accepted.
The hours of training will be the hours of the instructor providing the training as directed by the Engineer.

607.8-PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
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<tr>
<td>607018-001</td>
<td>High Tension Cable Barrier (HTCB)</td>
<td>Linear Foot</td>
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<tr>
<td>607018-005</td>
<td>Cable End Terminal</td>
<td>Each</td>
</tr>
<tr>
<td>607018-010</td>
<td>Cable End Terminal Foundation</td>
<td>Each</td>
</tr>
<tr>
<td>607018-050</td>
<td>HTCB Installation &amp; Maintenance Training</td>
<td>Hour</td>
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</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

HIGH TENSION CABLE GUARDRAIL

STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________

SECTION 607
GUARDRAIL

DELETE THE HEADING AND CHANGE TO THE FOLLOWING:

SECTION 607
GUARDRAIL AND HIGH TENSION CABLE BARRIER SYSTEM
MASH 2009

607.1-DESCRIPTION:

ADD THE FOLLOWING TO THE SUBSECTION:

The work includes furnishing and erecting a 4 wire rope High Tension Cable Barrier (HTCB) system meeting the requirements of Manual for Assessing Safety Hardware (MASH) 2009 for the cable barrier system, terminals and all appurtenances. The system shall have a letter of eligibility from FHWA for Test Level 3 (TL-3) for 6.0:1 side slopes.

The work shall conform to the lines, grades, and locations shown on the Plans or as directed by the Engineer. The cable barrier shall be placed in accordance with the cable system manufacturer’s instructions and in accordance with the Division approved shop drawings and submittals prepared by the manufacturer of the cable barrier system.

Unless provided for on the plans, the work covered by this special provision includes only work necessary to install the cable barrier system and appurtenances. It includes the following:

1. Furnishing and placement of concrete foundations for the anchors, line posts and the end terminals.
2. Providing and installing the cable system and all hardware and appurtenances for a complete and functional cable barrier system by one manufacture. All components are to be of the same type.
3. Conducting installation training prior to the installation of the barrier system and maintenance training after installation of the system.
4. No Value Engineering Change Proposals for alternative barrier types will be considered.

**607.2- MATERIALS:**

ADD THE FOLLOWING TO THE SUBSECTION:

**607.2.1-HTCB Materials:** The wire rope shall be galvanized, 3/4”-3x7 meeting requirements of AASHTO M30-92 Type I, Class A coating with minimum breaking strength of 39,000 pounds. Wire rope shall be pre-tensioned. Provide a Certificate of Quality from the wire rope manufacturer with each cable spool specifying breaking strength, modulus of elasticity and the amount of force used to elongate the wire rope.

Provide factory swaged threaded terminals for connecting the wire ropes at the turnbuckles. A maximum of two wedge-type connections that secure the wire rope by compression may be used per wire rope per segment.

Threaded terminals, turnbuckles and fittings shall be galvanized after threading and meet the requirements of ASTM A-153. The fittings shall be designed for the cable arrangement used and fully fitted connections shall have minimum breaking strength of 36,800 pounds, certified by test reports that shall be submitted to the Engineer. Turnbuckles shall be of the solid or closed body type with two holes to determine cable stud thread penetration. Turnbuckles shall be installed at a maximum spacing of 1000 Feet intervals.

The line posts shall meet the manufacturer’s specifications and be consistent with the post size specified in the FHWA MASH2009 acceptance letter. Furnish steel posts meeting the requirements of ASTM A-36 galvanized to ASTM A-123 requirements following fabrication. The posts shall be designed to hold the wire at the design height. The posts shall be inserted in galvanized metal sockets or sleeves conforming to the manufacturer’s design. Provide a low density polyethylene (or similar type material) excluder profiled to fit tightly around the post to prevent debris from entering the sockets.

The line post shall foundation shall be compatible with the concrete mow strip as shown in the plans.

The line post shall have retroreflective sheeting on every fourth post or 50 feet, whichever is less. The sheeting shall be Type XI, Fluorescent-yellow meeting the requirements of Section 715.9.2.4 with a minimum surface area of 9 square inches. Place Fluorescent-yellow sheeting applied directly on both sides of the post. A post cap method of sheeting attachment that may detach upon impact to the line post, shall not be permitted. The retroreflective sheeting shall be placed as high as possible on the line post.

All materials including wire rope, fittings, posts, reflectorized spacers or post caps, and terminals shall meet the approved manufacturer’s specifications and details and shall be approved by the Engineer prior to installation.

“Open wedge” connections as allowed on GR-3 low tension cable systems shall not be used. Swaged fittings shall be required. Connections at anchorages needed to field adjust the cables may be “closed wedge” compression type fittings.
Any damage (break in the coating) to exposed steel or metal that is required to be galvanized shall be repaired or retouched to the satisfaction of the Engineer or shall be replaced with fittings or materials with the factory coating intact.

The End Terminals shall have a minimum of 120 square inches of Type XI retroreflective sheeting meeting the requirements of Section 715.9.2.4 affixed to each of the terminal posts.

607.2.2-Geotechnical Data: The known soil data to the Division is made part of the Contract documents. Any additional soil data required, shall be the responsibility of the Contractor.

It is the Contractor’s responsibility to supply the cable barrier manufacturer with any soil information needed to design the End Terminal Foundations.

All soil information gathering shall be considered incidental to construction of the cable system at no additional cost to the contract.

The existing median shall be graded to a proposed 6:1 or flatter side slope where shown in the plans. The proposed grading and drainage work required shall not be part of this provision and shall be paid for separately per the appropriate items in this contract.

The cable barrier system described below requires side slopes of 6:1 or flatter. The steepening or elimination of the 6:1 grading and related drainage work by Value Engineering Proposal, Practical Design Change Proposal or other contract revisions shall not be considered applicable to this contract.

607.2.3-Submittals: Submittals listed below shall be provided at least 30 days prior to initiating work and submitted electronically.

1. Provide an FHWA Eligibility Letter meeting the requirements of Manual for Assessing Safety Hardware (MASH) 2009 for the cable barrier system, terminals and all appurtenances. The system shall be approved for Test Level 3 (TL-3) for 6:1 side slopes.
2. The cable system manufacturer shall be responsible for the design of any transitions between existing or proposed guardrail and the cable system that is not compatible by the manufacturer of the proposed HTCB system as shown on the plans. This design shall be submitted to the Division at least 30 days prior to beginning work and must be approved by the Engineer prior to beginning work on the barrier. The cable may not be tied to any guardrail or bridge structure but must be “overlapped” in a manner approved by the Engineer.
3. Provide manufacturer’s drawings, general notes, specifications and installation manuals for all components proposed for installation.
4. Provide manufacturer’s guidelines and instructions for repairs that may be required to the cable system and all appurtenances following a vehicle hit.
5. Submit material specifications and technical data information on all materials proposed for use on the project.
6. The design of the cable system termini, depth and size of line posts, concrete footings, and the concrete end-anchors shall bear the seal of a Registered Professional Engineer currently licensed in West Virginia.
7. Provide an Installation Plan, with schedule, for the barrier. The Installation Plan shall be linked to the Transportation Management Plan for the project and shall be subject to the approval of the Engineer.
8. Detailed drawings of all post and hardware including a post with all four (4) cable heights defined and construction tolerances to be met.
9. Two (2) sets of As-Built plans shall be submitted showing the locations of the turnbuckles and spice locations of the complete project.
10. The complete foundation design for all Cable End Terminal Foundations shall be submitted to the Engineer. The design shall provide detailed reinforcement layout, dimensions and material properties defined as a minimum. Plans must be sealed by a Registered Professional Engineer licensed in West Virginia.
11. Line Post Foundation shall be designed when geotechnical soil conditions are not met as required by the HTCB manufacturer’s standard criteria.
12. Blank Sample of the proposed Cable Tension Log are to be submitted upon completion.

**607.2.4-Design Criteria:** Base the minimum design load for the Cable End Terminal to cable connections on the theoretical cumulative tension expected at -20 degrees Fahrenheit. Limit Cable End Terminal foundation lateral deflection to 1 inch at the proposed ground surface using a minimum factor of safety of 2.0.

**607.2.5-Preconstruction Conference:** A Preconstruction Conference with all parties shall be held at least 30 days prior to commencement of the work to install the barrier system. At that time, all materials and methods must have been approved by the Engineer.

**607.4-ERECTING RAIL ELEMENTS:**

ADD THE FOLLOWING TO THE SUBSECTION:

**607.4.1-High Tension Cable Barrier System:** The cable barrier system and end terminals shall consist of pre-tensioned wire rope (cable), steel line posts set in steel sockets in concrete footings, end-anchors and all fittings meeting MASH 2009 for Test Level 3 for side slopes of 6H:1V.

The cable barrier system shall be 4 wire ropes with post spacing at 12feet or less as approved by the Engineer. The dynamic deflection shall be less than 8 feet using MASH 2009 testing requirements. In locations where a dynamic deflection distance of 8 feet is not attainable between a fixed object, the post spacing shall be decreased per manufacturer’s engineering calculations to reduce the deflection to achieve the required deflection.

The specified maximum dynamic deflection of 8 feet shall be met along the entire length of each cable barrier segment between end anchors. In addition to meeting the MASH 2009 testing requirements, the manufacturer shall provide documentation demonstrating that the proposed system meets the dynamic deflection requirements at the maximum distance between anchors that the system will be installed as specified in the plans. The documentation may be in the form of field testing results and/or computer simulations. Any testing or study supporting the claims shall either be done by the manufacturer and accepted by appropriate governmental entities or done by reputable and recognized testing or evaluation entities using the manufacturer’s materials and system design. If the manufacturer cannot adequately demonstrate the ability of their system to meet the dynamic deflection requirements at the maximum distance between anchors specified in the plans, they shall be required, at the sole
discretion of Division, to reduce post spacing and/or add additional anchors until the requirements are met and approved by the Engineer. Any additional cost associated with reducing the post spacing and adding anchors shall be considered incidental to construction and included in price bid for this item.

The manufacturer of the cable system must have been in operation for at least 3 years and must have successfully installed a minimum of 50 miles of high tension cable systems in the United States. The manufacturer shall present evidence of such to the Engineer at the barrier system preconstruction conference.

The cable barrier system shall be designed so that line post repairs following a vehicle hit can be made quickly by two maintenance technicians using readily available hand tools. In addition, the cable barrier manufacturer shall provide written repair instructions for all elements of the cable system including the cables, anchors, and connections. All repair instructions shall be provided in an electronic version and in a printed and bound version (minimum 2 copies).

607.4.2-Construction Methods:

607.4.2.1-Installation of the Cable Barrier Line Posts: Any grading and excavation shall be completed to finished line and grade prior to installation of the line posts.

Excavate for line posts in accordance with the approved manufacturer’s drawings. Each post shall be at the proper location, elevation, alignment and depth as proposed and approved. Excavation of line post footings shall be performed to place concrete, as required by the manufacturer, in undisturbed soil for the bottom and sides. In the event backfill is necessary, specification procedures must be followed to achieve the proper backfill method and compaction. Size and depth of footings shall be as approved by the Engineer but shall not be less than 14” diameter and 36” deep (14”x36”) unless larger sizes are recommended by the manufacturer and approved by the Engineer.

The galvanized steel line post sleeves shall be placed in concrete footings in accordance with the approved manufacturer’s drawings. Footings shall have reinforcing bars in accordance with the manufacturer’s approved shop drawings.

The line post footings shall be compatible with a concrete mow strip, as called for in the plans, and shall be separated by expansion material sufficient to protect both from cracking.

The line posts shall be set in the line post sleeves paying close attention to the horizontal and vertical alignment of the posts. It is critical that the posts be set to achieve the proper wire rope height. Line posts shall be set to achieve the vertical and horizontal tolerances set by the manufacturer in the approved shop drawings and installation manuals. Posts and foundations not set at the proper line and grade shall be replaced prior to the installation of the wire rope.

607.4.2.2-Installation of End Terminals: Install terminals in conformance with the requirements of the cable system manufacturer’s instructions and as approved by the Engineer.

End terminals shall be placed in excavations of natural, undisturbed ground, to size and shape required by the manufacturer based on soil types and ground conditions. If over-excavation is unavoidable as verified by the Engineer prior to installation of the concrete,
the sides must be vertical and additional concrete shall be used to fill completely the excavated area.

Provide an end terminal for each separate connection for each separate run of cable. Cables shall not be tied to anything but an approved terminal and shall not be tied to any proposed or existing guardrail, bridge structure or other unapproved object.

No incomplete runs subject to traffic shall be left overnight or unprotected. At the end of each working day, any section started shall be completed by the end of the day if the roadway is under traffic.

Any end-anchor movement exceeding 1 inch within twelve (12) months of complete installation will require re-construction and re-tensioning of the system by the Contractor at their cost as directed by the Engineer.

**607.4.2.3-Installation of the wire rope:** The wire rope shall be installed at the elevation and proper height as approved in the manufacturer’s design and approved drawings.

Tension shall be applied meeting manufacturer’s recommendations. Check the tension per manufacturer’s recommendations.

Three weeks following the initial tensioning, check and adjust the tension as necessary. No additional compensation will be provided for any subsequent tensioning required.

Maintain a tension log showing time, date, location, cable temperature, ambient air temperature and final tension reading, signed by the person performing the tension testing. The log will be reviewed to verify that the measured tension matches the temperature/tension chart provided by the manufacturer and is within the stated variance. The log shall be provided to the Engineer after tensioning is complete.

The number and location of splices will be subject to the approval of the Engineer. Splices shall be staggered in accordance with the manufacturer’s recommendations. Cable splices shall be made in accordance with the recommendations of the cable manufacturer.

**607.4.3-Maintenance During Construction:** Once the cable system has been erected the cable and that section of roadway returned to traffic, the Contractor is responsible for maintaining and repair of the cable barrier system until final acceptance of the entire project. Should the cable barrier be damaged by the traveling public, Contractor shall repair the barrier within 24 hours. The cable barrier posts shall be replaced and the cable reinstalled to the post. If that section of cable has been inspected and certified to by the manufacturer, the cable will be re-inspected and recertified as with the initial installation.

All repairs made to the cable barrier or terminals, no matter the cause of the repair, prior to final acceptance, shall be considered incidental to construction at no additional cost to the contract.

**607.4.4-Cable System Installation Training and Certification:**

**607.4.4.1-Manufacturer’s Certification:** A manufacturer’s representative shall be present during the installation of the first section of the cable barrier system and shall supervise installation of all components (i.e. posts, anchors, tensioning). Upon completion of the entire system, a manufacturer’s representative shall inspect and certify in writing that the cable system was installed in accordance with the manufacturer’s design and requirements.
607.4.4.2-On-Site Installation Training: All training shall be provided by the cable system manufacturer. Provide a minimum of 2 hours of classroom training on the installation of the system. This training shall be provided at the WVDOH District Office responsible for the construction of the system. The location and time of this training shall be subject to the approval of the Engineer.

Provide on-site field instruction using a minimum 2000-foot section of the system. The amount of training will be as necessary to provide the field training on all aspects of system installation, line post installation, wire rope installation and tensioning and testing, and terminal installation.

Provide Certification by the manufacturer of the system for the participants of the training. This certification shall require participants to pass a written examination prepared and given by the system manufacturer. The Contractor shall have certified personnel on the site at all times during the installation of all elements of the system.

The training and certification instruction described above shall be provided for a minimum of twenty participants to include the Contractor, WVDOH (Construction, Maintenance and Traffic Operations personnel) and FHWA. Twelve slots shall be reserved for WVDOH and FHWA and the remainder for the Contractor.

607.4.4.3-Training Following Installation: Provide a minimum of two hours of classroom instruction on the maintenance and repair of the cable system. This training shall be provided at the WVDOH District Office responsible for maintenance. The scheduling and location of this training shall be as approved by the Engineer.

Provide a minimum of one hour of on-site instruction on the maintenance and repair of the system.

A training session of two hours shall be provided to address the needs of emergency response personnel involved in extricating vehicles from the cables and the safety of the responders with techniques in minimizing damage to the system.

The training shall be for a maximum of 20 participants including WVDOH (Construction, Maintenance, and Traffic Operations), FHWA and representatives of local fire and rescue services.

607.6-METHOD OF MEASUREMENT:

ADD THE FOLLOWING TO THE SUBSECTION:

The quantity of HTCB will be measured in feet along the top cable constructed, tested and accepted. Each segment of HTCB shall be between Length of Need (LON) points as shown on the plans. The measured length between LON points shall pay for all 4 cables of the system, line post, line post foundation and appurtenances. The length of the End Terminals outside of the LON shall not be included in this measurement. The approved shop drawings shall define the location of the LON point of the system.

The Cable End Terminals will be measured separately and will be the actual number constructed and accepted.
The Cable End Terminal Foundations will be measured separately and will be the actual number constructed and accepted.

The hours of training will be the hours of the instructor providing the training as directed by the Engineer.

607.8-PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

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WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR
HIGH TENSION CABLE BARRIER SYSTEM

STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________

SECTION 609
SIDEWALKS

609.1-DESCRIPTION:

DELETE THE SUBSECTION AND REPLACE THE FOLLOWING:

Concrete Mow Strip: This work shall consist of the construction of Portland cement concrete mow strip in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

609.7-EXPANSION JOINTS:

DELETE THE SUBSECTION AND REPLACE THE FOLLOWING:

Expansion joints 1/4 inch (6 mm) wide shall be constructed at 30 ft. (9 m) intervals. Expansion joints shall be filled with preformed joint filler, which shall be shaped to fit the concrete section being placed.

Expansion joints, of the type specified above, shall be constructed between all such appurtenances and the mow strip.

Expansion joint material shall be placed between the concrete mow strip and the line post foundations.

When a manufacturer’s concrete mow strip and the line post foundations system is different than described above and the system has been tested, the contractor shall submit the manufacture’s drawings and tests to construct the tested system.
609.9-METHOD OF MEASUREMENT:

DELETE THE SUB-SECTION AND ADD THE FOLLOWING:

Concrete Mow Strip will be measured in square yards (meters), complete in place and accepted, which will be determined by the length measured upon the surface multiplied by the width constructed as shown on the plans. Any required excavation for the Concrete Mow Strip shall be incidental to the pay item for Concrete Mow Strip.

609.11-PAY ITEMS:

ADD THE FOLLOWING PAY ITEM:

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<td>Concrete Mow Strip</td>
<td>Square Yard (Meter)</td>
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WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

HIGH TENSION CABLE BARRIER SYSTEM

STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________

SECTION 639
CONSTRUCTION SURVEYING

DELETE THE HEADING AND CHANGE TO THE FOLLOWING:

SECTION 639
CONSTRUCTION LAYOUT STAKES FOR ELECTRONIC DATA

639.1-DESCRIPTION:

DELETE THE SUB-SECTION AND REPLACE WITH THE FOLLOWING:

When this item is included in the Proposal, it shall consist of furnishing, reviewing, and maintaining all necessary electronic data records for the proper prosecution of the work with the use of electronic grading under the Contract. This work shall conform to all provisions as outlined in the Specifications.

639.3-CONSTRUCTION LAYOUT STAKES:

DELETE THE SECOND AND THIRD PARAGRAPHS AND REPLACE WITH THE FOLLOWING:

The Contractor shall be responsible for having the layout staking work conform to the lines, grades, elevations, and dimensions called for on the Plans. The Contractor shall furnish a copy of their survey records and, if applicable as per 639.3.1, an electronic copy of the Constructed Terrain Model.
ADD THE FOLLOWING TO THE END OF THE SECTION:

639.3.1-Terrain Models and Control Data: The contractor shall use electronic stake out procedures as described in this section. The software utilized by the Contractor shall perform the volume computations.

For the purposes of these specifications a terrain model is a digital representation of a ground surface or terrain as defined more clearly below:

a) Existing Terrain Model: A digital representation of the ground elevations for the project prior to prosecution of the work.

b) Plan Terrain Model: A digital representation of the grading shown in the contract plans.

c) Constructed Terrain Model: A digital representation of the project construction grading at a given time during the prosecution of work.

d) Final Constructed Terrain Model: A digital representation of the final grading for the project.

e) Control Data: A digital file containing the Point Name and the XYZ values of any ground control points and a digital file representing the geometric alignment of the project centerline(s).

639.3.2-Review of Terrain Models and Control Data: Upon request, prospective bidders may obtain copies of the Existing Terrain Model, Plan Terrain Model, and a copy of the project control in ASCII format for evaluation. The Contractor shall evaluate this information as to its accuracy and submit to the Engineer for evaluation noting discrepancies relative to its representation of existing contours and other possible errors or issues with the electronic data prior to the award of the contract. The Division will review and respond to the Contractor within seven days. Any corrections to the electronic data will be performed by the Division and any time extensions due the Contractor for this corrective action shall be in accordance with Section 108. The Contractor may request in writing that a “Conditional Notice to Proceed” be issued to allow work to begin on items not affected by the Excavation.

During placement of the borrow material the median slope shall be field verified to be in accordance with the details in the plans and the Plan Terrain Model.

Any delays attributed to the contractor will not be eligible for time extensions as per section 108.6.2.

639.3.2.1-Partial Review of Terrain Models and Control Data: The Contractor may review the Electronic Data defined above in partial segments of the project to allow work to begin sooner. If reviewing the data in partial segments the Contractor will submit in writing to the Engineer noting what section of the roadway data is being reviewed. This information will detail the areas being evaluated by noting the Plan Station numbers ie: STA XXX+XX to STA YYY+YY or coordinates. All the time constraints and review process will be in accordance with section 639.3.2 before any work is done on this section. Future project sections will be reviewed in this manner.

639.3.3-Submittals: All submissions of any records in an electronic medium must be in such a format that it is directly compatible with current software products used by the Department as per Section 639.3.4. These records shall be furnished as they are completed during the progress of the work for review and payment by the Engineer. Any inspection or
checking of the Contractor’s layout by the Engineer and the acceptance of all or any part of it shall not relieve the Contractor of their responsibility to secure the proper dimensions, grades, and elevations of any part of the work.

The Final Constructed Terrain Model shall be submitted in digital format to be used to update the Division’s Existing Terrain Model for future work. The Final Constructed Terrain Model is subject to review by the Division before acceptance. The Contractor shall be responsible to address corrections in the model. Upon acceptance of the Final Constructed Terrain Model this data and model shall become the property of the Division.

639.3.4-Software Requirements: Any spreadsheets must be submitted in electronic format such as Microsoft Excel or other applicable formats. The software utilized in preparation of the various Terrain Models must be compatible with the current Bentley Systems© software products used by the Department.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________

FOR

SECTION 405
SURFACE TREATMENTS

DELETE THE HEADING AND CONTENTS AND REPLACE THE FOLLOWING:

SECTION 405
SCRUB SEAL TREATMENT

405.1-DESCRIPTION:
This work shall consist of the construction of a wearing course, composed of asphalt material and aggregate, in one or more applications upon an existing surface, in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and cross sections shown on the Plans or established by the Engineer.

The type of Scrub Seal will be indicated on the Plans (ex Standard, Rejuvenating, RAP, etc.). The Contractor may select the polymer modified emulsion grade from the table below, unless otherwise indicated. If approved by the Engineer the Contractor may specify the use of screened RAP as aggregate.

The Contractor shall notify the Engineer a-14 calendar days prior to starting any surface treatment Scrub Seal operation.

405.2-MATERIALS:
The materials shall conform to the requirements of the following Subsections of Division 700 .:
TABLE 405.2a

<table>
<thead>
<tr>
<th>Materials</th>
<th>Subsection</th>
<th>Kind or Gradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Coarse Aggregate</td>
<td>703.1-4</td>
<td>See Table 405.2b</td>
</tr>
<tr>
<td>2Polymer Modified Cationic Emulsified Asphalt</td>
<td>705.12</td>
<td>CRS-2P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2L</td>
</tr>
</tbody>
</table>

1When RAP is specified- as course aggregate the RAP shall be screened and meet the requirements of Table 405.2c
2Engineered asphalt emulsions may be used with testing and approval prior to construction. Testing shall be done a minimum or two weeks prior to the projected start date and follow the process outlined in Materials Procedure 401.02.25 Certification of Asphalt and Tar Shipping Terminals.

TABLE 405.2b

<table>
<thead>
<tr>
<th>Aggregate Gradations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>1/2 in (12.5 mm)</td>
</tr>
<tr>
<td>3/8 in (9.5 mm)</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
</tr>
<tr>
<td>No. 30 (600 μm)</td>
</tr>
<tr>
<td>No. 200 (75 μm)</td>
</tr>
</tbody>
</table>

RAP screenings shall be produced by crushing asphalt concrete pavement, free of detrimental quantities of deleterious materials, and have a minimum sand equivalent of 80.

TABLE 405.2c

<table>
<thead>
<tr>
<th>RAP Aggregate Gradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>3/4” (19 mm)</td>
</tr>
<tr>
<td>1/2” (1.5 mm)</td>
</tr>
<tr>
<td>3/8” (9.5 mm)</td>
</tr>
<tr>
<td>1/4” (6.4 mm)</td>
</tr>
<tr>
<td>#8 (2.36 mm)</td>
</tr>
<tr>
<td>#200 (75 μm)</td>
</tr>
</tbody>
</table>

If an asphalt rejuvenator is specified in the plans, it shall meet the requirement of RA1, RA5, or RA25 in the ASTM D4552 standard.
405.3-WEATHER RESTRICTIONS:
Scrub Seal Treatment shall be constructed only when the condition of the existing surface is satisfactory to the Engineer, when the temperature of the pavement being treated is 60° F or above, and when other weather conditions are satisfactory for construction. No Scrub Seals shall be performed between October 1 and May 1.
Operations shall be suspended immediately when rain begins or when the Contractor determines that a rain event is imminent.

405.4-EQUIPMENT:
Equipment shall include equipment for heating asphalt material, a self-powered emulsion distributor, scrub broom, an aggregate spreader, and compaction equipment. Equipment shall also include scrapers, hand brooms, power brooms, shovels, and other items as may be necessary to thoroughly clean the existing surface.

405.4.1-Distributor Truck: The distributor shall be so designed, equipped, maintained and operated that asphalt material may be applied uniformly on variable widths of surface up to 16 ft. (4.6 m) at readily determined and controlled rates from 0.05 to 2.0 gal. per sq. yd. (0.22 to 9.3 liters m²) with uniform pressure and with an allowable variation from any specified rate not to exceed 0.02 gal. per sq. yd. (0.09 liter m²). The distributor shall also have a cab-metering system that will automatically adjust the flow of the asphalt material as the speed of the truck changes and allow the operator to adjust the rate of application from the cab of the truck.
Distributor equipment shall include a tachometer, pressure gages, and accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. A manifold connection shall be provided and hand spraying equipment shall be available to cover areas and patches inaccessible to the distributor.
Documentation of distributor truck calibration within the last 12 months shall be available on the project site, preferably located within the cab of the truck.

405.4.2-Scrub Broom: Scrub brooms shall be composed of a rigid steel frame with hydraulically operated street brooms attached. The main body of the frame shall be a minimum of 6 feet wide by 8 feet long. The minimum frame reach width shall be 16 feet.
The nearest and furthest members, paralleling the back of the distributor truck, and the diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have broom heads angled at 15 degrees off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the scrub broom assembly shall be 3-1/2 inches wide x 8 inches high x 16 inches (minimum) long and shall have stiff nylon bristles. Bristle height shall be maintained at a minimum of 5 inches.
The scrub broom may be equipped with hinged wing assemblies which shall not to exceed 4 feet per side including diagonals, and shall be equipped with street brooms.
The weight of the broom assembly shall be such that it does not remove the asphalt emulsion from the roadway surface.
The scrub broom frame shall be attached to and pulled by the distributor truck. The distributor truck shall be equipped with the means to mechanically lift the scrub broom off of the roadway surface at intermediate points of completion and remain in the elevated position during transit.

405.4.3-Aggregate Spreader: The spreader for cover grades of coarse aggregates shall be self-propelled and capable of laying a uniform surface. It shall be a mechanical revolving cylinder type or mechanical roller hopper spreader that can be adjusted to spread accurately the required amounts of materials per square yard.

405.4.4-Compaction Equipment: Compaction equipment shall be a pneumatic-tired roller conforming to the requirements of Section 401.9.10. With a minimum tire pressure of 60 psi. The project shall have a minimum of 3-2 rollers operating together to embed the aggregate in the emulsion.

405.5-PREPARING AND REPAIRING EXISTING SURFACE:
No scrub seal shall be applied until breaks, holes, depressions, and other irregularities in the existing surface have been repaired, to the satisfaction of the Engineer, and cured sufficiently to permit the asphalt material to be placed in a uniform application. Patching and leveling material shall be plant mixed. Hand patching will be permitted where necessary. Remove all existing thermoplastic markings and raised pavement markers.

405.6-CLEANING AND SWEEPING:
Immediately before starting construction, the existing surface shall be swept and thoroughly cleaned by the use of tools or machinery as may be required to remove all mud, dirt, dust, vegetation, and other caked or loose material foreign to the type of surface to be placed. Cleaning shall be done to a minimum width of one foot on each side beyond the width of the surface to be placed excluding the shoulder. Materials collected in the cleaning operation shall be removed and disposed of as directed.

405.7-APPLICATION OF ASPHALT MATERIAL:
The asphalt material shall be applied by means of a pressure distributor so as to uniformly and completely coat the entire surface. The rate of application of asphalt material shall begin at the application 0.30 to 0.50 gallons per square yard, or as modified by the plans. Application temperatures of the asphalt material shall be within the range specified in Subsection 705 for the particular material being used, or in accordance with the manufactures recommendations.

Except when required to maintain traffic, surface treatment scrub seal operations shall be done upon the full width of the section.

After application, asphalt material shall completely and uniformly cover the underlying pavement and be free of streaks and voids.

405.7.1-Scrubbing: Immediately following application, the asphalt material shall be scrubbed into the existing pavement surface with a scrub broom that is pulled behind the distributor truck. Scrubbing shall fill cracks and voids, force the emulsion into the existing pavement surface, and distribute the material uniformly over the roadway cross section.
405.7.2-Test Strip: The initial application rate shall be 0.35 gallons per square yard. The Contractor may suggest a different application rate, if backed up with design documentation, sealed by a WV Professional Engineer, in accordance with the McLeod Method or the Asphalt Institute Modified Kearby Method on designing surface treatment Chip Seals.

If so requested by the Engineer, the Contractor shall apply emulsion on 100-foot test strips at different rates to assist in determination. The initial rate, and any necessary adjustments thereto during spreading, shall be approved by the Engineer.

405.8-APPLICATION OF AGGREGATE:

Immediately following each application of asphalt material, aggregate at the rate or rates called for in 405.42 shall be spread with the spreader in such a manner that the entire area being treated is uniformly covered. Equipment shall be operated so that asphalt material will be covered with aggregate before equipment passes over the area that was tacked with asphalt material. Additional aggregate shall be spread if necessary, and hand spreading shall be done to cover areas inaccessible to the spreading equipment. When directed by the Engineer, the aggregate shall be dried or moistened as required in order to obtain a near Surface Saturated Dry condition.

If the process must stop during that application any asphalt material that has been applied to the surface shall be covered with aggregate to prevent breaking of the emulsion prior to embedment of the aggregate.

405.8.1-Test Strip: The initial spread rate shall be 20 pounds per square yard. The Contractor may suggest a different application rate, if backed up with design documentation, sealed by a WV Professional Engineer, in accordance with the McLeod Method or the Asphalt Institute Modified Kearby Method on designing surface treatment Chip Seals.

If so requested by the Engineer, the Contractor shall spread screenings on 100-foot test strips at different rates to assist in determination. The initial rate, and any necessary adjustments thereto during spreading, shall be approved by the Engineer.

The calculated spread rate upon completion shall be within 5 percent of the rate approved by the Engineer.

405.9-BROOMING AND ROLLING:

Immediately following spreading of the aggregate, the entire surface of the aggregate shall be rolled until the aggregate is keyed into the asphalt material. Any area that ravels shall be repaired and rerolled. Rolling shall be parallel to the centerline and shall begin at the edges of the treatment and progress toward the center, each trip uniformly overlapping the preceding trip.

Rolling shall cease before the aggregate is crushed. Rollers shall be the type and weight specified in 405.4. The minimum number of rollers shall be three-two (32), more may be used to obtain embedment of the aggregate to the satisfaction of the Engineer.

The roller shall be operated between 3 and 7 miles per hour to prevent aggregate pick up and ensure embedment. Water, to prevent adhesion of the asphalt material to the roller wheels, shall not be used in excessive amounts. The use of fuel oil, paraffin oil, and kerosene on rollers or other equipment, for the purpose of preventing material from picking up or sticking, is prohibited.
405.10-JOINTS:
The longitudinal construction joints between adjacent lanes shall be kept clean of material foreign to the surface being treated. The joints shall be constructed without overlaps or gaps between the materials.

The beginning of the project and all transverse joints shall be covered with paper to prevent overlapping of the seal and provided a uniform joint. Following its use, the paper shall be removed and disposed of to the satisfaction of the Engineer.

405.11-FOG SEAL:
No less than 3 calendar days, but no more than 7 calendar days after the application of the scrub seal the surface shall have a fog seal applied. The surface shall be swept to remove loose material and an asphalt emulsion shall be applied at a rate of 0.40.09 ± 0.03 gallons per square yard to the surface. Any raveled areas, flushed areas, or other defects in the scrub seal shall be repaired by the Contractor prior to the application of the fog seal.

405.12-PROTECTION OF PAVEMENT AND TRAFFIC CONTROL:
The Contractor shall be responsible for the protection of the surface against damage by their equipment and personnel. Traffic shall not be permitted on any part of the work under construction until the treatment has cured sufficiently to prevent raveling or pickup under traffic. The Contractor shall be liable for any damage and cost to repair. The applicable provisions of 636 shall apply for regulating traffic.

405.13-SEQUENCE OF OPERATIONS AND QUANTITIES OF MATERIALS:
The quantities and kinds of materials to be used and the sequence of applications and operations for the various treatments shall in accordance with Section 405.7 and 405.8. The quantities shown are the rates per square yard (meter).

Maximum quantities of asphalt material shall be used only when the old surface is open or porous. The rates of aggregate and asphalt material may be adjusted by the engineer when in the opinion of the Engineer adequate coverage is not being obtained.

405.14-QUALITY CONTROL TESTING:
Quality control is the responsibility of the Contractor, as specified in 106.1.

405.14.1-Quality Control Plan: No less than 14 calendar days before beginning work the Contractor shall develop and submit a quality control plan in accordance with applicable section of MP307.00.50, excluding the attached page, detailing the methods by which the quality control program will be conducted. The quality control plan must be approved by the Engineer prior to the commencement of the work. Samples will be obtained at a minimum frequency of one sample per day of aggregate placement.

405.14.2-Acceptance Testing: Acceptance sampling and testing of aggregates is the responsibility of the Division, except for furnishing the necessary materials. Quality control sampling and testing performed by the Contractor may not be used by the acceptance.

405.14.3-Acceptance for the Grading of Coarse Aggregate: Acceptance for gradation shall be on the basis of test results on consecutive random samples from a lot. A lot shall be
considered the quantity of material represented by an average test value, not to exceed five sublots. Generally at the beginning of the project, the average shall be started on the second sample in accordance with MP 300.00.51. A sublot is the quantity of material represented by a single gradation test. In the case where only one sample is taken, this sublot shall be considered the lot. The material shall be sampled and tested in accordance with the applicable specification. The gradation test results shall be plotted on a control chart in accordance with MP 300.00.51. When the average, or when the most recent three consecutive individual test values fall outside the limits of Table 703.4 the lot of material represented will be considered nonconforming to the extent that the last of its sublots is nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 405.14.3.2. In the case where the average is nonconforming and the last sublot contained is conforming, then there would be no price adjustment. In no event, however, shall a sublot of material have its price adjusted more than once, and the first adjustment, which is determined, shall apply.

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405.14.3.1 Degree of Nonconformance: When a sublot of material is to have its price adjusted, the percentage point difference between the nonconforming test value and the specification limit shall be determined for each sieve size determined to be nonconforming and this value shall be multiplied by its appropriate multiplication factor as set forth in Table 405.14.3.1 to determine the degree of nonconformance on that sieve.

**TABLE 405.14.3.1**

<table>
<thead>
<tr>
<th>Nonconforming Sieve Size</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in (100mm) to No 16 (1.18mm)</td>
<td>1.0</td>
</tr>
<tr>
<td>No 40 (4.25µm) to No 50 (300µm)</td>
<td>2.0</td>
</tr>
<tr>
<td>No 100 (150µm)</td>
<td>3.0</td>
</tr>
<tr>
<td>No 200 (75µm)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

The total measure of nonconformance of an individual sublot is the sum of all nonconformances on the various sieve sizes of that sublot. When the total degree of nonconformance has been established and it is 12.0 or less, the material will be paid for at an adjusted contract price as specified in Table 405.14.3.2. When the degree of nonconformance is greater than 12.0, the nonconforming sublot shall be resolved on an individual basis, requiring a special investigation by the Engineer to determine the appropriate course of action to be followed.

If the degree of nonconformance exceeds 8.0 then the contractor shall cease operations and review material and the quality control procedure to come in compliance with these specifications.

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405.14.3.2 Price Adjustment: Aggregates not conforming with the gradation requirements will be paid for at the adjusted aggregate contract price based on the degree of nonconformance as specified in Table 405.14.3.2.

**TABLE 405.14.3.2**

Adjustment of Contract Price for Gradation not Within Specifications
<table>
<thead>
<tr>
<th>Degree of Nonconformance</th>
<th>Percent of Contract Price to be Reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 to 3.0</td>
<td>2</td>
</tr>
<tr>
<td>3.1 to 5.0</td>
<td>4</td>
</tr>
<tr>
<td>5.1 to 8.0</td>
<td>7</td>
</tr>
<tr>
<td>8.1 to 12.0</td>
<td>11</td>
</tr>
<tr>
<td>Greater than 12</td>
<td>*</td>
</tr>
</tbody>
</table>

* The Division will make a special evaluation of the material and determine the appropriate action. Pending resolution of the matter, additional lifts of treatment or pavement shall not be placed over the nonconforming material.

**405.14.1-Quality Control Testing:** Quality Control is the responsibility of the Contractor, as specified in 106.1. The contractor shall design and submit a quality control plan in accordance with applicable section of MP307.00.50 detailing the methods by which the quality control program will be conducted.

**405.14.2-Acceptance Testing:** Acceptance sampling and testing is the responsibility of the Division. Acceptance for aggregate will be based on the uniformity of the aggregate and the dust content. Samples shall be taken from the conveyor belt of the aggregate spreader, in accordance with MP 700.00.06. A sublot shall be defined as one lane mile. Fractions of a mile less than 0.5 will be included in the previous sublot, and fractions of a mile greater than 0.5 will be a separate sublot.

**405.14.2.1-Acceptance of Aggregate Uniformity:** The more uniform the material, the better performance potential of the scrub seal. Uniformity of the aggregate will be measured by the Coefficient of Uniformity, $C_u$, as defined in ASTM D2487. Adjustments per sublot will be as follows.

<table>
<thead>
<tr>
<th>$C_u$</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;1.7$</td>
<td>1% incentive per 0.1 below</td>
</tr>
<tr>
<td>1.7 – 3.0</td>
<td>No Adjustment</td>
</tr>
<tr>
<td>3.1 – 4.0</td>
<td>2% disincentive per 0.1 above</td>
</tr>
<tr>
<td>$&gt;4.1$</td>
<td>*Special evaluation to consider remove and replace</td>
</tr>
</tbody>
</table>

**405.14.2.2-Acceptance of Aggregate Dust Content:** Dust content will be determined by AASHTO T11. Adjustments per sublot will be as follows.

<table>
<thead>
<tr>
<th>% Dust</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1.0</td>
<td>2% incentive</td>
</tr>
<tr>
<td>1.1 – 2.0</td>
<td>No Adjustment</td>
</tr>
<tr>
<td>2.1 – 3.0</td>
<td>2% disincentive</td>
</tr>
<tr>
<td>3.1 – 3.5</td>
<td>5% disincentive</td>
</tr>
<tr>
<td>3.6 – 4.0</td>
<td>8% disincentive</td>
</tr>
<tr>
<td>4.1 – 4.5</td>
<td>12% disincentive</td>
</tr>
<tr>
<td>&gt;4.5</td>
<td>*Special evaluation to consider remove and replace</td>
</tr>
</tbody>
</table>

**405.15-METHOD OF MEASUREMENT:**

The quantity of “Asphalt Emulsion Material” and “Asphalt Emulsion Material, Fog Seal” shall be the number of gallons (liters) incorporated into the completed work, which volume will be measured as described in 109.1.

Scrub Seal aggregate shall be paid for by the Square Yard (Square Meter), measured by the total length of the area times the average applied width of treated area. No materials shall be removed from the Project for any purpose until the operation has been completed and the quantities of materials incorporated into the operations have been determined, except when authorized by the Engineer.

The quantities of work done will be measured as follows:

— The quantity of "Surface Treatment Aggregate" shall be measured by the ton (megagram) of material complete in place and accepted.

— The number of tons (megagrams) of "Surface Treatment Aggregate" shall be determined by the total of the weights shown on receipted delivery truck tickets.

— The quantity of "Asphalt Material" shall be the number of gallons (liters) incorporated into the completed work, which volume will be measured as prescribed in 109.1.

— There shall be no additional compensation allowed for "Cleaning and Sweeping".

— The Quantity of “Scrub Seal Treatment” when specified to be paid by the square yard shall be measured by the total length of the area the surface treatment is applied times the average applied width of the treated area. This calculation shall correspond with the quantities on the plans, ±5.0%.

**405.16-BASIS OF PAYMENT:**

The quantities, determined as provided above, will be paid for at the contract unit prices bid for the items listed below, which prices and payments shall be full compensation for furnishing all the materials and doing all the work prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, supplies, and incidentals necessary to complete the work.

— The Quantity of “Scrub Seal Treatment” when specified to be paid by the square yard shall include the cleaning and sweeping, asphalt material, aggregate and all labor and equipment required to perform the operation.
### 405.17-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>405001-*</td>
<td>Surface Treatment Scrub Seal Aggregate</td>
<td>Ton, Square Yards (Meters) (Megagram)</td>
</tr>
<tr>
<td>405012-*</td>
<td>Asphalt Emulsion Material</td>
<td>Gallon (Liter)</td>
</tr>
<tr>
<td>405013-*</td>
<td>Asphalt Emulsion Material, Fog Seal</td>
<td>Gallon (Liter)</td>
</tr>
<tr>
<td>405014-*</td>
<td>Scrub Seal (Complete In-Place)</td>
<td>Square Yards (Meters)</td>
</tr>
<tr>
<td>4050145-*</td>
<td>Scrub Seal RAP Aggregate</td>
<td>Square Yards (Meters), Ton (Megagram)</td>
</tr>
<tr>
<td>405016405015-*</td>
<td>Asphalt Rejuvenator</td>
<td>Gallon (Liter)</td>
</tr>
</tbody>
</table>

* Sequence number
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ______________________________
FEDERAL PROJECT NUMBER: ______________________________

FOR

SECTION 421
INTELLIGENT COMPACTION OF ASPHALT PAVEMENT

421.1-DESCRIPTION:
The work shall consist of providing Intelligent Compaction (IC) Rollers or IC Equipment
for Rollers used for compaction of all types of asphalt mixtures.
The unit of measurement for IC will be either by the ton (megagram) or square yard
(square meter) of asphalt mix placed.
The work will be accepted in accordance with these Specifications and the applicable
requirements of Sections 400 or 410 of the Standard Specifications.

421.2-MATERIALS:
IC is a construction methodology, no IC materials are incorporated into the completed
project.

421.3-EQUIPMENT:
In addition to the equipment specified in Subsection 401.9.9, a minimum of two (2) IC
rollers are to be used on the project at all times. These two (2) IC rollers are preferred as a
combination of the breakdown and finish rollers. The Contractor may elect to use IC on the
intermediate rollers. All IC rollers will meet the following minimum characteristics:

421.3.1: Equipped with a mounted positioning system to track the location of the roller
within the paving limits and track the number of passes of the rollers. This system may use
Real Time Kinematic (RTK-GPS), Global Navigational Satellite System (GNSS), or other
preapproved, by the Engineer, tracking units that monitor the location. Accuracy of the
positioning system is to be a minimum of 12 inches.

421.3.2: Equipped with non-contact temperature sensors for measuring pavement surface
temperatures.
421.3.3: Equipped with integrated on-board documentation systems that are capable of displaying real-time color-coded maps, which shall include the location of the roller, number of roller passes, machine settings, together with the material temperature, speed and the frequency and amplitude of roller drums. The display unit must be capable of transferring the data by means of a USB port.

421.3.4: When Intelligent Compaction Measured Value (IC-MV) is specified in the plans the output from the roller shall be designated as the Intelligent Compaction Measured Value (IC-MV) which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials. In addition to the equipment requirements of 421.3 the following apply.

421.3.4.1: Rollers shall be equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compactive effort. The IC rollers must have the approval of the Engineer prior to use.

421.3.4.2: The integrated on-board display must also show real-time stiffness response values.

421.3.4.3: The output from the on-board documentation system must be compatible with standardized data analysis software, Veta, which is available free online. [www.intelligentcompaction.com/veta](http://www.intelligentcompaction.com/veta)

421.4-WORK PLAN:
The Contractor shall submit to the Engineer an IC Work Plan at the Preconstruction Conference and at least 2 weeks prior to the beginning construction. Describe in the work plan the following:

1. Compaction equipment to be used including:
   a. Equipment Vendor(s)
   b. Roller model(s),
   c. Roller dimensions and weights,
   d. Description of IC measurement system,
   e. Position tracking capabilities,
   f. Documentation system,
   g. Temperature measurement system, and
   h. Software.

2. Roller data collection methods including sampling rates and intervals and data file types.
3. Transfer of data to the Engineer including method, timing, and personnel responsible. Data transfer shall occur at minimum twice per day or as otherwise directed by the Engineer. Data transfer is to be either electronic or digital.
4. Training plan and schedule for roller operators, project foreman, project surveyors, and Division personnel; including both classroom and field training. Training should be conducted at least 1 week before beginning IC construction. The training is to be performed by a qualified representative(s) from the IC Roller manufacturer(s) to be used on the project.
421.5-CONSTRUCTION:
Work shall not begin until the Engineer has approved, in writing, the IC submittals and the IC equipment.
The Contractor shall follow the requirements established in Section 400 or 410 for materials, equipment, acceptance plans, production, placement, and adjustments; except as noted or modified in this Specification. The Contractor shall provide the Engineer at least one day’s notice prior to beginning construction or prior to resuming production if operations have been temporarily suspended. Ensure paving equipment complies with all requirements specified in Section 400 or 410. The IC roller temperatures will be verified by the Division.

421.5.1-Pre-Construction Test Section(s) Requirements: Test methods shall be those listed in Section 401.5.1.
1. Prior to the start of production, ensure the proper setup of the GPS, IC roller(s) and the rover(s) by conducting joint GPS correlation and verification testing between the Contractor, GPS representative and IC roller manufacturer using the same datum. (Note: If non-GPS tracking is used, verify locations with survey grade control points.)
2. Compare coordinates between the roller and rover receivers. If the coordinates are within 12.0 in. of each other, the comparison is acceptable. If the coordinates are not within 12.0 in., diagnose and perform necessary corrections and repeat the above steps until verification is acceptable.
3. Do not begin paving until acceptable GPS correlation and verification has been obtained.
4. The Contractor and the Department should conduct random location verification testing during production to ensure data locations are accurate. The recommended rate is once per day.
5. All acceptance testing shall be as outlined in the applicable Section 400 or 410 Specification.

421.6-CONTRACTORS QUALITY CONTROL:
421.6.1-Quality Control Testing: Quality control of asphalt pavement is the responsibility of the Contractor.

421.6.2-Response to Test Results: The response to quality control tests for the test sections and during production compaction shall follow the Quality Control plan and include as a minimum the following:
1. Temperature. Follow the procedure outlined for corrective action when the QC or IC temperature readings are not within the recommended laydown values for the mixtures.
2. Density/Compaction. Follow the procedure outlined for corrective action when the maximum specific density (Gmm) results fall below 92.0%.
3. IC Coverage Area and Uniformity Criteria. Follow the procedures outlined when the IC criteria for coverage or the minimum IC-MV targets criteria are not being met.

421.6.3-Pre-Mapping: Pre-paving mapping (pre-mapping) with an IC roller of the existing support materials is recommended prior to tacking operations, in order to identify weak areas. The pre-mapping may be part of the test section evaluation of the project.
1. Pre-mapping is recommended on underlying materials such as soils subgrade, aggregate bases, rubblized concrete, or similar.
2. Mapping is not recommended on stabilized base, milled/non-milled existing asphalt pavements, concrete pavements, or similar underlying hard surfaces.

**421.7 through 421.11: Blank**

**421.12-METHOD OF MEASUREMENT:**

The Division will measure the total tons or square yards of asphalt mixtures compacted using the IC rollers. Compaction is to be performed by a minimum of two IC rollers, material compacted by rollers not equipped with properly functioning IC equipment will not be accepted for payment of the bid item asphalt mixtures IC rolled. Use of non-IC rollers can be accepted on small areas due to equipment malfunctions with the written approval of the Engineer. Paving operations should be suspended for equipment malfunctions that will extend over multiple days of operation.

**421.13-BASIS OF PAYMENT:**

The Division will make payment for the completed and accepted quantities under the following:

1. Payment is full compensation for all work associated with providing IC equipped rollers, transmission of electronic data files, two copies of IC roller manufacturer software, and training.
2. Delays due to IC equipment malfunction (ie. loss of GPS satellite reception of signals, digital communication errors, or IC roller breakdowns) will not only be considered justification for contract modifications or contract extensions at the discretion of the Engineer.

**421.14-PAY ITEMS:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>421001-001</td>
<td>Intelligent Compaction For Asphalt Pavement,</td>
<td>Ton (MG)</td>
</tr>
<tr>
<td>421001-002</td>
<td>Intelligent Compaction For Asphalt Pavement,</td>
<td>Square Yard (SY)</td>
</tr>
<tr>
<td>421001-003</td>
<td>Intelligent Compaction For Asphalt Pavement,</td>
<td>Lump Sum (LS)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 405
SURFACE TREATMENTS

DELETE THE ENTIRE CONTENTS AND REPLACE THE FOLLOWING:

SECTION 405
CHIP SEALS

405.1-DESCRIPTION:

This work shall consist of the construction of a wearing course, composed of asphalt emulsion immediately followed by a single layer of aggregate, in one or more applications, followed by a fog seal. The type of Chip Seal will be indicated on the Plans.

The contractor shall notify the Engineer a minimum of two weeks prior to starting any Chip Seal operation. In addition, the contractor shall submit proposed sources of all materials.

405.2-MATERIALS:

405.2.1-Aggregate: The aggregate shall be from an WVDOT approved source and shall conform to the requirements of the Standard Specifications Section 703.1-4. It is expected that the aggregate will be washed to reduce dust content. The aggregates shall be crushed with a minimum of 80% two face fracture. Aggregates shall meet the following gradations when specified in section 405.12:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Maximum Size</td>
<td>1/2 in (12.5 mm)</td>
<td>3/8 in (9.5 mm)</td>
<td>No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>1 in (25 mm)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3/4 in (19 mm)</td>
<td>100</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1/2 in (12.5 mm)</td>
<td>90-100</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>3/8 in (9.5 mm)</td>
<td>5-30</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0-10</td>
<td>5-30</td>
<td>90-100</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>–</td>
<td>0-10</td>
<td>5-30</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>0-2</td>
<td>–</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 30 (600 µm)</td>
<td>–</td>
<td>0-2</td>
<td>–</td>
</tr>
<tr>
<td>No. 50 (300 µm)</td>
<td>–</td>
<td>–</td>
<td>0-2</td>
</tr>
<tr>
<td>No. 200 (75 µm)</td>
<td>0-2</td>
<td>0-2</td>
<td>0-2</td>
</tr>
</tbody>
</table>
405.2.2-Asphalt Emulsion: The asphalt emulsion for Chip Seals and the emulsion for the fog seal shall be from an approved source and shall meet the requirements of the Section 705.

405.3-WEATHER RESTRICTIONS:
Chip Seal shall be constructed only when the condition of the existing surface is satisfactory to the Engineer, when the temperature of the existing pavement is 50° F (10° C) or above, and when other weather conditions are satisfactory for construction. The temperature may be waived but only when approved by the Engineer. No Chip Seal shall be performed between October 1 and May 1.
Chip Seal operations shall be suspended immediately when rain begins or when the Engineer determines that a rain event is imminent.

405.4-EQUIPMENT:
Equipment shall include equipment for emulsion distribution, aggregate spreading, compaction, and sweeping before and after application. Equipment shall also include scrapers, hand brooms, shovels, and other items as may be necessary to thoroughly clean the existing surface.

405.4.1-Emulsion Distributor: The distributor shall be so designed, equipped, maintained and operated that asphalt material may be applied uniformly on variable widths up to 16 ft. (4.6 m) at readily determined and controlled rates from 0.05 to 2.0 gal. per sq. yd. (0.22 to 9.3 liters sq. m) with uniform pressure and with an allowable variation from any specified rate not to exceed 0.02 gal. per sq. yd. (0.09 liter sq. m).
The distributor shall also have a cab-metering system that will automatically adjust the flow of the asphalt material as the speed of the truck changes and allow the operator to adjust the rate of application from the cab of the truck.
Distributor equipment shall include a tachometer, pressure gages, and a thermometer for measuring temperatures of tank contents.
Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. A manifold connection shall be provided and hand spraying equipment shall be available to cover areas and patches inaccessible to the distributor.
Verification of distributor truck calibration within the past 12 months shall be available on the project site, preferably located within the cab of the truck.

405.4.2-Aggregate Spreader: The aggregate spreader shall be self-propelled with front discharge capable of adjusting to evenly and accurately distribute at the required placement rates.

405.4.3-Compaction Equipment: A minimum of two self-propelled pneumatic tire rollers shall be used, at a minimum of 12 tons each. Roller tires shall have a minimum pressure of 60 psi.

405.4.4-Sweepers: Power sweepers, pickup sweepers, or rotary brooms shall be used for surface preparation as well as removing any loose aggregate after compaction. Steel bristles shall not be used on the Chip Seal after compaction.
405.5-PREPARING AND REPAIRING EXISTING SURFACE:

No chip seal shall be applied until breaks, holes, depressions, and other irregularities in the existing surface have been repaired and cured sufficiently to permit the asphalt material to be placed in a uniform application. Patching and leveling material shall be plant mixed. Hand patching will be permitted where necessary. Remove all existing thermoplastic markings and raised pavement markers. Protect any drains or other utility covers. Apply a light fog seal to asphalt patched surfaces less than 2 months old, using an asphalt emulsion that is compatible with the emulsion being used for the chip seal.

405.6-CLEANING AND SWEEPING:

Immediately prior to construction, the existing surface shall be swept and thoroughly cleaned to remove all mud, dirt, dust, vegetation, and other caked or loose foreign material. Cleaning shall be done to a minimum width of one foot on each side beyond the width of the surface to be placed excluding the shoulder. Materials collected in the cleaning operation shall be removed and disposed of as directed.

405.7-APPLICATION OF ASPHALT MATERIAL:

After the existing surface has been cleaned, and is in a dry condition, the asphalt material shall be applied by means of a pressure distributor. The spray bar shall be raised to a sufficient height so as to uniformly and completely coat the entire surface. The rate of application of asphalt material shall be in accordance with section 405.12, or as modified by the plans. Application temperatures of the asphalt material shall be within the range specified in Subsection 705 for the particular material being used, or as documented by the manufacturer.

Except when required to maintain traffic, Chip Seal operations shall be done upon the full width of the section.

After application, asphalt material shall completely and uniformly cover the underlying pavement and be free of streaks, voids, and puddles.

405.8-APPLICATION OF AGGREGATE:

Immediately following each application of asphalt material, aggregate at the rate or rates called for in 405.12 shall be spread with the spreader in such a manner that the entire area being treated is uniformly covered. No traffic, construction or otherwise, shall be allowed on the asphalt material before placing aggregate. Additional aggregate shall be spread if necessary, and hand spreading shall be done to cover areas inaccessible to the spreading equipment. The aggregate shall be dried or moistened as required in order to obtain a near Surface Saturated Dry condition.

If the process must stop during that application any asphalt material that has been applied to the surface shall be covered with aggregate to prevent breaking of the emulsion prior to embedment of the aggregate.

405.9-ROLLING AND SWEEPING:

Immediately following spreading of the aggregate, the entire surface of the aggregate shall be rolled until the aggregate is keyed into the asphalt material. Any area that ravelles shall be repaired and rerolled. Rolling shall be parallel to the centerline and shall begin at the edges of the treatment and progress toward the center, each trip uniformly overlapping the preceding trip. There shall be at least three passes made with a pneumatic tire roller.

Rolling shall cease before the aggregate is crushed to any appreciable extent. Rollers shall be the type and weight specified in 405.4.3. To ensure aggregate embedment before the emulsion
has set, the minimum number of rollers shall be two (2). More rollers may be used to obtain compaction to the satisfaction of the Engineer.

The roller speed shall not exceed 10 miles per hour to prevent aggregate pick up and ensure embedment. Water, to prevent adhesion of the asphalt material to the roller wheels, shall not be used in excessive amounts. The use of fuel oil, paraffin oil, and kerosene on rollers or other equipment, for the purpose of preventing material from picking up or sticking, is prohibited.

After the emulsion has cured, sweeping can commence. The status of being cured shall be determined by the ability to sweep all loose aggregate from the surface without removing any aggregate adhered to the asphalt emulsion.

405.10-JOINTS:

The longitudinal construction joints between adjacent lanes shall be kept clean of material foreign to the surface being treated. The joints shall be constructed without overlaps or gaps between the materials.

The beginning of the project and all transverse joints shall be covered with paper to prevent overlapping of the seal and provided a uniform joint. Following its use, the paper shall be removed and disposed of satisfactorily.

405.11-PROTECTION OF PAVEMENT AND TRAFFIC CONTROL:

The Contractor shall be responsible for the protection of the surface against damage by their equipment and personnel. Traffic shall not be permitted on any part of the work under construction until sweeping has been completed. The applicable provisions of 636 shall apply for regulating traffic.

405.12-SEQUENCE OF OPERATIONS AND QUANTITIES OF MATERIALS:

The quantities and kinds of materials to be used and the sequence of applications and operations for the various treatments shall be as follows. Maximum quantities of asphalt emulsion may be used only when the old surface is open or porous. Sweep each layer when applying multiple layers. The rates of aggregate and asphalt emulsion may be adjusted by the Engineer. The contractor may suggest different application rates to the Engineer for consideration by submitting a project specific Chip Seal design based on McLeod or Modified Kearby Design Methods.

<table>
<thead>
<tr>
<th>Type</th>
<th>Layer</th>
<th>Asphalt Emulsion (gal/SY)</th>
<th>Aggregate (lb/SY)</th>
<th>Gradation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>First</td>
<td>0.15 to 0.25</td>
<td>8 to 10</td>
<td>C</td>
</tr>
<tr>
<td>Single</td>
<td>First</td>
<td>0.25 to 0.40</td>
<td>15 to 25</td>
<td>B</td>
</tr>
<tr>
<td>Double</td>
<td>First</td>
<td>0.25 to 0.40</td>
<td>25 to 35</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>0.25 to 0.35</td>
<td>10 to 20</td>
<td>C</td>
</tr>
<tr>
<td>Triple</td>
<td>First</td>
<td>0.30 to 0.50</td>
<td>25 to 45</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>0.30 to 0.50</td>
<td>25 to 35</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Third</td>
<td>0.25 to 0.35</td>
<td>10 to 20</td>
<td>C</td>
</tr>
</tbody>
</table>
405.13-FOG SEAL:

Unless otherwise specified, a fog seal shall be applied on the final surface. This shall be done no less than 3 but no more than 7 calendar days after the application of the Chip Seal. The surface must be dry before application, and the surface shall be swept to remove loose material. An asphalt emulsion shall be applied uniformly at a rate of 0.09 ± 0.03 gallons per square yard to the surface. Any raveled areas, flushed areas, or other defects in the chip seal shall be repaired prior to the application of the fog seal.

405.14-TESTING AND ACCEPTANCE:

405.14.1-Quality Control Testing: Quality Control is the responsibility of the Contractor, as specified in 106.1. The contractor shall design and submit a quality control plan in accordance with applicable section of MP307.00.50 detailing the methods by which the quality control program will be conducted.

405.14.2-Acceptance Testing: Acceptance sampling and testing is the responsibility of the Division. Acceptance for aggregate will be based on the uniformity of the aggregate and the dust content. Samples shall be taken from the conveyor belt of the aggregate spreader, in accordance with MP 700.00.06. A sublot shall be defined as one lane mile. Fractions of a mile less than 0.5 will be included in the previous sublot, and fractions of a mile greater than 0.5 will be a separate sublot.

405.14.2.1-Acceptance of Aggregate Uniformity: The more uniform the material, the better performance potential of the chip seal. Uniformity of the aggregate will be measured by the Coefficient of Uniformity, C_u, as defined in ASTM D2487. Adjustments per sublot will be as follows.

<table>
<thead>
<tr>
<th>Cu</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.7</td>
<td>1% incentive per 0.1 below</td>
</tr>
<tr>
<td>1.7 – 3.0</td>
<td>No Adjustment</td>
</tr>
<tr>
<td>3.1 – 4.0</td>
<td>2% disincentive per 0.1 above</td>
</tr>
<tr>
<td>&gt;4.1</td>
<td>*Special evaluation to consider remove and replace</td>
</tr>
</tbody>
</table>

Table 405.13.2.1
Adjustment Of Contract Item Price For Aggregate Uniformity
405.14.2.2-Acceptance of Aggregate Dust Content: Dust content will be determined by AASHTO T11. Adjustments per subplot will be as follows.

<table>
<thead>
<tr>
<th>% Dust</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1.0</td>
<td>2% incentive</td>
</tr>
<tr>
<td>1.1 – 2.0</td>
<td>No Adjustment</td>
</tr>
<tr>
<td>2.1 – 3.0</td>
<td>2% disincentive</td>
</tr>
<tr>
<td>3.1 – 3.5</td>
<td>5% disincentive</td>
</tr>
<tr>
<td>3.6 – 4.0</td>
<td>8% disincentive</td>
</tr>
<tr>
<td>4.1 – 4.5</td>
<td>12% disincentive</td>
</tr>
<tr>
<td>&gt;4.5</td>
<td>*Special evaluation to consider remove and replace</td>
</tr>
</tbody>
</table>

405.15-METHOD OF MEASUREMENT:

The quantity of “Asphalt Emulsion Material” and “Asphalt Emulsion Material, Fog Seal” shall be the number of gallons (liters) incorporated into the completed work, which volume will be measured as described in 109.1.

Chip Seal aggregate shall be paid for by the Square Yard (Square Meter), measured by the total length of the area times the average applied width of treated area.

405.16-BASIS OF PAYMENT:

The quantities, determined as provided above, will be paid for at the contract unit prices bid for the items listed below, which prices and payments shall be full compensation for furnishing all the materials and doing all the work prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, supplies, and incidentals necessary to complete the work.

405.17-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>405007-*</td>
<td>Chip Seal Aggregate, Type **</td>
<td>Square Yards (Square Meters)</td>
</tr>
<tr>
<td>405010-*</td>
<td>Asphalt Emulsion Material</td>
<td>Gallon (Liter)</td>
</tr>
<tr>
<td>405011-*</td>
<td>Asphalt Emulsion Material, Fog Seal</td>
<td>Gallon (Liter)</td>
</tr>
</tbody>
</table>

* Sequence number
** Type of Aggregate Gradation from Section 405.2.1, either A, B, or C
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 679
OVERLAYING OF PORTLAND CEMENT

679.3-CONSTRUCTION METHODS:

679.3.7-Placing and Finishing Specialized Concrete Overlay:

DELETE SUBSECTION 679.3.7.1 AND REPLACE THE FOLLOWING.

679.3.7.1-General: The following requirements shall apply for specialized concrete overlay placements:

a) The overlay thickness shall be determined in accordance with Section 679.3. The Contractor shall restore the concrete overlay in a uniform manner to match existing grade unless otherwise directed by the Engineer. Under no circumstance, the overlay thickness shall not be less than 1 ¼ inches.

b) The prepared surface of the structural slab shall be protected from contamination by any source and shall be in a saturated surface dry condition immediately prior to concrete placement.

c) Concrete may be mixed at the point of deposition.

d) When placing Specialized Concrete Overlays on a newly placed deck, the deck concrete shall be a minimum of 28 days old. The sidewalks, parapets, or curbs shall be a minimum of 7 days old.

679.5-FINAL BRIDGE DECK FINISH:

679.5.1-Straightedge Test:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE THE FOLLOWING:

679.5.1-Straightedge Test: After defective or damaged concrete has been repaired and cured in accordance with 679.4.9 and before opening to traffic, the bridge deck shall be grooved as set forth in 679.5.2. Prior to grooving, the entire deck shall be checked by the Contractor in the presence of the Engineer with an approved rolling straightedge as outlined in section 601.11.4.
679.5.2-Finished Deck Grooving:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE THE FOLLOWING:

679.5.2-Finished Deck Grooving:

679.5.2.1-Transverse Grooving: After corrective grinding and before opening to traffic, grooves shall be cut into the concrete using a mechanical saw. These grooves shall be 0.10 inch (2.5 mm) wide and 0.25 inch (6 mm) deep. Groove spacing shall be 1.5 inches (37 mm) center to center. No later than one week prior to grooving operations, the Contractor shall provide the Engineer with two accurate, easily readable gauges with which to verify groove dimensions. Groove depth and spacing tolerances are limited to ±1/16 inch (1.5 mm). Groove width tolerances are +0.02 inch (0.5 mm) and -0.0 inch (0 mm). Grooves shall be cut continuously across the deck to within 1 ft. (300 mm) of gutter lines or drainage structures. Grooves shall also be continuous across the full width of the deck surface including construction joints. Grooves shall terminate within 1 in. (25 mm) of any exposed metal component or elastomeric concrete of an expansion joint. When the deck is skewed and the contractor is using gang blades to saw the grooves, the maximum distance (measured perpendicular to the centerline of the expansion joint) from the last groove termination in the pass to the expansion joint shall be 1 ft., 8 inches (200 mm). Radial grooving shall be performed in increments limited to 12 ft. (3.6 m) of bridge length.

679.5.2.2-Longitudinal Grooving: Use diamond blades mounted on a multi-blade arbor on self-propelled machines that were built for grooving of concrete surfaces. The groove machines shall have depth control devices that detect variations in the pavement surface and adjust the cutting head height to maintain the specified depth of the groove. The grooving machines shall have devices to control alignment. Do not use flailing or impact type grooving equipment. More than one size grooving machine may be required in order to saw the grooves as specified.

Provide an experienced technician to supervise the location, alignment, layout, dimension, and grooving of the surface.

Saw grooves parallel to the bridge centerline in a continuous pattern across the surface. Begin and end sawing 9 to 12 inches (220 to 300 mm) from any device in place in a bridge deck, such as scuppers or expansion joints. Stop sawing a minimum of 2 inches (50 mm) to a maximum of 24 inches (600 mm) from skewed expansion joints. Maintain a clearance of a minimum of 2 inches (50 mm) and a maximum of 4 inches (100 mm) from the grooves to longitudinal joints in the deck. Maintain a minimum clearance of 9 inches (220 mm) to a maximum of 30 inches (750 mm) clearance between the grooves and the curb or parapet toe. However, at no point shall un-grooved portions of deck extend beyond edge line and into the temporary or permanent traveled lanes. Saw grooves in a uniform pattern spaced at 3/4 inch minus 1/4 inch or plus 0 inches (19 mm minus 6 mm or plus 0 mm). Saw grooves 0.15 inches (4 mm) deep and 0.10 inches (3 mm) wide. Groove tolerances for depth are +0.0625 inches (2 mm) and minus 0 inches (0 mm). Groove tolerances for width are +0.02 inches (0.5 mm) and minus 0 inches (0 mm).

For staged, or phased bridge deck work, saw the grooves parallel to the final, permanent bridge centerline. If the different stages or phases of the bridge deck work occur within one construction season, any stage opened to traffic shall receive an interim coarse broom finish during placement, then saw the longitudinal grooves after the final stage. The interim
broom finish will not be allowed as a surface texture when opened to traffic over a winter season. Saw longitudinal grooves in the deck prior to opening to traffic for a winter season.

For bridge decks that widen from one end to the other, saw the longitudinal grooves parallel to the centerline of the roadway. On the side of the bridge that widens, saw the longitudinal grooves to follow the edge line. Saw longitudinal grooves in the gore areas, avoiding the overlapping of grooves.

At the beginning of each work shift, furnish a full complement of grooving blades with each saw that are capable of cutting grooves of the specified width, depth, and spacing.

If during the work, a single grooving blade on a machine becomes incapable of cutting a groove, continue work for the remainder of the work shift. The Contractor is not required to cut the groove omitted because of the failed blade. Should two or more grooving blades on a machine become incapable of cutting grooves, cease operating the machine until it is repaired.

Continuously remove all slurry and remaining residue from the grooving operation and leave the deck surface in a clean condition. Prevent residue from grooving operations from flowing across shoulders or across lanes occupied by public traffic or from flowing into gutters or other drainage facilities. Remove solid residue before the residue is blown by passing traffic or by wind.

Provide water as necessary to saw grooves according to this subsection.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: __________________________

FOR

SECTION 668
CCTV- (CLOSED CIRCUIT TELEVISION)

668.1-DESCRIPTION:

Functional Requirements-The primary function of the CCTV system is to verify nonstandard conditions detected by the system, surveillance of major construction projects, events, or other reported information from an external source. Images from CCTV cameras will be displayed at operator workstations within the WVDOH Transportation Management Center (TMC) via the ATMS (Advanced Traffic Management System) platform, the CCTV output is required to be displayed on a limited number of peripheral systems as designated by the ITS Coordinator. The Contractor is responsible for integration of the CCTV communication to the WVDOH Transportation Management Center’s (TMC) working with the ATMS platform provider, or their designee.

Closed Circuit Television (CCTV) camera installation Contractor requirements:
1. General electrical work as a prime or as a subcontractor – five (5) years.
2. Communications, including radio, wire and wireless - one (1) year.

All electrical work shall conform to current requirements of the National Electrical Code, latest edition, all local codes and Section 631 of the Standard Specifications.

All details not specified or not shown on the Plans shall conform to the requirements of the latest issue of the Manual on Uniform Traffic Control Devices, (referred to as the MUTCD). This Manual is published by the Federal Highway Administration of the U.S. Department of Transportation and supplemented by the publication "Official Ruling on Request" and the West Virginia Division of Highways Traffic Engineering Division Directives.

668.2-MATERIALS:

The CCTV shall be IP addressable, using a H.264 Video Encoder, or approved equal. The CCTV Unit must provide a pressurized housing that incorporates a high-definition, pan/tilt positioner that is sealed from the environment. The environmental constraints are as described
below, however, in addition to these restraints the camera unit shall be sealed from rain, dust, dirt, and other undesirable contaminants. The pan/tilt assembly shall be environmentally sealed but not pressurized. The entire camera unit shall have been tested and passed a water immersion test according to IEC 60529 section 14.2.7 using an immersion depth of 1 meter measured at the bottom of the camera and a test duration of 30 minutes. All components of the camera shall have an IP67 rating.

The CCTV shall provide a color output, while converting to monochrome output in lowlight conditions as desired. System software shall be provided by the manufacturer that will control the camera functions as described (camera DSP functions, lens functions, positioner pan/tilt functions). The manufacturer or manufacturer’s representative shall be on-site for each camera field set-up.

(a) Camera Control – The CCTV camera shall fully support panning, tilting, and zooming. The camera must be able to be reset through the vendor software, while also being able to exercise iris and focus controls.

(b) Preset Scenes – The CCTV camera must be able to store presets. The scene shall comprise camera position (pan and tilt), zoom, focus, and/or controller selection options. Each preset scene should allow an associated text phrase. The contractor will work with the ATMS provider to establish an initial set of preset scenes for each camera.

**668.3-SYSTEM COMPATIBILITY:**

The Contractor shall be responsible for coordinating with WVDOH’s ITS Coordinator to ensure equipment capability with regard to components and communication.

**668.4-COMMUNICATIONS:**

CCTV camera(s) shall communicate through the CCTV manufacturer’s system software over a wireless network (cellular HSPDA - High Speed Packet Data Access). The Contractor shall be responsible for furnishing and installing all conduits, junction boxes and communication cables install on West Virginia right-of-way as specified within the plans. The Contractor shall be responsible for the installation and correct operation of all communications systems from the switch located in the field cabinet to the field device. Testing of the Contractor’s work will be performed by the ITS coordinator or their designee both locally and remotely to ensure proper configuration and integration into the ATMS platform Wireless communications shall employ a cellular modem that incorporates ATTHSPDA (High Speed Packet Data Access) communications system.

**668.5-EQUIPMENT AND MATERIALS:**

All equipment and materials shall be new. All equipment shall be the latest model and shall contain the latest firmware unless it can be shown that an earlier version is required for compatibility with existing WVDOH communication protocols.

**668.5.1-Cabinet:** The cabinet/enclosure shall be a NEMA 4X stainless steel enclosure. The cabinet/enclosure shall have a continuously hinged door on one side, and shall be provided with a standard, #2 keyed brass lock. The enclosure shall be sized by the contractor that will provide ample space for all electrical connections, bus bar, surge protection, cellular
modem/antennae, H.264 encoder, and all other functional equipment pertinent to the operation of the CCTV.

**668.5.2-Cable:** The Contractor shall provide a separate power conductor from the nearest power control station or other pertinent power service as approved by the Engineer. Any conductor deriving power from a light source shall utilize a separate conductor to bypass any photocell control.

(a) The Contractor shall size this conductor so that there is less than a 5% power loss from the control station to the CCTV.

(b) The CCTV power conductor shall be distinctive from all other conductors within the existing raceway(s).

**668.5.3-Grounding** Unless otherwise specified, ground wiring shall be solid bare copper #4 AWG and securely connected inside enclosures with #4 AWG copper clamp connectors. Nuts and washer securing the wire are not acceptable. All grounding shall meet the National Electric Code. Ground wires shall be exothermically welded to the ground rods. Ground rod clamps are not acceptable. The following devices shall be grounded:

(a) Cabinet

(b) Camera system

(c) Communications

The resistance to ground shall be less than 10 Ohms as measured with a ground resistance meter or equivalent.

**668.6-WARRANTY:**

The Contractor shall provide an equipment list containing the following information:

(a) Type of equipment

(b) Field location

(c) Make

(d) Model

(e) Serial Number

(f) Date of Purchase

(g) Manufacturer’s contact information

(h) Equipment vendor contact information if different

(i) Date of installation

(j) Date warranty expires

The Contractor shall provide a copy of all equipment warranty information to the WVDOH ITS Coordinator. The Contractor shall, if necessary to satisfy the manufacturer’s warranty requirements, ship and receive defective equipment still under warranty on behalf of the WVDOH. The cost for this service shall be incidental to the cost of the equipment. The WVDOH shall receive a minimum two (2) year warranty for all CCTV components on receipt or employment of device(s).

**668.7-ASSEMBLY:**

The Contractor shall provide a CCTV Assembly at the site(s) shown on the plan. The CCTV Assembly shall be from the WVDOH Approved Product List (APL), or approved equal.
The Contractor shall obtain approval from the ITS Coordinator prior to the WVDOH Preconstruction Meeting. Proposed alternates shall be commercially available, as well as the attendant system software. The Contractor shall identify to the WVDOH Traffic Engineering Division (TED) an installed site where the proposed CCTV Assembly has been operating at least one-year in a similar climate region. A dedicated manufacturer’s representative, as well as the ITS Coordinator or their designee shall be present when installing the CCTV.

668.7.1-Product Description: The video Camera Positioning System shall provide dual mode, day (color) and night (monochrome) video camera with optical zoom lens and a high-speed positioning system. The lens has a focal length of 3.4mm to 119mm (35:1) with auto/manual focus. A digital zoom range of up to 12X provides an effective zoom ratio of 350:1. The effective focal length is 3.4mm to 1190mm. The ¼” format Progressive Scan CCD image sensor and lens combination results in an effective horizontal angle of view of 55.8° wide angle to 1.7° max. telephoto. The camera shall provide Wide Dynamic Range (WDR) by use of dual shutter exposure technique. In addition, the camera shall be provided with electronic stabilization using the two-motion-frequency selectable stabilization method. The pan function shall provide 360° of continuous rotation, with a variable speed from 0.0003° per second to 100° per second. The tilt function shall provide 360° of continuous movement, (0° to 360°) with a variable speed from 0.0003° per second to 100° per second. Up to 64 presets shall be available for storing and recalling zoom, pan and tilt positions. The CCTV positioner shall be capable 8 or 16-point compass annotation with primary direction spelled out and intermediate directions abbreviated with two letters and a tour sequence defined using up to 64 preset positions. Must include a compass calibration device, or be calibrated prior to testing. All camera and pan & tilt functions are operable via RS-422 serial communications. Communications protocol command set shall be public domain.

668.7.2-Features:
(a) ¼” Progressive Scan Color Sensor  
(b) Horizontal Resolution of 540 TV Lines  
(c) 35:1 (33.4m to 119m) optical zoom lens  
(d) Continuous digital zoom with selectable range from OFF to 12X  
(e) Effective overall focal length from 3.4 to 1190mm  
(f) Electronic Image Stabilization  
(g) Auto/Manual Focus  
(h) Selectable shutter speeds from ½ second to 1/30,000 second  
(i) Composite video output; NTSC format  
(j) Adjustable color balance  
(k) Crystal or Internal phase adjust line-lock, software adjustable  
(l) Programmable on screen character generator  
(m) Wide Dynamic Range (WDR) by use of dual shutter exposure technique  
(n) RS-422 serial control protocol command set to be public domain.  
(o) Camera Addressing via serial control  
(p) 8 or 16-point compass annotation  
(q) 4” diameter Sealed Enclosure Pressurized with dry nitrogen  
(r) Continuous rotation capability in either direction  
(s) Variable pan speed from 0.0003°/sec to 100°/sec (Preset Mode)
Variable tilt speed from 0.0003°/sec to 100°/sec  
64 zoom, focus, pan and tilt preset positions, each with a unique user programmable preset ID  
H.264 compression algorithm using an external Video Encoding device  
Shall utilize QuickTime Multi-media player platform or approved equal
(z)  Signal and Noise Ratio: >50 dB
(aa) Synchronization: Crystal or Phase-Adjust Line Lock on 60Hz.
(bb) Sensitivity: 3200K: Scene Illumination
  F1.4, Wide Angle
  0.5 Lux @ 1/60Sec., F1.4, Shutter, Color I.R. Cut On
  0.05 Lux @ 1/2Sec., F1.4, Shutter, Color I.R. Cut On
  0.2 Lux@ 1/60Sec., F1.4, Shutter, monochrome mode I.R. Cut Off
  0.01 Lux@ 1/4Sec., F1.4, Shutter, monochrome mode I.R. Cut Off

668.7.4-Camera Housing: The camera housing shall be a corrosion resistant and tamperproof sealed and pressurized Housing with five pounds psi dry nitrogen with Schrader purge fitting and 20 psi relief valve for each camera. The camera housing shall include a loss of pressure sensor that will trigger an alarm message that will be inserted in the video output signal. The enclosure shall be constructed from 6061-T6 standard aluminum tubing with a wall thickness of 0.25 inches +/- 0.03 inches. Internal components shall be mounted to a rail assembly. A copper plated spring-steel ring shall be used to ensure electrical bonding of the rail assembly and components to the camera housing. The housing exterior shall be finished by pre-treatment with conversion coating and baked enamel paint. The camera enclosure shall be designed to withstand the effects of sand, dust, and/or hose-directed water.

The internal humidity of the housing shall be less than 10 percent, when sealed and pressurized. Desiccant packs shall be securely placed inside the housing to absorb any residual moisture and maintain internal humidity at 10 percent or less.

The outside surface of the camera lens shall be treated with a high temperature vacuum deposited hydrophilic coating to minimize lens leaning.

The inside surface of the camera lens shall be treated with an electrically conductive coating to allow direct heating of the lens glass to prevent fogging.

The temperature sensor and microprocessor controlled image sensor heater shall provide reliable operation of the zoom lens down to -34°C.

668.7.5-Mechanical Specifications (DSP Camera Assembly):

Weight:
  Max weight of 5.0 lbs.

Dimensions:
  Length (less connectors): Maximum 15.0 inches
  Housing Diameter: Maximum 4.5 inches
  Height (Including mounting base): Maximum 7.0 inches

Mounting:
  4 mounting nuts on bottom of base

668.7.5.1 - Character Generator Specifications:

(a) ID Characters are White with a Black Border.
(b) A maximum of six (6) lines of user programmable alphanumeric text can be displayed. Plus 2 fixed lines for low-pressure indicator and Privacy Zones.
(c) Text can only be displayed in uppercase characters.
(d) Camera ID: Up to 2 lines, each up to 24 characters long. If both lines are programmed Line 1 of Camera ID shall always appear above Line 2 of Camera ID regardless of top or bottom selection.

(e) Preset ID: 1 line, up to 24 characters long, user programmable for each of the 64 preset positions. When a preset position is recalled the corresponding preset ID shall be displayed. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.

(f) Compass Annotation: 8-point or 16-point compass annotation shall be settable for a true north position. Display shall include North, NE, East, SE, South, SW, West, and NW. Position shall be able to be grouped with the site location or separate from site location. Shall be user selectable for a 3-second time out or permanent display and for enable/disable.

(g) Azimuth and Elevation: Position shall be displayed in 0-359 degrees for AZ position and +95 to -95 in EL elevation. Shall be user selectable for 3-second time out or permanent display and for enabled/disabled.

(h) Low Pressure Indicator: 1 line, “Low Pressure”, messages can be displayed in “blinking” or “non-blinking” mode and be displayed when activated by low internal pressure. Adjustable set points by altitude shall be provided via the serial port to activate low-pressure. Message shall be enabled or disabled. In maintenance mode readings of the internal pressure of the camera housing shall be displayed from 5 down to 1 PSI, in .1 PSI increments.

(i) Internal Temperature Indicator: 1 line, in degrees C numeric messages can be displayed in “blinking” or “non-blinking” mode. Message shall be enabled or disabled. In maintenance mode, camera readings of the internal temperature of the camera housing in 1 degree increments.

(j) Sector Message: Up to 16 sectors in 360° may be defined with up to 24 characters long. Message shall be programmable via the RS422 serial communications.

668.7.5.2-Message Positioning:
(a) Right Side Positioning is accomplished by padding left side of message with spaces.
(b) Messages can be positioned at either the top or the bottom of the display.
(c) Blank lines are not displayed. Any programmed line being displayed shall fill in toward the top if top positioning is selected, or toward the bottom if the bottom position is selected.
(d) Display Order

668.7.5.3-Privacy Zones: Video blanked for up to 8 Privacy zones shall be provided. The video shall be blanked out for privacy. A one (1) line, numeric message can be displayed. Message shall be displayed in “blinking’ or “non-blinking” mode and be enabled or disabled. Privacy Zones shall be programmed via the RS422 serial communications.

668.7.5.4-Communication and Camera Addressing Protocol:
(a) Control and addressing shall be via RS422/RS232 optically isolated serial communications. Additional protocols shall consist of WTI, Axis, Cohu,
American Dynamics, Javelin, Philips/Bosh, Vicon and Pelco-D. The National Transportation Communications of ITS Protocol (NTCIP) 1205 protocol communications shall be included as an option. Refer to NTCIP 1205 protocol for detailed description. This allows for migration to the NTCIP standard, while still maintaining operation of existing CCTV system protocols.

(b) Upon receipt of any given command, the Camera Positioning System shall not take longer than 3.0 second to respond.

(c) All programmable functions shall be stored in non-volatile Memory and shall not be lost if a power failure occurs. System configurations such as video privacy zones, preset text and sector I.D. shall be able to be stored in a computer file and a camera personality can be cloned or uploaded into a camera in the event that a camera replacement is necessary.

668.7.5.5-Pan and Tilt Positioning Specifications:
(a) Continuous rotation capability in either direction
(b) 360° of continuous tilt movement, 360° unobstructed
(c) Pan Speed (Operator Control): Variable from 0.0003°/sec to 100°/sec
(d) Pan Speed (Preset Control): >100°/sec
(e) Tilt Speed (Operator Control): Variable from 0.0003°/sec to 100°/sec
(f) Tilt Speed (Preset Control): 100°/sec
(g) 64 Pan and Tilt preset positions with repeatability within +/- 0.5°
(h) The positioning system shall be invertible for mounting to a ceiling connection

668.7.5.6-Power Requirements:
(a) Operating Voltage: 89VAC to 135VAC, 120VAC Nominal 50/60 Hz. (±3.0 Hz) National Electrical Manufacturers Association (NEMA) standard TS-2 (1998) for traffic control system. 2.1.2 Or 24VAC nominal (21.6 – 26.4) 60 Hz Or 230VAC nominal (207 – 253) 50 Hz
   The line variation specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.
(b) Primary Input Power Interruption: The is defined in section 2.1.4 “power interruption” NEMA standard TS-2 (1998). Transients Power Service: The CCTV field equipment shall meet the requirements of section 2.1.6 “transients, power service” of the NEMA standard TS-2 (1998). The surge specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.
(c) Power consumption shall not exceed a total of 50 Watts
(d) 30 Watts for camera/receiver/P&T driver (pan & tilt in motion)
(e) 20 Watts for heater (heater on)

668.8-ENVIRONMENTAL SPECIFICATIONS:
(a) Ambient Temperature Limits (Operating): -34°C to +74°C (-29°F to 165°F) NEMA 2.1.5.1 Standard TS-2 (1998)
(b) Ambient Temperature Limits (Storage): -45°C to +85°C (-50°F to 185°F) NEMA 2.1.5.1 Standard TS-2 (1998). The environmental specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.

(c) Humidity: Ap to 100% relative humidity (per MIL-E.5400 T, paragraph 3.2.24.4) IP 67 Rating

(d) Other: Withstands exposure to sand, dust, fungus, and salt atmosphere per MIL-E-5400 T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9.

(e) Shock: Up to 10G’s, 11ms, in any axis under non-operating conditions, per MIL-E-5400 T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9.

(f) Vibration: Sine vibration from 5 to 30Hz, 1/2g, 3 axis one hour without damage

(g) Wind Loading: 150 MPH Wind load survivability, operability to 70 MPH.

668.9-MECHANICAL SPECIFICATIONS:

(a) Weight: Shall not exceed 19 lbs.
(b) Dimensions: maximum of 11” (h) x maximum 13” (w)

668.10-MOUNTING CONFIGURATIONS:

The Camera Positioning System shall include these possible mounting configurations, a wall mount, pole mount, parapet mount, corner mount or pedestal mount.

668.11-MAIN INTERFACE CONNECTOR:

The main interface connector shall be equivalent to an Amphenol 206036-3 with back shell 206070-1 and mating connector equivalent to an Amphenol 206037-11 with clamp 206070-1.

668.12-INSTALLATION CCTV:

Assembly shall be installed as shown in plans and according with the CCTV manufacturer’s instructions. All materials shall be installed in a neat and professional manner. All installation services will comply with all warranty provisions and warranty contract maintenance services in accordance with these specifications. All installations services shall comply with all local, state and federal building, and electrical codes. All coax/power/control assemblies shall use watertight fittings. All wiring entry and exits shall be made at the side or underneath components; no exposed top entry or exits are permitted. This requirement extends to all enclosures, or any other externally exposed devices.

High Mast Tower Installation:

(a) The fitting (typically a vertical two (2) inch galvanized steel conduit section) for the CCTV on the lowering device shall be designed to support and lower a closed-circuit television camera, lens, housing, pan/tilt/zoom (PTZ) mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations.

(b) The camera housing shall be supported by the luminaire high-mast lowering ring, and will be counter-balanced to the opposing/adjacent lighting fixture(s). The camera shall be “piped down” approximately two (2) feet below the horizontal axis of the present luminaire(s) – in this manner, the CCTV housing shall be inverted.
(c) There shall be an accessible ‘hub’ in close proximity of the CCTV for access to the camera’s “quick” disconnect.

(d) The high mast tower cabling shall be as prescribed by the lowering device manufacturer to allow for consistent power to the camera device. The CCTV cable shall have a quick disconnect within close proximity to the camera housing, as well as at the base of the high mast tower for installation and maintenance concerns.

(e) The Contractor shall provide a continuous, separate power to supply power to the CCTV. This power shall not be controlled by photocell. All coax/power/control connections shall be protected from exposure to the weather.

(f) The camera shall be weighted and balanced to assure that the alignment of pins and connectors are proper for the camera support to be raised into position without binding the lowering ring.

(g) The Contractor shall demonstrate to the Engineer the proper and repeated operation of the lowering device. Proper camera operation and electrical connections shall be verified by the ITS Coordinator.

**Luminaire Pole Installation:**

(a) CCTV assembly shall be mounted to a vertical upright affixed at the top of the luminaire pole. Typical attachment will be made at the top of the designated pole by an adapter plate (see figure).

(b) A two (2) inch, aluminum square box shall be utilized as the vertical support structure for the CCTV fixture. This conduit sized as necessary and approved by the Engineer and shall be referred to as the CCTV Support Channel.

(c) Plan and verify the system cable routing prior to any installation.

(d) Most CCTV units already have an integrated cabling “pig-tail”, so care must be used in routing the system cable up to the designated pole and exit the access port near the pole mount bracket prior to permanently mounting the camera unit (contractor shall need the manufacturer’s mating connector(s) both at the end of the CCTV’s “pig-tail”, as well as within the cabinetry).

(e) Provisions shall be made to support the vertical cabling within the structure itself, so that undue tension is not placed on the CCTV cabling.

(f) Utilize manufacturer’s strap tensioner to secure stainless steel straps to pole per recommendation.

**Structure Installation:**

(a) A minimum of a two (2) inch, aluminum square box shall be utilized as the vertical support structure for the CCTV fixture, or as prescribed by the CCTV representative and approved by The Engineer.

(b) Plan and verify the system cable routing prior to any installation.

(c) Contractor to attach the CCTV Support Channel to the apex of the vertical upright of an existing sign structure pole as noted within plans.

(d) Most CCTV units already have an integrated cabling “pig-tail”, so care must be used in routing the system cable down the designated structure and exit the access port near the channel mount bracket prior to permanently mounting the camera unit (contractor shall need the manufacturer’s mating connector(s) both at the end of the CCTV’s “pig-tail”, as well as within the cabinetry).
(e) A minimum of six (6) inches of the CCTV Support Channel shall be connected within the peak of the structure, and this channel shall be connected by a minimum of two (2) stainless steel through-bolts. The opening at this entrance shall be sealed with a rubber boot.

(f) The Contractor shall mount the CCTV adaptor plate to the Support Channel by the manufacturer’s recommendations. The height of this adaptor plate/CCTV shall be as designated on plans or by note.

(g) Provisions shall be made to support the vertical cabling within the structure itself, so that undue tension is not placed on the CCTV cabling.

(h) Utilize manufacturer’s strap tensioner to secure stainless steel straps to pole per recommendation

668.13-SPECIFICATIONS FOR CCTV KEYBOARD CONTROLLER:

668.13.1-Description: The Contractor shall furnish a CCTV Keyboard Controller/Field Operating Device for the purpose of camera installation, set-up and testing.

668.13.2-Materials: The CCTV Controller/Field Operating Device shall be compatible with the WVDOH Approved Product List (APL), or approved equal, and shall meet the following minimum requirements within 668.13.

668.14-SOFTWARE (NETWORK CAMERA ADMIN./MONITORING SOFTWARE):

The Contractor shall provide an IP addressable, Network ready CCTV control system for general surveillance of installed camera(s). This software shall provide a Graphics Based User Interface (GBUI) with icon maps for intuitive control and response. This software shall be able to integrate or combine the WVDOH's existing GIS Graphic Interface. This Software will be able to provide support for up to 1000 cameras and shall utilize an industry standard Ethernet infrastructure with TCP/IP and RS-232 Serial Com Interfaces, as well as ‘QuickTime” multi-media player platform or approved equal. This software shall be designed to operate on existing personal computer systems with Windows TM 4.0 and later and Windows 98 and later networks. This software shall easily configure and control the camera digital signal processing (DSP) camera within its software. This software shall place all essential system elements on the computer monitor. Within the GBUI the operator shall be able to access live video from any camera within the network access control camera functions (pan/tilt/zoom, focus, iris, power, color balance), and store and recall presets positions for fast system configuration.

668.14.1-Firmware: The CCTV Controller/Field Operating Device shall be capable to “receive” functions controlled by the Controller/Field Operating Device herein shall be supported.

668.14.2-Specifications for Surge Devices: The Contractor shall furnish video surge device, data surge device (cellular) and power surge device within the CCTV camera cabinet as polyphaser between the Cellular Antenna and the modem.

The Contractor shall provide for surge suppression devices (10 kA surge current capacity) that are in series with each line (camera video connection, PTZ circuit, and Power circuit) within the cabinet location, as well as at the video camera.

Suggested Surge Suppression should be:
(a) EDCO Part# CX12-BNC-Y or approved equal.

(b) The surge protector shall have a clamping voltage response time of less than one nanosecond. The surge protector shall have a maximum clamping voltage of 12 volts when subjected to a 3kA 8x20 microsecond wave.

RF Conductor Surge Devices shall meet all manufacturer recommendations for the particular use of the radio/cellular antenna coax conductors.

(a) Power Conductor Surge Devices

(b) Northern Technologies TCS-HWR or approved equal

(c) Nominal Line Voltage 120 volts

(d) Max. Continuous Line Voltage 132 Vrms

(e) Nominal Clamping Voltage 216 Vpk

668.15-COMMUNICATIONS SPECIFICATION:

Cellular communications shall utilize HSPDA (High Speed Packet Data Access) broadband wireless modem compatible with manufacturer’s CCTV camera. The Contractor is responsible for setting up the data/video communication, working with the ATMS Systems Engineer to ensure proper functionality and integration into the ATMS platform,

668.15.1-Description Wireless Communications: Equipment shall consist of furnishing and installing cellular modem, antenna, power supply, mounting hardware and all associated equipment necessary to establish a wireless communications network for CCTV.

668.15.2-Testing: The Contractor shall demonstrate proper functioning of all devices at the field communications demarcation point as well as over the wireless network. The field communications demarcation point is the location where the communications equipment supplied by the contractor is installed. The wireless test can be conducted anywhere an internet connection is available. After the device(s) are successfully operated at the field demarcation point and over the wireless network, a 30-day equipment burn-in test will begin after device(s) have been successfully employed and remotely controlled from the ATMS platform and/or the vendor provided software. If the 30 day burn-in test fails, the WVDOH will test the device at the field cabinet. If the device cannot be operated at the field cabinet, the Contractor shall repair or replace any device until a satisfactory operation is provided. The 30 day burn-in shall begin again for that device after successful repair.

668.16-METHOD OF MEASUREMENT AND BASIS OF PAYMENT:

The CCTV Assembly will be measured for payment per unit each complete and in place after passing component and subsystem/software and communication testing. This price includes the color camera, encoder/decoder software/hardware, IP addressable system software, zoom lenses, environmental enclosure, pan/tilt unit, housing assembly, mount and mounting hardware, cabinetry, cellular modem(s), connections, surge protection and incidentals to complete an operating CCTV.
705.5-PERFORMANCE GRADED ASPHALT BINDERS:
Performance graded binders shall conform to the requirements of AASHTO M-322, Table 1. Manufacturers are not required to perform Direct Tension Testing, AASHTO T-314. The naming convention for asphalt binder grades will be as followed:

<table>
<thead>
<tr>
<th>Old binder Grade Designations</th>
<th>New Binder Grade Designations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG-58—28</td>
<td>PG-58S—28</td>
</tr>
<tr>
<td>PG-64—22</td>
<td>PG-64S—22</td>
</tr>
<tr>
<td>PG-70—22</td>
<td>PG-64H—22</td>
</tr>
<tr>
<td>PG-76—22</td>
<td>PG-64E—22 Note 1</td>
</tr>
</tbody>
</table>

Note 1: The indication of elastic response for binders tested in accordance with AASHTO T-350 shall be determined using the Appendix XL—Indications of Elastic Response in AASHTO M-332.

DELETE THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

Performance Graded (PG) Asphalt Binders shall conform to the requirements in Table 1 of AASHTO M-332, with the following deviations:

- Manufacturers are not required to meet the requirements of AASHTO T-314 in Direct Tension.
- For Binders grades with a \( J_{tr\, 3.2} \) max requirement of 0.5 kPa\(^{-1}\), the manufacturer is not required to meet the 75% requirements for \( J_{tr\, Diff} \).
- The indication of elastic response for PG 64E — 22 binders shall be determined using the Appendix X1—Indications of Elastic Response in AASHTO M 332.
- For Standard Testing Temperatures see Table 705A below.
### Table 705A – Performance Graded Asphalt Binders

<table>
<thead>
<tr>
<th>Binder Grade Designations</th>
<th>Testing Temperature</th>
<th>Non-recoverable creep compliance at 3.2kPa, Jnr(3.2), kPa (^{-1}), Max</th>
<th>% Difference in Non-Recoverable Creep Compliance, Jnr(diff), %, Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58S – 28</td>
<td>58°C</td>
<td>4.5</td>
<td>75%</td>
</tr>
<tr>
<td>PG 64S – 22</td>
<td>64°C</td>
<td>4.5</td>
<td>75%</td>
</tr>
<tr>
<td>PG 64H – 22</td>
<td>64°C</td>
<td>2.0</td>
<td>75%</td>
</tr>
<tr>
<td>PG 64E – 22</td>
<td>64°C</td>
<td>0.5</td>
<td>-</td>
</tr>
</tbody>
</table>

A certified producer or distribution terminal will be the last source to handle/manipulate a PG binder before being shipped to an asphalt concrete plant or project. The producer or terminal will provide the PG binder certification report with the shipment.
107.21-POLLUTION: The Contractor shall exercise every reasonable precaution throughout the life of the Project to prevent pollution of rivers, streams, or impoundments. Pollutions such as chemicals, fuels, lubricants, bitumen, raw sewage, products associated with bridge cleaning and painting, and other harmful wastes shall not be discharged into or alongside of rivers, streams, impoundments, or into natural or man-made channels leading thereto. The quality of the surface waters affected by construction shall meet the requirements of the West Virginia Code, Volume 8A, Chapter 22, Article 11.

The manual entitled, “West Virginia Division of Highways, Best Management Practice for Containment/Disposal of Waste Products Generated during Bridge Cleaning and Painting Activities”. Latest addition, as amended is made part of the contract as a guide to follow for containment/disposal activities.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 204
MOBILIZATION

204.5-BASIS OF PAYMENT:

DELETE THE CONTENTS AND REPLACE THE FOLLOWING:

Partial payments will be made as the work progresses in accordance with the following schedule.

i. 2.5% of the original contract amount or 50% of the amount bid for mobilization, whichever is less, will be released to the Contractor as the first estimate payable, not less than 15 days after the start of work at the project site.

ii. 2.5% of the original contract amount or the remaining 50% of the amount bid for mobilization, whichever is less, shall be released with the estimate payable 30 days after the first estimate.

iii. For small projects where the duration of the project is expected to be less than one month and the amount bid for mobilization is less than 5% of the original contract amount – 50% of the amount bid for mobilization shall be released to the Contractor on the first estimate payable after the start of work, with the remaining 50% being paid once the project is substantially complete. If the amount for mobilization was more than 5% of the original contract amount section i. and ii above still apply.

Upon completion of all work on the project, payment of any amount bid for mobilization in excess of 5% of the original contract amount will be released.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided for by the contract.

No deduction will be made, nor will any increase be made, in the lump sum mobilization item amount regardless of decreases or increases in the final total contract amount or for any other cause.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________

FEDERAL PROJECT NUMBER: ____________________________

FOR

SECTION 601

STRUCTURAL CONCRETE

601.1-GENERAL:

ADD THE FOLLOWING SUBSECTION:

601.1.1-Ultra High Performance Concrete: The Contractor shall furnish all materials, tools, and labor necessary for the performance of all work to form, cast, finish, and cure Ultra High Performance Concrete (UHPC) where required per plan. Before casting UHPC for actual construction, the Contractor will cast mockups to demonstrate the ability to properly cast the UHPC for transverse, longitudinal and vertical closure pours.

All UHPC shall be produced using “Ductal” concrete materials manufactured by Lafarge North America. See contract plan sheets for UHPC placement locations.

601.2-MATERIALS:

ADD THE FOLLOWING:

A. Ductal JS1000 Concrete: Use the concrete mix supplied by Lafarge North America with the following proportions of mix parameters based on the supplier’s recommendations.

<table>
<thead>
<tr>
<th>Material</th>
<th>lbs./cu. yd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premix</td>
<td>3700</td>
</tr>
<tr>
<td>Water</td>
<td>219</td>
</tr>
<tr>
<td>Super Plasticizer Liquid</td>
<td>51</td>
</tr>
<tr>
<td>Steel Fiber</td>
<td>263</td>
</tr>
</tbody>
</table>

Qualification Testing: The Contractor shall complete the qualification testing of the UHPC two months before placement of joint. The minimum concrete compressive strength shall
be 12 KSI at 96 hours and 15 KSI for opening the bridge to traffic. The compressive strength shall be measured by modified AASHTO T22/ASTM C39. Only a concrete mix design that passes these tests may be used to form the joint. Testing performed by an approved testing lab. The casting of mockups, as described in 601.5.D, also apply.

Material supplier for Ductal Concrete:
Lafarge North America
3210B Hwy 17 East
Kenora, ON P9N 3x7
Phone: (403) 225-5456
Fax: (403) 278-7420

B. Water: Water used for mixing shall be potable.

C. Admixtures: Chryso Premia 150 (30% solid content)

D. Fiber Reinforcement: Steel chord type Bekaert OL 13/0.2 inches or equivalent – high carbon fibers with a minimum tensile strength 300,000 psi.

601.3-PROPORTIONING:

ADD THE FOLLOWING SUBSECTION:

601.3.4-UHPC Submittals: The Contractor shall submit his batching sequence, forming, placing, curing, and testing procedures to the Engineer for review seven (7) working days prior to casting. The mixing sequence shall include the order and time of introduction of the materials, mixing time and QA/QC procedure for the verification of the mix uniformity.

601.5-CONSTRUCTION METHODS:

ADD THE FOLLOWING:

A. Quality Assurance:
   1. The Contractor shall be pre-qualified by Lafarge North America that they have the capability to mix and place Ductal concrete. Proof of pre-qualification shall be submitted in writing from the Contractor to the Engineer seven (7) working days before any UHPC is cast.
   2. The surface of the UHPC field joints shall be filled flush with the precast deck to within a tolerance of plus or minus 1/8 inch. Other tolerances shall be in compliance with PCI Manual – 116 or otherwise specified on plans.

B. Pre-Pour Meeting: A day before the initial placement of the Ductal, the Contractor shall arrange for an onsite meeting with the Lafarge Representative and Engineer. The Contractor’s staff shall attend the site meeting. The objective of the meeting will be to clearly outline the procedures for mixing, transporting, finishing and curing of the UHPC material. The Contractor shall arrange for a Representative of Lafarge to be on site during the placement of the UHPC. The Lafarge representative shall be knowledgeable in the
supply, mixing, delivery, placement, and curing of the Ductal material. Mockup requirements will be performed per the recommendations of the Lafarge representative.

C. **Storage**: The Contractor shall assure the proper storage of Ductal premix including power, fibers, and additives, obtained from Lafarge North America, as required by the Lafarge specifications in order to protect materials against loss of physical and mechanical properties.

D. **Forming, Batching, Placement, And Curing**: The Contractor shall work together with Lafarge to ensure appropriate initial strength gains to meet the desired project schedule. An initial strength gains to meet the desired project schedule. An initial strength of 12 KSI can be achieved by adding accelerators and by maintaining the ambient temperature above 60°F for 96 hours after placement.

Grinding of the UHPC surface can be performed upon recommendations from Ductal. If significant fiber pullout is observed during grinding operations, grinding shall be suspended and not resumed until approved by the Engineer.

The bridge can be opened to traffic when strength of 15 KSI has been achieved.

Construction loads applied to the bridge during UHPC placement and curing are the responsibility of the Contractor. Contractor shall submit the weight and placement of concrete buggies, grinding equipment or other significant construction loads to the Engineer for review prior to the pre-pour meeting describe above.

Forming, batching, placing, and curing shall be in accordance with the procedures recommended by Lafarge and as submitted and accepted by the Engineer.

The design and fabrication of forms shall follow approved installation drawings and shall follow the recommendations of Lafarge. All the forms for UHPC shall be constructed from medium density overlay plywood.

Mockups of each UHPC pour shall be performed prior to actual UHPC construction and conducted per the requirements of this special provision and the recommendation of the Lafarge Representative. Mockups of the horizontal closure pours shall be four feet in length with all other dimensions to match those required by the plans. Mockups for vertical closure pours shall be two feet in length with all other dimensions to match those required by the plans. The mockup process shall be observed by the Lafarge Representative.

Two portable batching units will be supplied by Lafarge to the Contractor for mixing of the UHPC. The Contractor shall follow the batching sequence as specified by Lafarge and approved by the Engineer.

Each UHPC placement shall be cast using one continuous pour. No cold joints are permitted.

The concrete in the form shall be cured according to manufacturer’s recommendations at minimum temperature of 60°F to attain the design strength.

E. **Testing**: The following tests shall be performed following casting of the mockup and for each day of UHPC placement:

1. Concrete compressive strength test according to modified ASTM C 39. Use twelve specimens 3 inch diameter by 6 inches. Prior to Contractor grinding UHPC, three specimens shall be tested to validate the achievement of 10 KSI compressive strength. Three specimens shall be tested to validate the achievement of 15 KSI compressive strength prior to opening the bridge to traffic. Thermally threated three final specimens shall be tested at 28 days to verify final strength. WVDOH will reject portion or all of
the UHPC closure pour should testing indicate not meeting required minimum strengths. The remaining three specimens shall be treated as reserves. All specimens shall be tested at Lafarge North America or by an approved testing lab. Each specimen shall have ends ground to 0.5 degree planeness. Testing by Lafarge shall be sent to their facilities as directed by Lafarge representatives.

2. Cast 3 additional 4” diameter by 8” cylinders and provide to Cement and Concrete Group of the WVDOH, MCS&T Division for their evaluation.

3. Determination of flow performed on a flow table constructed according to ASTM C 230. The measured diameter of the concrete after 20 table drops shall be within the limits: minimum 7 inches; maximum 10 inches. The test shall be performed on every concrete batch.

Note: All specimens shall be exposed to the same process as the mockup and each UHPC placement and shipped to Lafarge North America and an approved testing lab accordingly for testing. A flow table may be obtained from Lafarge North America to conduct testing.

F. Contacts: Material Supplier and Cylinder Testing:
   Kyle Nachuk, Bridge Construction Manager
   Lafarge North America
   3210 B Hwy 17 East
   Kenora, OH, P9N 3X7
   (403) 815-4720
   Kyle.Nachuk@lafarge-na.com

601.14-METHOD OF MEASUREMENT:

ADD THE FOLLOWING:

The concrete quantities shown on the plan, measured by the cubic yards, are for contractor’s information only.

601.15-BASIS OF PAYMENT:

ADD THE FOLLOWING:

The quantity, determined as provided above, will be paid for at the contract unit price bid for this item, which price and payment shall be full compensation for furnishing all the materials and doing all the work prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, field laboratory, supplies, and incidentals necessary to complete the work.

601.16-PAY ITEM:

ADD THE FOLLOWING:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>601800-001</td>
<td>Ultra High Performance Concrete</td>
<td>Cubic Yard</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 614
PILING WALLS

614.5-CORROSION PROTECTION:

DELETE THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

Piles will be protected from corrosion and sealed by the placement of concrete or grout, from the bottom of the hole to the bottom of the lagging or as directed by the Engineer. Vibration of the concrete or grout is not required. The Contractor shall complete all concrete or grout operations for holes drilled during the work day.

The drilled hole shall be pumped free of water and shall be reasonably free of fall-in soil or other debris prior to the placement of the concrete or grout. The concrete or grout in the bedrock/shale portion of the hole will be pumped or tremied through a pipe beginning at the bottom of the drilled hole. The pipe shall be slowly raised ensuring the pipe end remains at least 2 feet (600 mm) below the surface of the concrete or grout. A means of positively measuring the elevation of the concrete or grout as it is placed shall be provided by the Contractor.

After placing the concrete or grout in the bedrock/shale, the Contractor has the option of either pumping or pouring directly into the hole the remainder of the concrete or grout. Placing the concrete or grout from the bottom of the hole to the bottom of the lagging shall be accomplished in one continuous operation.

The Contractor will inform the Engineer, at the preconstruction conference, as to the type of corrosion protection that will be used. Intermixing of concrete and grout will not be allowed, unless approved by the Engineer.

Concrete shall be in accordance with Section 601, Class B. The job site testing is waived. Grout will be furnished and placed in accordance with the requirements specified herein. The acceptance sampling and testing of the grout is the responsibility of the Division.

Quality Control of the concrete or grout is the responsibility of the Contractor as designated in Materials Procedure MP 601.03.50. The Contractor shall maintain equipment and qualified personnel, who shall direct all field inspection, sampling, and testing necessary to determine the magnitude of the various properties of the concrete and grout governed by the Specifications and shall maintain these properties within the limits of this Specification. The Quality Control Plan designated in MP 601.03.50 shall be submitted to the Engineer at the pre-construction conference. Work shall not begin until the Plan is reviewed for conformance with the contract documents.
The required 7-day compression strength of the grout shall be a minimum of 2,000 psi (14 MPa). Grout which does not attain the 2,000 psi (14 MPa) strength in 7 days but exceeds a strength of 1,600 psi (11 MPa) shall be subject to price reduction based on the percentage of strength attained.

A grout strength test shall consist of testing three 6 in x 12 in (150 mm x 300 mm) cylindrical specimens. The test results shall be the average of the three specimens. One set of three specimens shall be made for each day’s operations.

The bid price for the piling with grout compressive strengths greater than or equal to 2,000 psi (14 MPa) will be paid at 100 percent unless the piling installation does not meet Specifications for other reasons. Between 1,600 psi (11 MPa) and 2,000 psi (14 MPa) compressive strengths, the cost of the grout will be deducted from the actual grout cost on a proportional basis with 2,000 psi (14 MPa) being 100 percent and 1,600 psi (11 MPa) being zero percent payment. With 1,600 psi (11 MPa) grout, the piling installation would be considered to meet 80 percent of the Specifications and the penalty being zero payment for the grout.

The penalty would involve only the quantity of grout represented by the failing compressive strength results.

The bid price for the piling will be reduced for the piles grouted with grout having less than 1,600 psi (11 MPa) compressive strengths as follows:

\[ F = D + (BC - D) \times \frac{(E - A)}{E} \]

Where:

- **A** = Compressive strength of grout
- **B** = Total foot (meter) of piling grouted with grout < 1600 psi
- **C** = Unit bid price per foot (meter) of piling
- **D** = Total $ amount of the cost of grout represented by failing compressive strength results (from Contractor)
- **E** = 2,000 psi (14 Mpa)
- **F** = Total penalty
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 614
PILING WALLS

614.7-LAGGING AND BACKFILLING:

DELETE PARAGRAPH ONE AND REPLACE WITH THE FOLLOWING:

Lagging of the type and size as specified on the Plans shall be installed between the piles. Backfilling and restoration of the roadway template shall be as shown on the Plans. Precast concrete lagging shall be fabricated in accordance with the requirements of MP 604.02.40.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 620
THREE-SIDED REINFORCED CONCRETE BRIDGE/CULVERT

620.3-DESIGN CRITERIA:

620.3.2-Precast Three-Sided Bridge/Culverts:

DELETE PARAGRAPH ONE AND REPLACE WITH THE FOLLOWING:

The bridge/culvert unit dimension and reinforcement details shall be as prescribed in the plan and the shop drawings provided by the manufacturer. The minimum concrete compressive strength shall be 4000 psi (28MPa). The minimum steel yield strength shall be 60 ksi (414 MPa). The minimum required strength for form removal and handling shall be 70% of Design Strength unless otherwise specified by the Designer. The precast three-sided bridge/culvert unit shall also conform to MP 604.02.40.
626.5-MATERIALS:
   626.5.1-Mechanically Stabilized Earth Components:
      626.5.1.1-Facing Elements:
         626.5.1.1.1-Reinforced Concrete Facing Elements:

   DELETE THE LAST PARAGRAPH OF THIS SUBSECTION 626.5.1.1.1 AND REPLACE WITH THE FOLLOWING:

   All reinforcing steel shall be in accordance with Section 602 of the Standard Specifications and shall be epoxy coated. Precast concrete Mechanically Stabilized Earth wall facing elements shall also conform to MP 604.02.40.
714.23-PRECAST REINFORCED CONCRETE BOX CULVERTS:

DELETE PARAGRAPH ONE AND REPLACE WITH THE FOLLOWING:

Precast reinforced concrete box culverts shall conform to the requirements of AASHTO M259 where depth of cover is 2 feet (600 mm) or more and AASHTO M273 where depth of cover is less than 2 feet (600 mm). Interstate live load design shall be provided for Interstate highway facilities: and HS20 live load design shall be provided for other locations. Precast reinforced concrete box culverts shall also conform to MP 604.02.40.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 715
MISCELLANEOUS MATERIAL

715.19-PRECAST CONCRETE UNITS FOR MANHOLES AND INLETS:

DELETE PARAGRAPH ONE AND REPLACE WITH THE FOLLOWING:

Precast concrete units for manholes shall conform to the requirements in AASHTO M 199 and MP 604.02.40. In addition, air entrainment in the concrete shall be seven percent plus or minus two percent.
715.42-TRAFFIC SIGNAL MATERIALS AND EQUIPMENT:
  715.42.11-Junction Boxes:
    715.42.11.2-Type H-(Heavy Duty):

DELETE PARAGRAPH TWO OF SUBSECTION 715.42.11.2 AND REPLACE WITH THE FOLLOWING PARAGRAPH.

  Precast concrete junction boxes shall be fabricated in accordance with the requirements of MP 604.02.40. The walls and floor of the concrete box shall be either precast or cast in place.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 636
MAINTAINING TRAFFIC

636.9-TRAFFIC CONTROL DEVICES:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE THE FOLLOWING:

Traffic control devices for work areas include, but may not be limited to, signs, barricades, drums, cones, channelizer cones, delineators, and flashers. They shall be installed in accordance with standards detailed in the manual “Manual on Temporary Traffic Control for Streets and Highways”, latest version, published by the Division, or as shown on the plans.

If the Total Contact Bid Amount is over $500,000 or otherwise noted on the plans Traffic Control Devices also include work area signs indicating fines. These signs shall be installed 500' (150 m) after the first maintenance of traffic sign installed for each project. The signs shall be installed in both directions on the road under construction. The sizes, messages, and designs shall as shown in the Sign Fabrication Manual or as directed by the Engineer. With the larger size used for four lane expressway roadways with speeds of 55 MPH or greater and the smaller sign used for two lane roadways with speeds of 50 MPH or greater and with an ADT at 3,000 or greater. A 12' x 6' expressway sign (Item 636011-* - 300 units) placed behind guardrail on 3-4 #BB U-Channel or on 3 - 4” x 4” wood post (breakaway) or 8’ x 4’ - two lane highway sign (Item 636011- * - 180 units) placed behind guardrail on 2 - 4 #BB U-Channel or on 2 - 4” x 4” wood post (breakaway).

If the project is on an Interstate Highway, an APD (Appalachian Highway Corridor), a controlled access highway with posted speed limit of 40 Miles Per Hour (MPH) or greater, or if otherwise noted on the plans, Traffic Control Devices shall include work area signs designated “GIVE ‘EM A BRAKE” (GEAB). The sign size, message, and design shall be as shown on Sign Fabrication G30-1 or as directed by the Engineer.

The sign (Item 636011-* , 300 units) shall be installed 500’-1500’ after the first lead-in work area sign unless the work zone is greater than one (1) mile, in length, in which case the GEAB sign shall be installed approximately ¼ mile in advance of the active work area. At no time shall the GEAB sign be closer than 500’ from any other work area signing. The sign shall be installed in both directions on the right side of the highway. All GEAB signs shall be installed on three, 3 pound per foot u-channel posts driven to a depth of 3 ½ feet. The u-channel posts shall be continuous in length, or a combination of a stub driven to a depth of 3 ½ feet, an approved splice.
arrangement and an appropriate length supporting post.

GEAB sign shall only be installed in active work areas where workers are present and visible to passing motorists. During periods of inactivity in the work area, the GEAB sign(s) shall be covered or removed.

All traffic control devices installed shall be devices which meet the mandatory crash testing performance requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) and/or the American Association of State and Highway Transportation Officials publication Manual for Assessing Safety Hardware (AASHTO-MASH), latest version. With the exception of Category 1 work zone devices, as defined by the FHWA, all devices shall have a supporting NCHRP-350 and/or AASHTO-MASH acceptance letter from the FHWA. Category 1 work zone devices shall have supporting self-certification from the device manufacturer that the device meets the mandatory crash testing performance requirements of NCHRP-350 and/or AASHTO-MASH.

Temporary work zone devices, including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH. Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives.

All devices shall be assembled and utilized in a manner that is consistent with the crash testing of the devices. For example, portable traffic control sign stands shall only be used within the parameters of the crash testing of the stands unless otherwise allowed for by the FHWA in the FHWA acceptance letter or by other written FHWA guidance or policy. These parameters include, but are not necessarily limited to sign mounting height, sign substrate material, maximum sign size, and the application of warning lights. Unless included as part of the testing of the device or allowed for as part of the manufacturer’s self-certification for Category 1 work zone devices, additional ballast added to devices shall only be as allowed for by the FHWA in the FHWA acceptance letter or by other written FHWA guidance or policy.

Devices utilized by the Contractor shall be a model listed on the Division’s Approved Products List (APL), as applicable. Devices approved and/or certified at Test Level 2, but not Test Level 3, shall not be utilized on roads having a normal posted speed limit greater than forty (40) MPH. Devices approved and/or certified at Test Level 1 only shall not be utilized on roads having a normal posted speed limit greater than twenty-five (25) MPH.

636.14-TEMPORARY BARRIER:

636.14.1-Materials:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE THE FOLLOWING:

Temporary Barrier manufactured before December 31, 2019 shall meet the requirements of NCHRP Report 350 and/or MASH-0809 for the different test levels as shown in Table 3.1 “Test Matrix for Longitudinal Barriers” in NCHRP Report 350. Temporary Barrier manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH. Specific types of temporary barrier will not be used unless crash tested and approved by the Engineer. Historical performance will help determine use of a product. Poor performance may be grounds for non-acceptance.
Temporary Barriers shall have adequate drainage slots to allow runoff to pass through. Temporary Barrier shall have 8” x 12” Type B-1 Delineators (white or yellow as appropriate) facing traffic at 40 foot centers.

636.14.2-Installation:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE THE FOLLOWING:

This barrier type shall conform to the details on the Plans, set as directed on the Plans, with the barrier sections securely connected together by satisfactory fastening devices to provide a more stable structure against impact.

A Temporary Barrier Installation Plan shall be approved according to Section 105.2.1.2 “Contractor Approval Method”. It shall have information adequate to ensure it meets the installation conditions below and shall include barrier type, barrier connection type, NCHRP/MASH test approval and data, individual segment length, anchorage details, end treatments, and transition details.

The temporary barrier shall be placed to match test conditions as determined by the Engineer. These conditions may include, but not be limited to, anchorages, total length of barrier, individual segment length and connection details. Only one type of temporary barrier shall be used for any one continuous run of barrier in a project. To clarify, the entire length of temporary barrier shall not be intermixed in regard to type of barrier, connection type, or individual barrier length unless that configuration has been tested.

Anchorage spacing and installation, if required, shall be per manufacturer subject to shop drawing review and approval and meet or exceed test conditions. Shop drawing information shall include details for anchor removal and patching and /or repair of pavement or bridge deck.

Where temporary barrier adjoins guardrail barrier, regardless if one is temporary and the other is permanent (newly constructed or previously in existence) or if both are temporary, they must be connected with a Temporary Guardrail Connector conforming to 636.16.2.

Where temporary barrier adjoins bridge parapet or other essentially non-yielding barrier or obstacle, they must be joined in a manner to maintain barrier continuity and prevent vehicle snagging during impact. If they cannot be joined in this manner, a connection device must be used to assure barrier continuity and to prevent vehicle snagging during impact.

When the temporary barriers are no longer needed, they will become the property of the Contractor, unless otherwise noted on the Plans.

J-J Hook connections shall be tensioned by pulling the barrier segments apart to make this type connection “tight”.

Vehicles, materials or any other equipment shall not be stored in the Temporary Barrier buffer area. Unless required as a part of the contract, vehicles and equipment shall not work in the Temporary Barrier buffer area and if required, shall be limited to that time that it is necessary to be in that area.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 636
MAINTAINING TRAFFIC

636.2 - MATERIALS

ADD THE FOLLOWING SUBSECTIONS:

636.2.1 – Materials Certification: The Contractor will furnish a notarized Letter of Certification for all traffic control items.

This letter shall state that the Contractor has inspected all materials upon arrival and that where applicable the materials are supplied from pre-approved DOH sources with respective lab numbers included on all invoices. The Contractor’s letter shall state that all traffic control devices, flaggers, pilot trucks, signs, temporary pavement marking materials, materials for temporary structures, aggregate for temporary roads, and dust palliatives all conform to the requirements specified in Section 636 of the Standard Specifications and all related Contract Documents.

This Letter of Certification is not allowed to be from any Subcontractor, nor will the Division accept any pass-through letters.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR
STATE PROJECT NUMBER: ________________________________
FEDERAL PROJECT NUMBER: ________________________________
FOR
SECTION 642
TEMPORARY POLLUTION CONTROL

642.2-MATERIALS:
ADD THE FOLLOWING:

Flocculant blocks shall be a semi-hydrated gel polyacrylamide block that is specifically designed for the project and shall meet the approval of the Engineer.

642.6-TEMPORARY PIPE, CONTOUR DITCHES, BERMS, SLOPE DRAINS, DITCH CHECKS, SILT FENCE, PREMANUFACTURED DITCH CHECKS AND SUPER SILT FENCE:
DELETE AND REPLACE WITH THE FOLLOWING HEADING:

642.6-TEMPORARY PIPE, CONTOUR DITCHES, BERMS, SLOPE DRAINS, DITCH CHECKS, SILT FENCE, PREMANUFACTURED DITCH CHECKS, SUPER SILT FENCE AND FLOCCULANT BLOCKS:

ADD THE FOLLOWING SUBSECTION:

642.6.67-Flocculant Block: Flocculant blocks shall be applied to drainage upstream of any sediment facility. The placement and the location of the flocculant blocks shall meet the approval of the Engineer. The Contractor shall be responsible for all details, devices, accessories
and special construction necessary to properly furnish, install, adjust and place in continuous satisfactory service and complete the work in an acceptable manner.

642.7-METHOD OF MEASUREMENT:

ADD THE FOLLOWING:

The Flocculant Block will be paid per each device used.

642.9-PAY ITEMS:

ADD THE FOLLOWING ITEM:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
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<tbody>
<tr>
<td>642042-001</td>
<td>Flocculant Block</td>
<td>Each</td>
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</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ______________________________
FEDERAL PROJECT NUMBER: ______________________________

FOR

SECTION 667
LED DYNAMIC MESSAGE SIGNS
FRONT ACCESS DOOR
FULL COLOR/FULL MATRIX

667.1-DESCRIPTION:
This work shall consist of furnishing and installing various types of Dynamic Message Sign systems. It shall include, but not be limited to, dynamic message signs and the related communications equipment between the sign and the Traffic Management Center to be installed in accordance to this Specification, as shown on the Plans or as directed by the Engineer.

All electrical work shall conform to current requirements of the National Electrical Code, latest edition, all local codes and Section 631 of the Standard Specifications.

All details not specified or not shown on the Plans shall conform to the requirements of the latest issue of the Manual on Uniform Traffic Control Devices, (referred to as the MUTCD). This Manual is published by the Federal Highway Administration of the U.S. Department of Transportation and supplemented by the publication "Official Ruling on Request" and the West Virginia Division of Highways Traffic Engineering Division Directives.

667.1.1-Glossary: The following abbreviations and definitions shall govern this specification:

AASHTO-American Association of State Highway and Transportation Officials

AlInGaP-Aluminum Indium Gallium Phosphide - Refers to the chemical composition of an LED.

ANSI-American National Standards Institute

AWS-American Welding Society
Bin-Group of LEDs categorized and sorted by intensity or color. Each “bin” has upper and lower intensity or color specifications and contains only LEDs that are measured to be within that range. LED manufacturers sort LEDs into bins to ensure consistent intensity and color properties.

Control Computer/ Central Controller-A desktop or laptop computer used in conjunction with DMS control software to communicate with DMS sign controllers. The control computer can instruct a DMS sign controller to program and control the DMS, monitor DMS status, and run DMS diagnostic tests. A control computer can be used for remote control of one of more DMS, as well as for local control of a single DMS.

Display-Same as message.

Dynamic Message Sign (DMS)-An industry term that applies to various types of changeable sign technology, such as DMS, CMS and BOS. It includes the following major components: sign face, sign housing, controller, and if present, the controller cabinet.

Font-The style and shape of alphanumeric characters that are displayed on the DMS matrix to create messages viewed by motorists and travelers.

Frame-see page

FSORS-An NTCIP term meaning “Full, Standardized Object Range Support.” See the NTCIP standards for additional information.

GUI-Graphical user interface

ITE-Institute of Transportation Engineers

ITS-Intelligent Transportation System

LED-Light Emitting Diode

Message-Information displayed on the DMS for the purpose of visually communicating with motorists. A DMS message can consist of one or more pages of data that are displayed consecutively.

Management Information Base (MIB)-Set of object definitions that define the attributes, properties and controllable features of devices on a network, which can be remotely monitored, configured and controlled. The information is provided in a format called Abstract Syntax Notation 1 (ASN.1), which is an international standard for defining objects.

Module-Assembly consisting of a two-dimensional LED pixel array, pixel drive circuitry, and mounting hardware. Modules are installed in the display adjacent to each other to form the display matrix.

NEMA-National Electrical Manufacturers Association
NCHRP - National Cooperative Highway Research Program

NTCIP - National Transportation Communications for ITS Protocol

**Object** - An NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device.

**Page** - An NTCIP term referring to the data that is displayed on the DMS display matrix at a given moment in time. Also, referred to as a “frame”.

**Pitch** - Distance measured from center to center of adjacent pixels within a matrix. This distance is measured both horizontally and vertically.

**Pixel** - Any of the small discrete elements that, when arranged in a pixel matrix, create a character. A pixel contains a cluster of LEDs.

**PMPP** - Point to multi-point protocol

**PPP** - Point to point protocol

**Pole** - The central controller and laptop computer are said to “poll” a sign when they request the sign’s status information. The term is derived from the periodic status polling which a central controller can perform, but is loosely used to refer to any status request.

**PWM** - Pulse width modulation

**RGB** - Red, Green, and Blue

**Schedule** - A set of data that determines the time and date when a DMS sign controller will cause a stored message to be displayed on the DMS

**Sign** - The sign housing and its contents.

**Sign Controller** - A stand-alone computer that is located at a DMS site, which controls a single DMS. A sign controller received commands and sends information to a control computer. The controller can be located in a ground cabinet or in the sign (as detailed in the plans).

**Stroke** - Refers to the vertical and horizontal width of the lines and curves of a display font. “Single stroke” denotes character segments that are one pixel wide. “Double stroke” denotes character segments that are two pixels wide.

**True Message Display Verification (TMDV)** - The ability of the DMS to display the state of each pixel as it is currently displayed to the motorist, including any errors. The TMDV is an actual real time read of the current flowing through each string of LEDs at the time of the associated sign poll or message download, rather than a simulation of errors based on the last pixel test.
Variable Message Sign (VMS)-A type of DMS that is fully programmable such that the content of its messages are fully changeable remotely and electronically.

WYSIWYG-What You See Is What You Get. More specifically, what you see on the DMS control computer monitor is a scaled representation of how a message will appear when it is being displayed on the DMS. Similarly, after a pixel diagnostic test routine has been run, what you see on the control computer monitor is a scaled representation of the functional status of each pixel in the DMS display matrix.

667.1.2-Manufacture Requirements: This section describes the minimum qualifications required for a dynamic message sign manufacturer to be selected. This section also details the product documentation that must be provided by the contractor.

667.1.2.1-Manufacture Qualifications: To be valid for these experience requirements, the LED DMS must meet this specification and be designed for State Highway or Interstate Highway use.

To be valid for these experience requirements, a front-access LED DMS must meet this specification and be a State Highway or Interstate Highway, permanently mounted, LED DMS with a minimum of three (3) lines of 18-inch characters, minimum 15 characters per line, 5x7 pixel font, 66 mm pitch, full color/full matrix, pure LED characters and minimum housing dimensions of 7.5 feet high by 18.3 feet wide. Non-LED DMS, hybrid DMS, lift-face DMS, non-highway DMS, portable DMS, indoor DMS, smaller DMS and commercial DMS will not satisfy these experience requirements. A DMS manufacturer must meet these minimum qualifications prior to bidding.

Non-LED DMS, hybrid DMS, lift-face DMS, non-highway DMS, portable DMS, indoor DMS, smaller DMS and commercial DMS will not satisfy these experience requirements. A DMS manufacturer must meet these minimum qualifications prior to bidding.

Manufactures shall meet the following requirements:

1. Have been in the business of manufacturing large outdoor permanently mounted LED DMS, which are used to manage vehicular roadway traffic, for minimum period of ten (10) years prior to the contract bid date.

2. Have in operation a minimum of one thousand (1000) large outdoor permanently mounted LED DMS as defined above. Each of these DMS shall have successfully operated for a minimum period of three (3) years prior to the contract bid date.

3. Have in operation as of the contract bid date a minimum of ten (10) State or City Department of Transportation (DOT) owned and operated LED DMS systems. Each of the ten (10) systems shall use the NTCIP as their primary communication protocol. Each of the DMS signs shall be communicating over dial-up telephone, cellular telephone, spread spectrum radio, and/or fiber optic/highspeed data networks.

4. Have been in business under the same corporate name for a period of no less than ten (10) years prior to the contract bid date.

5. Have previously demonstrated that their DMS controller is NTCIP compliant via compliance testing performed by an independent third party testing organization. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon’s NTester, Intelligent Devices’ Device Tester, and/or Frontline’s FTS for NTCIP.
6. Utilize a documented certified welding procedure.

667.1.2.2-Material, Manufacturing and Design Standards: The design of the DMS must comply with the following standards. If no revision date is specified, the most recent revision of the standard applies:

1. General DMS Requirements-The DMS must be designed in accordance with NEMA Standards Publication TS 4, Hardware Standards for DMS, with Requirements.
2. Aluminum Welding-All welding must be by an inert gas process and shall be designed, fabricated, welded and inspected in accordance with the latest revision of ANSI/AWS D1.2/D1.2M Structural Welding Code for Aluminum.
3. Electrical Components-High-voltage components and circuits (120 VAC and greater) must be designed, wired, and color-coded per the National Electric Code (NEC).
4. Environmental Resistance-The DMS housing must be designed to comply with type 3R enclosure criteria as described in the latest revision of NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
5. Product Electrical Safety –The DMS and all associated equipment and enclosures must be listed by the Underwriters Laboratories (UL) and will bear the UL mark on the outside of the DMS enclosure. DMS will be listed as conformant to UL 48 Standard for Electric Signs and UL 50 Enclosures for Electrical Equipment. Control equipment and enclosures must be listed as conformant to UL 1433 Standard for Control Centers for Changing Message Type Electric Signs.
6. Radio Frequency Emissions-All equipment must be designed in accordance with Federal Communications Commission (FCC) Part 15, Subpart B as a “Class A” digital device.
7. Maintenance Access and Safety-The DMS equipment provided must be compliant with all relevant OSHA requirements.
9. Structural Integrity-The DMS housing must be designed and constructed to comply with all applicable sections of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, latest standards, as well as the fatigue resistance requirements of NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.
10. Communication Protocols-The sign controller hardware/firmware and DMS control software shall conform to the applicable National Transportation Communication for ITS Protocol (NTCIP) standards. Refer to the NTCIP section of this specification for detailed NTCIP requirements for this contract.

667.1.2.3-Quality Management System (ISO 9001 Certified): The DMS manufacturer must have an in-house Quality Management System (QMS) in place that is certified by an approved registrar to ISO 9001:2008 or the latest released standard of ISO 9001. ISO 9001 certification is a means of ensuring the DMS organization conforms to specific requirements through quality planning in accordance to the latest standard of ISO 9001.
The manufacturer’s pre-build technical submittal must provide a copy of the company’s ISO 9001 certification.

667.1.2.4 Pre-Build Product Testing: The DMS manufacturer shall provide documentation indicating that the DMS product has been tested to the following standards. It shall be acceptable for the testing to be performed on scale-sized versions of the actual DMS provided that the test unit is functionally and structurally equivalent to the full size DMS.

Product party test reports shall be submitted for the following testing:

1. NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements - Section 2, Environmental Requirements. Test report shall detail results of mechanical vibration and shock, electrical noise and immunity, temperature, and humidity.
2. Underwriters Laboratories (UL), UL 48 Standard for Electric Signs, UL 50 Enclosures for Electrical Equipment, and UL 1433 Standard for Control Centers for Changing Message Type Electric Signs. The UL report number(s) for all DMS and control equipment manufactured by the DMS manufacturer shall be listed by the UL or an accredited 3rd party testing organization such as ETL, Semko, and shall bear the organization’s mark.
3. NTCIP Standards:
   a. NTCIP 1101 and Amendment 1 Simple Transportation Management Framework (STMF)
   b. NTCIP 1102, Octet Encoding Rules (OER) - Base Protocols NTCIP 1103 v1.26a Transportation Management Protocols
   c. NTCIP 1201 and Amendment 1 Global Object (GO) Definitions
   d. NTCIP 1203 and Amendment 1 Object Definitions for Dynamic Message Signs
   e. NTCIP 2001 and Amendment 1, Class B Profile
   f. NTCIP 2101 Point to Point Protocol (PMPP) Using RS-232 Subnetwork Profile
   g. NTCIP 2103 Point to Point Protocol (PMPP) Using RS-232 Subnetwork Profile
   h. NTCIP 2104 Ethernet Subnetwork Profile
   i. NTCIP 2201 Transportation Transport Profile
   j. NTCIP 2202, Internet (TCP/IP and UDP/IP) Transport Profile
   k. NTCIP 2301, Simple Transportation Management Framework (STMF) Application Profile

667.1.2.5 Pre-Build DMS Housing Structural Certification: Professional Engineer registered in the State of West Virginia shall analyze the DMS structural/electrical design and shall certify that the DMS:

1. Will withstand the temporary effects of being lifted by the lifting eyebolts provided
2. Will comply with the applicable requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
3. Will support a front face ice load of 4 pounds per square foot (19.5 kg/square meter)

The Professional Engineer shall analyze the complete DMS structural design. This includes the housing, mounting brackets, and lifting eyebolts, as well as the bracket-to-housing mounting hardware (nuts, bolts, washers, direct tension indicators, etc.) provided by the DMS manufacturer. Analysis shall include, but shall not be limited to:

1. The quantity and type of lifting eyebolts to be provided
2. The quantity and type of mounting brackets to be provided
3. The quantity and type of hardware (nuts, bolts, washers) used to attach the mounting brackets to the DMS
4. Verification that no dissimilar metals problem will exist and/or affect the structural integrity of the DMS to bracket attachment points
5. A recommendation of the number of attachment points, as well as the attachment locations, that the installing contractor should use when mounting the DMS to its support structure

The DMS manufacturer shall include a signed and sealed copy of this P.E. certification, including all supporting calculations, with the pre-build technical submittal.

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667.1.2.6 Pre-Build Technical Submittal: The DMS manufacturer shall provide a complete pre-build technical submittal within 30 days of contract award and shall not proceed with DMS manufacture until the Engineer has approved the submittal. The DMS manufacturer shall provide seven (7) copies of the submittal both in electronic format on CD and in paper format in three ring binders.

The submittal shall include:

1. All DMS manufacturer qualification information, as specified herein.
2. DMS shop drawing, including an illustration of the recommended installation method.
3. DMS structural calculations and certification by a registered professional engineer from the State of West Virginia.
4. DMS site riser diagram.
5. AC site power requirements, including the number of legs, current draw per leg, and maximum and typical site power consumption.
6. Major DMS schematics in block diagram form, including AC power distribution inside and outside the DMS, DC power distribution within the DMS, and control signal distribution inside and outside the DMS.
7. Drawings of major DMS components, including LED display modules, driver boards, control/logic components, environmental control assemblies, DMS sign controller, control equipment cabinet assembly, and control cabinet mounting footprint.
8. Catalog cut sheets for major DMS components, including front face paint material, polycarbonate face material, LEDs, regulated DC power supplies, circuit board conformal coating material, hookup wire, signal cable, surge suppression devices, load center, circuit breakers, utility outlets, sign controller, ventilation/cooling fans, heaters, ventilation filter, thermostats, and any other major system components.
9. Test reports and certification for all items identified in the “Product Testing” specifications herein/
10. DMS control software operator’s manual.

Documentation that proves the DMS manufacturer complies with these specifications shall be provided with the DMS manufacturer’s pre-build technical submittal. A cross-matrix shall be provided that lists each specification point and indicates whether the manufacturer meets that requirement.

This submittal shall also include five (5) references from states that have had NTCIP-compliant DMS from the manufacturer installed for a minimum of five (5) years and project information for all the manufacturer’s DMS customers of the last five (5) years, including:

1. Equipment owner/operator agency name.
2. Contact person name, telephone number, fax number, and email address.
3. DMS system name and location of operations control center (project name/number, roadway name/number, state, county, and country).
4. DMS commissioning date (first date of successful on-site operation).
5. DMS quantity.
6. DMS display pixel technology (LED, fiber optic, flip disk, etc.).
7. DMS display matrix size (pixel rows by pixel columns) and type (full matrix, line matrix, or discrete character).
8. DMS housing access type (walk-in, front, rear, or other specific access type).
9. Communications protocol used (NTCIP or proprietary; if proprietary, provide a name or description).
10. Type of communications backbone used (telephone, fiber optic, direct, etc.).
11. NTCIP compliance test reports prepared by independent testing companies, including contact information.

The pre-build submittal shall also include the following background information about the DMS manufacturer:

1. Full corporate name.
2. Corporate address.
3. Contact person name, telephone number, fax number, and email address.
4. Names and qualifications of the primary project team members, including the following: sales person, project manager, product manager, application engineer, and manufacturing manager.
5. Number of years in business under the current corporate name.
6. Copy of the DMS manufacturer’s in-house quality management system.
7. Copy of the DMS manufacturer’s certified welding procedure.
8. Copy of welding certifications for all personnel who will perform welding of the DMS housing.
10. DMS product literature.

Failure to provide complete and accurate submittal information, as specified herein, will be cause for rejecting the DMS manufacturer.

667.2-MATERIALS:

All materials furnished, assembled, fabricated or installed under this item shall be new, corrosion resistant and in strict accordance with the details shown in the plans and as detailed in
this specification. All details and functionality listed in this specification will be thoroughly inspected and tested by the department. Failure to meet all details and functionality detailed in this specification shall be grounds for rejection of the equipment.

The equipment design and construction shall utilize the latest available techniques with a minimum number of different parts, subassemblies, circuits, cards and modules to maximize standardization and commonality. The equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance. Test points shall be provided for checking essential voltages.

The DMS housing shall provide front service access for all LED display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components.

The DMS shall contain a full display matrix, dimensions of DMS is listed in the contract scope of work. Any deviation from the requested DMS dimensions must be approved by the ITS Coordinator or their designee. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

Each display pixel shall be comprised of multiple monochrome color LEDs according to the contract plans. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, and incandescent lamp, will not be accepted.

The pixel matrix shall be capable of displaying alphanumeric character fonts measuring a minimum of 18 inches (460 mm) high to a maximum of the display matrix height.

The sign shall be designed for a minimum life of 15 years.

The sign shall be designed and constructed so as to present a clean and neat appearance. Poor workmanship shall be cause for rejection of the sign.

All cables shall be securely clamped/tied in the sign housing. No adhesive attachments will be allowed.

The complete sign housing shall be designed and manufactured in-house by the LED DMS Sign Manufacturer.

The performance of the sign shall not be impaired due to continuous vibration caused by wind, traffic or other factors. This includes the visibility and legibility of the display.

The DMS hardware, along with the sign controller hardware, software and firmware, shall support all DMS functionality described throughout the remaining specification sections.

The DMS assembly shall be listed by an accredited 3rd party testing organization for conformance to Underwriters Laboratories (UL) standards 48 (Standard for Electric Signs) and 1433 (Control Centers for Changing Message Signs). Proof of this conformance shall be provided with submittal materials.

The Department acknowledges there may be alternative methods to meet the intent of the specification without meeting the exact wording of the specification. The Department encourages DMS Manufacturers to propose advances in technology and alternates to meet the Department's intent. Each deviation of the written specification must be clearly shown and the benefits explained in the bid proposal. The Department reserves the right to reject any specification alternate without reason to the DMS Manufacturer.

667.2.1-Electronic Materials and Components: All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods.

All workmanship shall comply with IPC-A-610C, Class 2 titled "Acceptability of Electronic Assemblies", ANSI/IPC-7711 titled "Rework of Electronic Assemblies" and
ANSI/IPC-7721 titled "Rework and Modification of Printed Boards and Electronic Assemblies."

All electronic components shall comply with Section Electronic Materials and Construction Methods, located in this document.

667.2.1.1-Printed Circuit Boards: Printed Circuit Board (PCB) design shall be such that components may be removed and replaced without damage to boards, traces or tracks. Only FR-4 0.062-inch minimum thickness material shall be used. Inter component wiring shall be copper clad track having a minimum weight of 2 ounces per square foot with adequate cross section for current to be carried. Jumper wires will not be permitted, except from plated-through holes to component. The maximum number of jumper wires allowed per circuit board is two.

All Printed Circuit Boards (PCBs), except for the UPS PCBs, modem PCBs shall be completely conformal coated with an acrylic resin conformal coat. The material used to coat the PCBs shall meet the military specification: MIL-I-46058C Type SR and IPC-CC-830.

All PCBs shall be finished with a solder mask and a component identifier silk screen.

667.2.1.2-Components: All components shall be of such design, fabrication, nomenclature, or other identification so as to be purchased from a wholesale electronics distributor, or from the component manufacturer, except for printed circuit board assemblies.

Circuit design shall be such that all components of the same generic type, regardless of manufacturer, shall function equally in accordance with the specifications.

All discrete components, such as resistors, capacitors, diodes, transistors, and integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and replacement.

667.2.1.2.1-Capacitors: The DC and AC voltage ratings as well as the dissipation factor of a capacitor shall exceed the worst-case design parameters of the circuitry by 50%.

A capacitor which can be damaged by shock or vibration shall be supported mechanically by a clamp or fastener.

Capacitor encasements shall be resistant to cracking, peeling and discoloration.

667.2.1.2.2-Resistors: Any resistor shall not be operated in excess of 50% of its power rating.

667.2.1.2.3-Semiconductor Devices: All transistors, integrated circuits, and diodes shall be a standard type listed by EIA and clearly identifiable.

667.2.1.2.4-Connectors: All display circuits PCB edge connectors and cable connectors, except for those found in the power supply, UPS, modem and sign controller, shall be base plated with nickel and finished with 30 micro-inches of gold.

667.2.2-Mechanical Components: All external screws, nuts, and locking washers shall be stainless steel. No self-tapping external screws shall be used. All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. All materials used
in construction shall be resistant to fungus growth and moisture deterioration. Dissimilar metals shall be separated by an inert dielectric material.

667.2.3-Sign Controller: This section describes the minimum specifications for the dynamic message sign (DMS) controllers and auxiliary control panels to be provided with this contract. The contractor shall provide all the materials, software, and services necessary to install DMS controllers, auxiliary control panels, and any associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

667.2.3.1-General Controller Requirements: Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following electrical and mechanical requirements:
1. All printed circuit boards shall be sealed with an acrylic conformal coating
2. Mount in a standard EIA 19-inch (480 mm) equipment rack with a maximum 4U space requirement
3. Weigh no more than 10 pounds, including its enclosure
4. Consume no more than 30 watts of power
5. Powered by an internal regulated DC power supply capable of operating on 120VAC or 240VAC at both 50Hz and 60Hz
6. The DMS shall operate on 120 VAC.

The sign controller shall meet the following operational requirements:
2. Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation.
3. Include a front panel user interface with LCD and keypad for direct operation and diagnostics as described herein.
4. Contain a minimum of three (3) NTCIP-compliant RS232 communication ports.
5. Contain a minimum of one (1) NTCIP-compliant RS422 communication port with RJ45 connector
6. Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector.
7. Contain a minimum of three (3) NTCIP-compliant Ethernet ports with RJ45 connector.
8. Contain a minimum of three (3) NTCIP-compliant Ethernet ports with RJ45 connector.
9. Consume no more than 30 watts of power

667.2.3.1.1-Equipment Cabinet and Sign Controller Location: The DMS sign controller shall be located in a pole mounted control equipment cabinet within a 336S-type or equivalent cabinet. The cabinet shall enclose the sign controller panel board, 120 VAC electrical outlets, and remote communication devices, such as a modem.

The DMS cabinet shall meet NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
Internal cabinet component hardware shall be fabricated from hot dipped galvanized steel, stainless steel, aluminum, nylon or other durable corrosion-resistant materials suitable for roadway signage applications.

The DMS controller cabinet shall be constructed using a minimum of 0.125-inch-thick aluminum alloy 5052-H32. The exterior of the controller cabinet shall be natural mill-finish aluminum.

The DMS cabinet shall provide safe and convenient access to all modular assemblies. The base of the cabinet shall be mounted at three (3) feet above ground. The minimum cabinet dimensions shall be 46 inches in height, 24 inches wide, and 20 inches in depth. There shall be two (2) doors extending the full length of the cabinet, with a full-length stainless steel hinge and mounting hardware. The door shall latch to a double-flanged door opening with a three-point draw-roller mechanism. The door handle shall be stainless steel. The doors shall each be equipped with a #2 lock.

A fluorescent lamp shall be located at the top of the controller cabinet to illuminate the cabinet interior. A switched mounted near the front door shall automatically turn on the light when the door is opened.

The cabinet shall contain a full-height EIA 19-inch rack. This rack shall contain a minimum of one (1) pull-out drawer. The drawer shall be able to latch in the out position to function as a laptop/utility shelf.

The cabinet shall contain a power panel board and circuit breakers that meet the following minimum requirements:
1. Service entrance-rated
2. Minimum of 12 circuit breaker mounting positions
3. Short circuit ratings of 22,000 amps and 10,000 amps for the main and Service branch circuits respectively
4. UL listed

The cabinet shall contain a utility outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets, with ground-fault circuit interrupters. The outlets shall be mounted inside the cabinet and located near the panel board. The cabinet shall include one (1) earth ground lug that is electrically bonded to the cabinet. All earth grounding shall conform to the National Electrical Code.

One (1) thermostatically controlled 100 cfm exhaust fan shall be mounted near the top of the control cabinet. Filtered air intake ports shall be located on the bottom third of each access door. The fan and air filters shall be removable and replaceable from inside the cabinet.

The sign controller cabinet shall include the following:
1. Communications equipment
2. Display system interface circuits
3. Local/remote control switch
4. Local control LED indicator
5. AC and Communication surge protection
6. RS-232 plug-in connection for a laptop computer
7. RS-232 cable (minimum of four feet long)
8. Uninterruptible Power Supply

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667.2.3.1.2.1-Front Panel User Interface: The sign controller’s front panel shall include a menu driven architecture, 16-button keypad, and a 64x240 graphical LCD screen. These devices shall be used to perform the following functions with the sign controller and DMS:

1. Monitor the current status of the sign controller, including the status of all sensors and a monochromatic -What-You-See-Is-What-You-Get (WYSIWYG) representation of the message visible on the display face including the use of graphical messages
2. Perform all diagnostics testing of various system components, including pixels, power systems, sensors, and more
3. Activate, create, preview, and delete messages stored in memory
4. Blank the sign
5. Start and stop the schedule
6. Configure display parameters, including display size and color technology
7. Configure date and time
8. Configure communications port settings and NTCIP options
9. Configurable level of password protection per user
10. Select automatic or manual brightness mode of operation

The front panel interface shall also include:

1. Power switch to turn the controller on and off
2. LED power “on” indicator
3. “Local/remote” switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
4. LED to indicate state of the “local/remote” mode switch
5. Reset switch to quickly restart the controller
6. LED “Active” indicator that blinks when the controller is operating correctly
7. LED to indicate when any of the NTCIP communication channels are active

667.2.3.1.2.2-Memory: The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of 100 changeable messages in non-volatile RAM.

667.2.3.1.2.3-Internal Clock: The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 30 days without external power, and the clock shall automatically adjust for daylight savings time and leap year using hardware, software, or a combination of both. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

667.2.3.1.2.4-System Status Monitoring/Diagnostics: The DMS controller shall be capable of monitoring the status of DMS components and subsystems in real-time and/or manual modes. The DMS controller shall provide the following:

1. Message Display Status-Monitor and display the currently active message on
the controller’s front LCD display. This display shall be in a WYSIWYG format.

2. LED Pixel Testing - Upon command from either the front panel interface or via NTCIP remote control software, the controller shall direct all of the LED modules to perform diagnostic tests of all pixels.

3. Power Supply Operation - The sign controller shall monitor and report the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.

4. Door State - The DMS shall monitor and report “door open status”.

5. Fan Operation - The DMS will be equipped with fan diagnostic systems and the controller shall monitor and report the status of the fans.

6. Environmental Conditions - The DMS controller shall monitor the readings of all light, temperature, and humidity sensors installed within the DMS housing.

667.2.3.1.2.5 - Error Notification: The DMS controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and the central control system (via NTCIP communications) of the occurrence of important events and subsystem failures. The major component and subsystem errors shall be indicated on the controller’s LCD front panel. The controller shall be capable of sending event notifications to the control system via SNMP “traps” as allowed by NTCIP.

The following errors and events that the controller shall report as defined above:

1. Over Temperature Shutdown - The DMS controller shall continuously monitor the DMS housing’s temperature sensors and shall automatically shut down the DMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +140 degrees Fahrenheit and shall be configurable at the controller. If the temperature approaches the threshold the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign shall remain blank until the temperature begins to drop. The sign controller shall include a visual indication on the controller’s front panel LCD.

2. Controller Restart - When the Controller detects that is been restarted due to a manual reset or error condition, it shall send a notification to the central system.

3. Power Loss - When the DMS controller detects that it has lost power, it shall automatically indicate that on the front panel LCD. It shall also send a notification to the central system.

4. Power System Failure - The DMS controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. This failure shall be reported and notified to the central system.

5. Door Opened - When the sign controller detects that one of the sign cabinet or control cabinet doors have been opened, it will report this alarm to the central system.

6. Communication Loss - The DMS controller shall monitor the frequency of communication packets from the central system for longer that a configurable timeout, then the controller will automatically activate a communication loss
message as defined by NTCIP.

**667.2.3.2-Auxiliary Control System:** The DMS shall include an auxiliary control panel that will provide a secondary user interface panel for DMS control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical and environmental specification as the DMS controller. It shall be powered independently from a 120 VAC outlet.

This auxiliary system shall be located inside the DMS cabinet to facilitate operation by maintenance personnel while working inside the DMS.

The auxiliary control panel shall interface to the DMS controller using Category 5 copper cable. It shall be capable of operating up to 4000 feet from the DMS controller.

The auxiliary control system shall be an extension of the sign controller and shall have the following characteristics:

1. Have a LCD panel and keypad identical to those found on the DMS Controller.
2. Run diagnostic tests and display any faults.
3. Ability to program messages for display on sign without connecting a laptop Computer,
4. Display pixels in a WYSISYG format.
5. RS-232 that meet the same specifications as the DMS Controller.
6. Local/remote switch
7. Reset switch
8. Status LEDs
9. Two-120 VAC GFI duplex outlets

**667.2.3.3-Communication Modes:** All remote communication ports shall be NTCIP-compatible as defined in the “Requirements for NTCIP Compatibility” section of these specifications.

The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

1. Remotely via direct or Broadband/LTE communications with a remotely located computer. The system communications backbone, as well as all field modems or signal converters, shall provide the DMS sign controller with an RS232 signal.
2. Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RS232 null modem connection.

Communication between the central controller and the sign controller must be capable of operating with one of the modem(s) described below:

**667.2.3.3.1-Fiber-Optic Modem:** The fiber-optic modem shall be a Model FO212 Multimode modem, and shall match the fiber and communications characteristics of the fiber-optic modem at the central office.

**667.2.3.3.2-Ethernet Port:** The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for optional use for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.
Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

**667.2.3.3.3-Serial Communication Ports:** The DMS sign controller shall contain a minimum of three (3) NTCIP-compatible RS232 communication ports. These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

The baud rate, connection type, and NTCIP communication protocol shall be configurable. Each port must support all typical serial baud rates ranging from 1200 to 115,200 baud. All three ports shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP) or NTCIP 2103 (PPP). They shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles. Only one each of the transport and sub network profiles shall be active at any time on each port.

**667.2.3.3.4-Switching Between Dial-Up, Multi-Drop and Fiber-Optic Operation:** Switching between dial-up, multi-drop and fiber-optic operation shall require no software or hardware modifications. No tools, other than a standard screw driver, shall be required. No jumpers or switches shall be changed, except for front-panel switches to set baud rate or other communication parameters. The only required changes shall be:

1. The existing modem shall be removed and replaced with the new modem.
2. The sign’s communication type shall be easily reconfigured at the controller front panel.

**667.2.3.3.5-Controller Addressing:** The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

**667.2.3.4-Uninterruptible Power Supply (UPS):** A UPS shall be provided to allow the sign controller to notify the central controller when an improper power condition at the DMS persists for longer than a user selectable “short power loss time”.

The UPS shall meet the following minimum specifications:

3. Capacity: Must be able to operate controller & modem for 10 minutes
4. Voltage Nominal: 120VAC
5. Voltage Range: 92-135 VAC
6. Transfer time: <150 ms typical
7. Battery: Sealed, maintenance-free lead acid
8. Battery recharge time: 2-8 hours; must be temperature-compensated
9. Over current protection: UPS automatic shutdown if overload exceeds 110% of nominal for 3 minutes.
10. Communications: RS-232 Interface (monitor, control and calibrate), DB-9 connection
11. Front panel display indicators: Fault, Test, Low Battery, On Battery, On Line
12. Operating temperature range: \(-37^\circ C\) to \(+74^\circ C\)

(NO\(\text{E}\)TE: The UPS shall be mounted and operated in a manner to meet the temperature range requirements of the DMS as outlined in Section 667.2.4 (-34°C to 74°C (-29°F to 165°F) with a relative humidity of up to 100% condensing).

**667.2.4-Front Access Housing:** The front access housing dimensions and total weight shall be as shown in the plans. The front access housing shall be designed and manufactured to be rain and weather tight.

DMS and sign controller components shall operate in a minimum temperature range of \(–30^\circ F\) to \(+165^\circ F\) (-34°C to +74°C) and a relative humidity range of 0 to 99%, non-condensing. DMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of \(-40^\circ F\) to \(+185^\circ F\) (-40°C to +85°C).

External DMS component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the roadway signage application.

DMS and sign controller components shall be 100% solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DMS and the sign controller shall be UL (Underwriter’s Laboratory) listed and meet all local NEC codes applicable to DMS applications.

The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DMS system. The DMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DMS and its sign controller.

The equipment within the sign housing shall be protected from moisture, dust, dirt and corrosion. The sign housing shall meet NEMA 3R enclosure criteria as defined in NEMA Standards Publication 250, “Enclosures for Electrical for Electrical Equipment (1000 Volts Maximum).

The sign housing shall be engineered to AASHTO and NCHRP Report 411 specifications for basic AASTHO wind speeds and centerline sign heights up to 40ft. The sign housing shall also be engineered to withstand group loading combinations as outlined in AASHTO including: sign weight, repair personnel and equipment, snow (40 psf), ice and wind loads, and shall also meet strength requirements for truck-induced gusts as specified in NCHRP Report 412.

**667.2.4.1-Surface Finish:** The major structural frame members in the DMS housing shall consist of aluminum extrusions made from 6061-T6 aluminum alloy. Minor structural frame members shall consist of 0.125 inch (3.17 mm) thick formed sheet stock made from 5052-H32 aluminum alloy. The rear of the DMS housing exterior shall be covered with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum
alloy. This external aluminum skin shall be attached to the structural framework using a proven method of attachment.

The DMS housing’s right, left, front and rear exterior walls shall be vertical. The top and bottom walls shall be horizontal. LED display modules shall be mounted parallel to the front wall so the legible LED viewing area is optimized.

DMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be stainless steel or galvanized A325 high-strength steel and shall be appropriately sized for the application.

**Chemical Bonding:** The external aluminum sheets shall be attached to the cabinet frame members using a two-part chemically bonding structural adhesive. The adhesive shall be applied in a continuous bead on all cabinet frame surfaces that contact the aluminum sheet. The adhesive shall ensure a watertight seal is obtained around the entire perimeter of the cabinet and where any aluminum sheets are spliced.

To ensure that appropriate procedures are followed to bond the aluminum sheet and cabinet frame members, the structural adhesive manufacturer shall certify the DMS manufacturer’s adhesive application process. The DMS manufacturer is responsible for performing all necessary testing of the adhesive to meet all requirements of the contract specifications.

**Exterior Finish:** DMS front face panels and front face border pieces shall be coated with semi-gloss black Kynar 500 resin, which has an expected outdoor service life of 10 to 15 years. All other DMS housing surfaces, including the DMS mounting brackets, shall be natural mill-finish aluminum.

**667.2.4.2-Internal Structure:** The interior housing structural members shall be 6061-T6 aluminum alloy extrusions, and shall be designed to accommodate air distribution to the LED display modules.

**667.2.4.3-Mounting:** Multiple mounting brackets in the form of Z-bar extrusions shall be bolted to the DMS housing exterior rear wall to facilitate attachment of the DMS to the support structure. Mounting brackets shall be:

1. Extruded from aluminum alloy number 6061-T6
2. Attached to the DMS structural frame members, not just the exterior sheet metal
3. Installed at the DMS manufacturer’s factory
4. Attached to the DMS using mechanically galvanized A325 high-strength steel bolts
5. Attached to the DMS using direct tension indicators to verify that mounting hardware is tightened with the proper amount of force
6. Installed such that all bracket-to-DMS attachment points are sealed and watertight
7. Designed and fabricated such that the installing contractor can drill into them without penetrating the DMS housing and compromising the housing’s ability to shed water

**Lifting Hardware:** For moving and installation purposes, multiple galvanized steel lifting eyebolts shall be attached to the top of the DMS housing. Eyebolt hardware shall
attach directly to the DMS housing structural frame and be installed at the DMS factory.
All mounting points for eyebolts shall be sealed to prevent water from entering the DMS
housing. Lifting hardware, as well as the housing frame, shall be designed such that the
DMS can be shipped and handled without damage or excessive stress being applied to the
housing prior to or during DMS installation on its support structure.

The lifting eyebolts shall be easily removed by one individual without opening or
entering the display and without any risk of compromising water-tightness. Special tools
shall not be required. Removal of the eyebolts shall not create holes and no replacement
bolts or other hardware shall be necessary to seal the cabinet.

667.2.4.4-Front Face Construction: The DMS front face shall be constructed with
multiple vertically hinged rigid door panels, each of which contains a full-height section of
the LED display matrix. The door panels shall be fabricated using aluminum sheeting on
the exterior and polycarbonate sheeting on the interior of the panel.

The DMS housing shall provide safe and convenient access to all modular assemblies,
components, wiring, and subsystems located within the DMS housing. All of those internal
components shall be removable and replaceable by a single technician.

Door Construction: One (1) access door shall be provided for each 10 or 15 pixel
wide section of the sign housing. These doors shall be vertically hinged and shall contain
a section of the sign’s front face. The doors shall swing out from the face to provide access
to the cabinet interior. Each door shall extend the full height of the display matrix.

To prevent open doors from blowing in wind, they shall each have a retaining latch
mechanism to hold the door open at a 90-degree angle.

Each door shall form the face panel for a section of the sign. The LED modules shall
be mounted to the door and be removable from the door when in the open position. Other
sign components, such as power supplies, wiring, etc. shall be located inside the sign
cabinet and be accessible through the door opening. Each door shall cover an opening that
is a minimum of 23-inches (584 mm) wide and the same height as the display pixel matrix.

Each door shall contain a minimum of two (2) captive-type latches to lock them in the
closed position. These latches shall be captive to prevent them from falling off. They shall
pull the door tight and compress a gasket located around the perimeter of each door. They
shall also be capable of providing leverage to easily release the gasket seal when opening
the doors. The gasket shall prevent water from entering the cabinet around the doors.

Face Panels: Front face panels shall provide a high-contrast background for the DMS
display matrix. The aluminum mask of each door panel shall be painted black and shall
contain an opening for each pixel. Openings shall be large enough to not block any portion
of the viewing cones of the LEDs.

Each door panel shall have a single polycarbonate sheet attached securely to the inside
of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The
polycarbonate shall be sealed to prevent water and other elements from entering the DMS.
The polycarbonate shall contain UV inhibitors that protect the LED display matrix from
the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate
itself. The use of a plastic lens system will not meet the requirements and will be cause for
rejection. Polycarbonate sheets shall have the following characteristics:

1. Tensile Strength, Ultimate: 10,000 PSI
2. Tensile Strength, Yield: 9,300 PSI
3. Tensile Strain at Break: 125%
4. Tensile Modulus: 330,000 PSI
5. Flexural Modulus: 330,000 PSI
7. Rockwell Hardness: M75, R118
8. Heat Deflection Temperature Under Load: 264 PSI at 270F and 66 PSI at 288F
9. Coefficient of Thermal Expansion: 3.9X10^-5 in/in/F
10. Specific Heat: 0.30 BTU/lb/F
11. Initial Light Transmittance: 85% minimum
12. Change in Light Transmittance, 3 years’ exposure in a Southern latitude: 3%
13. Change in yellowness Index, 3 years’ exposure in a Southern latitude: less than 5%

LED display modules shall mount to the inside of the DMS front face door panels. No tools shall be needed for removal and replacement of LED display modules.

DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility. The surrounding borders shall be a minimum of 12” in accordance with NEMA TS4 Hardware Standards for Dynamic Message Sign with NTCIP requirements.

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

**667.2.4.5-Drain Holes:** The DMS housing bottom side shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes and ventilation -exhaust hoods shall be screened to prevent the entrance of insects and small animals.

**Housing Ventilation System:** The DMS shall contain an electronically controlled ventilation system and a failsafe thermostat designed to keep the internal DMS air temperature lower than +140°F (+60°C), when the outdoor ambient temperature is +115°F (+46°C) or less.

The ventilation system shall consist of one or more air intake ports. Intake ports shall be located near the bottom of the DMS rear wall. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger. One or more ball bearing-type fans shall be mounted at each intake port. These fans shall positively pressure the DMS cabinet.

Fans and air filters shall be removable and replaceable from inside the DMS housing. To ease serviceability, the fans shall be mounted no more than four (4) feet from the floor of the DMS cabinet.

Each ventilation fan shall contain a sensor to monitor its rotational speed, measured in revolutions per minute. The fan speed shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The ventilation system shall move air across the rear of the LED modules in a manner such that heat is dissipated from the LED’s. The airflow shall move from the bottom of the cabinet towards the top to work with natural convection to move heat away from the modules.
Each exhaust port shall be located near the top of the rear DMS wall. One exhaust port shall be provided for each air intake port. All exhaust port openings shall be screened to prevent the entrance of insects and small animals.

An aluminum hood attached to the rear wall of the DMS shall cover each air intake and exhaust port. Openings shall be screened to prevent the entrance of insects and small animals. All intake and exhaust hoods shall be thoroughly sealed to prevent water from entering the DMS.

**Over Temperature Safety Shutdown:** The DMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and shall have a default factory setting of 140°F (+60°C).

**Sign Controller Signal Interface:** With the sign controller being located in a ground-mounted traffic cabinet, the communication signals from the external sign controller to the DMS shall use fiber optic cable with the following specifications:

1. 62.5/125 μm diameter
2. ST-style connectors
3. Rated for indoor/outdoor use
4. UL-rated
5. PVC outer jacket
6. Tight buffer inner jacket
7. Operating temperature range: –40°F to +185°F (–40°C to +85°C)

A minimum of six (6) fibers shall be provided with one (1) for controller to sign commands, one (1) for sign to controller responses, and four (4) spares.

**Discrete LED:** DMS pixels shall be constructed with discrete LEDs manufactured by a reputable manufacturer such as Avago Technologies (formerly Agilent Technologies), Toshiba Corporation, Nichia Corporation, OSRAM, or EOI. Discrete LEDs shall conform to the following specifications:

1. All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer’s product specifications and shall not exceed +/- 5 degrees. Using optical enhancing lenses with 15 degree LED’s will not conform to 30 degree half-power viewing cone specifications and will be cause for rejection.
2. Red LEDs shall utilize AlInGaP semiconductor technology and shall emit red light that has a peak wavelength of 615-635nm.
3. Green LEDs shall utilize InGaN semiconductor technology and shall emit green light that has a peak wavelength of 520-535nm.
4. Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 464-470nm.
5. The LED packages shall be fabricated from UV light resistant epoxy.
6. The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive luminous intensity “bins” as defined by the LED manufacturer.
7. The LED manufacturer shall perform color sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive color “bins” as defined by the LED manufacturer.

8. The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.

9. The LED manufacturer shall assure color uniformity and consistency on the LED display face within the 30-degree cone of vision. Inconsistent color shifts or intensity will be cause for rejection.

10. LED package style shall be through-hole flush-mount. Through-hole LEDs with standoffs or surface-mount LEDs will not be accepted.

11. All LEDs used in all DMS provided for this contract shall be from the same manufacturer and of the same part number, except for the variations in the part number due to the intensity and color.

12. The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 70% of the original brightness.

**RGB LED Display Modules:** The DMS shall contain LED display modules that include an LED pixel array and LED driver circuitry. These modules shall be mounted adjacent in a two-dimensional array to form a continuous LED pixel matrix. Each LED display module shall be constructed as follows:

1. Each LED display module shall consist of one circuit board.

2. All LED modules shall be manufactured using laminated fiberglass printed circuit boards.

3. Each LED display module shall be mounted to the rear of the display’s front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel’s pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels. The use of light enhancing lenses to achieve defined viewing cone shall be cause for rejection.

LED display module electrical connections shall use a quick-disconnect locking connector. Removal of an LED display module from the DMS, or a pixel board or driver circuit board from its display module, shall not require a soldering operation.

1. All exposed metal on both sides of each printed circuit board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of conformal coating. Bench level repair of individual components, including discrete LED replacement and conformal coating repair, shall be possible.

2. Individual addressing of each LED display module shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.

3. It shall not be possible to mount a display module upside-down or in an otherwise incorrect position within the DMS display matrix.

4. All LED display modules shall be identical and interchangeable throughout the DMS.
5. Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.

**RGB LED Pixel Boards:** Each LED module shall contain a printed circuit board to which LED pixels are soldered. The LED pixel matrix shall conform to the following specifications:

1. Each LED pixel circuit board shall contain a minimum of 45 LED pixels configured in a two-dimensional array. The pixel array shall be a minimum of nine (9) pixels high by five (5) pixels wide.
2. The distance from the center of a pixel to the center of each adjacent pixel, both horizontally and vertically, shall be 2.6 inches (66 mm).
3. All pixels shall contain an equal quantity of discrete LEDs and LED strings. If a pixel contains four (4) or more discrete LEDs, then each pixel shall contain a minimum of two (2) independent and parallel strings of discrete LEDs.
4. The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DMS.

Each pixel shall also be capable of displaying colored light with a minimum luminous intensity of 9,200 candelas per square meter when measured using a photometric meter through the front face panel assembly. Failure to conform to the requirements will be cause for rejection.

1. The circular base of the discrete LEDs shall be soldered so that they are parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

**RGB Pixel Drive Circuitry:** Each LED display module shall contain electronic driver circuitry that shall individually control all pixels on that module. The driver circuitry shall conform to the following specifications:

1. Each LED driver circuitry shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.
2. Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer’s recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer’s recommendations for the 100,000-hour lifetime requirement.
3. The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.
4. The LED driver circuitry shall receive updated display data at a minimum rate of ten (10) frames per second from the sign controller.
5. Each LED driver circuit shall be powered by 24 VDC from external regulated DC power supplies. Each driver circuit shall receive power from a minimum
of two (2) independent power supplies. Indicator LEDs shall be provided to indicate the status of each power source.

6. Each LED driver circuit shall contain a microprocessor-controlled power regulation circuit that controls the voltage applied to the LED strings. The power circuit shall automatically adjust the voltage supplied to the LEDs to optimize power consumption efficiency as the temperature changes.

7. The voltage of each power input shall be measured to the nearest tenth of a volt and reported to the sign controller upon request. Each driver circuit shall also contain one status LED for each power source that indicates if the power source is present or not.

8. The LED driver circuitry shall be able to detect that individual LED strings or pixels are stuck off and shall report the pixel status to the sign controller upon request.

9. The LED driver circuit shall contain a seven-segment numeric LED display that indicates the functional status of the driver and pixel boards. At a minimum, it shall indicate error states of the LED pixels and communication network. The indicator shall be positioned such that a maintenance technician can easily view the status code for diagnostic purposes. The status codes shall also be reported to the sign controller upon request.

**RGB Regulated DC Power Supplies:** The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the DMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two (2) physically and electrically independent supplies. Each pair of power supplies shall be parallel but shall not be wired in a current sharing configuration. Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100% of the pixels in that display region at 100% brightness when the internal DMS air temperature is +140°F (60°C) or less.

Each power supply within each pair shall receive 120VAC power from separate circuits on separate circuit breakers, such that a single tripped breaker will not disconnect power from both supplies. It shall be acceptable for a single circuit breaker to power multiple DC power supplies provided that none of those power supplies are in the same power supply pair.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The output of each power supply shall be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DMS.
The power supplies used to power the LED pixel modules shall be have an application of acrylic conformal coating, to protect from the environmental elements, and must be UL listed.

1. Regulated DC power supplies shall conform to the following specifications:
   2. Nominal output voltage of 24 VDC +/- 10%
   3. Nominal maximum output power rating of 1000 watts
   4. Operating input voltage range shall be a minimum of 90 to 260 VAC
   5. Operating temperature range shall be a minimum of –30°F to +165°F (-34°C to +74°C)
   6. Maximum output power rating shall be maintained over a minimum temperature range of –30°F to +140°F (-34°C to +60°C)
   7. Power supply efficiency shall be a minimum of 80%
   8. Power factor rating shall be a minimum of 0.95
   9. Power supply input circuit shall be fused
   10. Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
   11. Power supplies shall be UL listed
   12. Printed circuit boards shall be protected by an acrylic conformal coating

667.2.4.6-Display Assembly: Display modules shall be assembled to achieve a full matrix. Each display module shall include an LED display circuit board. The driver board shall contain the solid-state electronics necessary to control pixel data and read pixel status.

All LED boards and driver boards shall be fully interchangeable and shall not require any manual addressing switches or adjustment when interchanged or placed in service.

The display modules shall be mounted to the display face in a manner that facilitates easy and rapid removal of each display module without disturbing adjacent display modules. Replacement of a complete display module shall be possible without the use of any tools.

667.2.5-Power: The sign and its sign controller shall be capable of operating with 120 VAC, 60 Hz, single-phase power.

667.2.5.1-Power and Signal Entrances: Two threaded conduit hubs shall be located on the rear wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

667.2.5.2-Load Center: The DMS shall contain a power load center and circuit breakers that meet the following minimum requirements:
   1. Service entrance-rated
   2. Minimum of 20 circuit breaker mounting positions
   3. Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
   4. UL listed load center and circuit breakers

667.2.5.3-Internal Wiring: Inside the sign housing, all 120 VAC service lines shall be independently protected by a thermo magnetic circuit breaker at the sign housing entry point. All 120 VAC wiring shall be located in conduit, pull boxes, raceways or control cabinets as required by the National Electric Code (NEC). No 120 VAC wiring shall be
exposed to the inside or outside of the sign housing. The sign housing shall not be considered as a raceway or control cabinet.

Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

The presence of power transients or electromagnetic fields, including those created by any components of the system, shall have no deleterious effect on the performance of the system. The system shall not conduct or radiate signals which will adversely affect other electrical or electronic equipment including, but not limited to, other control systems, data processing equipment, audio, radio, and industrial equipment.

667.2.5.4—Earth Grounding: The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing’s rear wall. The DMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

667.2.6—Surge Protection: The DMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:

Site AC Power: The AC power feed for all equipment shall be protected at the load center by a parallel connection surge suppression rated for a minimum surge of 10 kA.

Control Equipment Power: A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communications equipment. This device shall conform to the following requirements:
1. Withstand a peak 50,000 ampere surge current for 8 x 20 microsecond waveform
2. Maximum continuous operating current of 15 amps at 120 VAC, 60Hz
3. Series inductance of 200 micro henrys (nominal)
4. Temperature range of -40°F to +158°F (-40°C to +70°C)
5. The device shall be UL-1449 recognized with a surge rated of 400 V or less.

Tripping of the surge protection shall cause the sign controller to report an error condition to the central operation, or report an error condition to central office on the next poll. Tripping of the surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced.

667.3—OPERATIONAL CHARACTERISTICS:
The DMS System shall have the ability to produce the following message types, styles and fonts. These are the minimum required, but if the manufacture normally utilizes additional features, they shall not be removed to meet the wording in this specification.
667.3.1-Messaging: The DMS controller shall have the ability to display messages on the DMS display face as required herein.

667.3.1.1-Legibility: DMS messages shall be legible within a distance range of 50 ft (15.2 m) to 300 ft (91.4 m) from the DMS display face under the following conditions:
   1. Whenever the DMS is displaying alphanumeric text that is 5.5-inches (140 mm) high
   2. 24 hours per day and in most normally encountered weather conditions
   3. During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DMS
   4. When viewed by motorists and travelers that have 20-20 corrected vision
   5. When the motorist eye level is 3 feet (914 mm) to 12 feet (3,658 mm) above the roadway surface.

667.3.1.2-Message Presentation on the DMS Display Matrix: The sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the sign controller shall support the following features as described in the DMS specification:
   1. Display of alpha numeric characters, including letters, numbers, and punctuation
   2. Selection of particular character fonts style
   3. Horizontal alignment of text on the display, including left, center, and right justification
   4. Vertical alignment of text on the display, including top, middle, and bottom justification
   5. Adjusting the spacing horizontally between characters or vertically between lines of text
   6. Alternating between pages of a multiple-page message
   7. Display of graphic bitmaps of various sizes ranging to very small to the size of the entire DMS matrix

667.3.1.3-Message Effects: The DMS shall be able to display messages using the following types of effects:
   1. Static Message-The selected message is displayed continuously on the sign face until the sign controller blanks the sign or causes the display of another message
   2. Flashing Message-All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
   3. Scrolling Message-The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
   4. Multiple-Page Message-A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page’s display time is user programmable from 0.1 seconds to 25.5 seconds, and adjustable in increments of 0.1 seconds.

667.3.1.4-Message Activation: Messages shall be activated on a DMS in three ways:
   1. Manual-An operator using the front panel LCD/keypad interface or NTCI-
compatible control software manually instructs a particular message to be activated.

667.3.1.5-Message Display Functions: A displayed message shall remain on the sign until one of the following occurs:
1. The message’s duration timeout expires
2. The controller receives a command to change the message
3. The controller receives a command to blank the sign

It shall be possible to confer a “priority” status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

The DMS shall also be capable of the following:
1. The sign controller shall also be able to accept a downloaded library from the central or laptop computer of a minimum of 500 changeable messages stored in non-volatile RAM. These messages may be called for display on the sign from the keypad on the front panel of the controller.
2. The sign controller shall also be capable of displaying messages on the sign that are downloaded from the central controller or laptop computer, but are not located in the library stored in non-volatile memory of the sign controller.
3. The sign shall have the capability to display automatically-scaled character fonts applied to a given message to maximize the font size of the displayed text, up to the full height of the display for a single line of text.
4. The sign controller shall have the capability to display graphic images and icons downloaded from the central controller.
5. There shall be no perceivable blinking, flickering or ghosting of the pixels at any time, except during a pixel test as described above. The displayed message will not be affected in any way at any time for the pixel status read as described above.
6. The sign controller shall be able to put a self-updating time, temperature and/or date display on the sign.
7. The sign controller shall allow a moving arrow to be displayed by the central controller or laptop computer. The moving arrow shall be on one line with a standard message on the other lines. The moving arrows shall be from the left or right and shall start from one end or in the middle of the sign and continue to the end of the sign.

667.3.1.6-Display of Alphanumeric Text: The DMS sign controller shall support the storage and use of a minimum of twenty (20) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. All text font files shall include the following characters:
1. The letters “A” through “Z”, in both upper and lower case
2. Decimal digits “0” through “9”
3. A blank space
4. Eight (8) directional arrows
5. Punctuation marks, such as: . , ! ? – ‘ ” : ;
6. Special characters, such as: # & * + / ( ) [ ] < > @
The DMS supplier shall provide the DMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

Should include the following fonts (height x width, line width, fixed width)
1. 7 x 4, 1, variable
2. 7 x 6, 1, variable
3. 7 x 6, 2, variable
4. 7 x 8, 3, variable
5. 8 x 4, 1, variable
6. 8 x 6, 2, variable
7. 8 x 8, 3, variable
8. 9 x 5, 1, variable
9. 9 x 6, 2, variable
10. 9 x 8, 3, variable
11. 11 x 7, 2, variable
12. 11 x 9, 3, variable
13. 14 x 8, 2, variable
14. 14 x 10, 3, variable
15. 16 x 8, 2, variable
16. 16 x 10, 3, variable
17. 7 x 5, 1, fixed, as defined by NEMA 4 standards
18. 8 x 5, 1, fixed
19. 11 x 7, 2 fixed
20. 14 x 8, 2, fixed

**667.3.1.7-Display of Graphic Image:** The DMS control software shall support the inclusion of graphics in messages. If the NTCIP 1203 v2 standard has not reached a “recommended” or “approved” state by the time of contract award, the vendor shall support graphics using manufacturer-specific objects and MULTI tags.

If a manufacturer-specific means of supporting graphics is used, the vendor shall commit to provide NTCIP 1203 v2 firmware updates at no cost to the customer. These updates will include all current requirements of these specifications and also standard graphics support. The vendor shall install the updates no later than six months after the NTCIP 1203 v2 standard reaches the “approved” state.

**667.3.1.8-Brightness Control:** Automatic adjustment of the LED brightness shall occur in small enough increments so that the brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. Provision shall be made to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night. Pixel brightness shall be controlled by pulse width modulation of the DC current.

**667.3.1.8.1-Brightness Table:** The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness. The photo circuit readings shall be correlated with a brightness table in the sign controller. The brightness table shall have a minimum of 248 brightness levels. Each sign shall have its own, independent brightness table.
The brightness table in each individual sign controller shall be downloadable, both locally and from the central controller, and can be customized according to the requirements of the installation site.

667.3.1.8.2-Automatic Brightness Control: The DMS shall be capable of automatically adjusting LED brightness to account for changing ambient light conditions. The system required for this function consists of three primary component groups: Photocells, an adjustable brightness table and the overall brightness capability of the DMS.

667.3.1.8.2.1-Photoelectric Sensor Devices: Three (3) photocells shall be installed in the sign. These devices shall permit automatic light intensity measurement of light conditions at each sign location. These photocells shall be mounted in a manner to measure front, rear and ambient light conditions.

667.3.1.8.3-Manual Brightness Control: Brightness shall be manually settable from the front panel of the controller and remotely from the central computer in 1% increments from one to 99 percent. Brightness control shall be able to be returned to automatic from the sign controller front panel and the central computer.

667.3.2-Monitoring Functions: The following monitoring functions shall be conducted automatically on a set schedule and/or upon request from the central controller (a poll).

667.3.2.1-Power Supply Monitoring: Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

In addition, each group of power supplies may be monitored by a voltage monitor that is independent from the power supplies. This circuit shall monitor the voltage of each power supply. The power supply voltages shall be reported to the sign controller upon request.

This monitoring shall also be able to transmit to the central controller alert messages for:

1. AC power failure
2. AC power recovery
3. DC power supply failure
4. Surge protection has been tripped

667.3.2.2-Display Intensity Variation: There shall be a power distribution system that connects each display module to all power supplies and minimizes the voltage drop over the face of the sign. The voltage measured at the display modules shall not vary more than 50 milli-volts over all the display modules in the sign with 17 pixels on at 100% intensity in each and every display module.

667.3.2.3-Pixel Status Feedback: Pixel status feedback shall be provided to the central controller from the local sign controller and shall include the following:
667.3.2.3.1-Pixel Test: The pixel test shall be performed from the central controller on command and automatically once a day. During a pixel test, the full operational status of each string of LEDs in each pixel shall be tested and then transmitted to the central controller or laptop computer. A list of defective pixels shall be provided, listing pixel status, line number, column number and row number for each defective pixel. The pixel test must be completed in less than 0.5 seconds, regardless of message status.

667.3.2.3.2-True Message Display Verification (TMDV): The TMDV shall return the state of each pixel to the central controller as it is currently displayed to the motorist, including any errors. The TMDV shall be an actual real time read of the current flowing through each string of LEDs at the time of the associated sign poll or message download and shall not be accomplished by simulating errors based on the last pixel test. This shall allow the central controller operator to see what is visibly displayed to the motorist on an individual pixel basis.

The TMDV shall be performed during both message downloads and during every sign poll from the central controller or laptop computer. During a TMDV, the state of each pixel (full-on, or full off) in the sign shall be read by the sign controller to allow the central controller or laptop computer to show the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign. This message shall be shown on the central controller screen as a graphic representation, on an individual pixel basis. This pixel verification shall take place while a message is displayed on the sign without disturbing the message in any way. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel read shall be cause for rejection of the sign.

667.3.2.4-Door States: If the DMS or control equipment cabinet is equipped with access doors and sensors to monitor their open status, the controller shall monitor the status of those doors. This information shall be transmitted back to the central controller.

667.3.2.5-Environmental Conditions: The DMS controller shall monitor the readings of all light, temperature, humidity, and fan status sensors installed in the DMS housing. This system shall also monitor and report the status of all ventilation devices install within the DMS housing. This information shall be transmitted back to the central controller.

667.4-TESTING REQUIREMENTS:
The equipment covered by this specification shall be subjected to design approval tests (DAT), factory demonstration tests (FDT), stand-alone tests, systems tests and 72 hour and 90-day test periods to determine conformance with all the specification requirements. The Engineer may accept certification by an independent testing lab in lieu of the design approval tests to verify that the design approval tests have previously been satisfactorily completed. The DMS vendor shall arrange for and conduct the tests in accordance with the testing requirements stated herein. Unless otherwise specified, the DMS vendor is responsible for satisfying all inspection requirements prior to submission for the Engineer’s inspection and acceptance. The contract periods will not be extended for time lost or delays caused by testing prior to final Department approval of any items. The Engineer reserves the right to have his representative witness any and all tests. The results of each test shall be compared with the requirements specified herein. Failure to conform to the requirements of any test shall be counted as a defect, and the equipment shall be subject to rejection by the Engineer. Rejected equipment may be offered again for a retest, provided that all non-
compliance’s have been corrected and retest by the DMS vendor and evidence thereof submitted to the Engineer.

Final inspection and acceptance of equipment shall be made after installation at the designated location as shown on the plans, unless otherwise specified herein.

667.4.1-Test Procedures: The DMS vendor shall provide seven (7) copies of all design approval, factory demonstration, stand-alone and system test procedures and data forms for the Engineer’s approval at least sixty (60) days prior to the day the tests are to begin. The test procedures shall include the sequence in which the tests will be conducted. The test procedures shall have the Engineer’s approval prior to submission of equipment for tests.

The DMS vendor shall furnish data forms containing all of the data taken, as well as quantitative results for all tests. The data forms shall be signed by an authorized representative (company official) of the equipment manufacturer. At least one copy of the data forms shall be sent to the Engineer.

The DMS vendor shall be responsible for providing the test fixtures and test instruments for all the tests.

667.4.2-Design Approval Tests: Design approval tests shall be conducted by the DMS vendor on one or more samples of equipment of each type, as approved by the Engineer, to determine if the design of the equipment meets the requirements of this Specification. The test shall be conducted in accordance with the approved test procedures as described in Section 3.5.

If the design approval tests have not previously been satisfactorily completed by an independent testing lab and accepted by the Engineer, the Engineer shall be notified a minimum of thirty (30) calendar days in advance of the time these tests are to be conducted.

The design approval tests shall cover the following:

667.4.2.1-Temperature and Condensation: The DMS sign system equipment shall successfully perform all the functionality requirements listed in this specification under the following conditions in the order specified below:

1. The equipment shall be stabilized at –29°F (–34°C). After stabilization at this temperature, the equipment shall be operated without degradation for two (2) hours.
2. Moisture shall be caused to condense on the equipment by allowing it to warm up to room temperature in an atmosphere having relative humidity of at least 40% and the equipment shall be satisfactorily operated for two (2) hours while wet.
3. The equipment shall be stabilized at 165°F (74°C). After stabilization, the equipment shall be satisfactorily operated for two (2) hours without degradation or failure.

667.4.2.2-Primary Power Variation: The equipment shall meet the specified performance requirements when the nominal input voltage is 115 V ±15 V. The equipment shall be operated at the extreme limits for at least 15 minutes during which the operational test of the FDT shall be successfully performed.
667.4.2.3-Power Service Transients: The equipment shall meet the performance requirements, specified in the parent specification, when subjected to the power service transient specified in Section 2.1.6, “Transient, Power Service”, of the NEMA standard TS4. The equipment shall meet the performance requirements specified in the parent specification.

667.4.2.4-Relative Humidity: The equipment shall meet its performance requirements when subjected to a temperature of 149°F (65°C) and a relative humidity of 90%. The equipment shall be maintained at the above condition for 48 hours. At the conclusion of the 48 hour soak, the equipment shall meet the requirements of the operational test of the FDT within 30 minutes of beginning the test.

667.4.2.5-Vibration: The equipment (excluding cabinets) shall show no degradation of mechanical structure, soldered components, or plug-in components and shall operate in accordance with the manufacturer’s equipment specifications after being subjected to the vibration tests as described in Section 2.2.5, “Vibration Test”, of the NEMA standard TS4.

667.4.2.6-Consequences of Design Approval Test Failure: If the unit fails the design approval test, the design fault shall be corrected and the entire design approval test shall be repeated. All deliverable units shall be modified, without additional costs to the Department, to include design changes required to pass the design approval tests.

667.4.3-Factory Demonstration Tests: The DMS vendor shall be responsible for conducting Factory Demonstration Tests on all units at the DMS Vendor’s Manufacturing Facility. These tests shall be performed on each unit supplied. The Engineer shall be notified a minimum of thirty (30) calendar days before the start of tests. The DMS Vendor shall pay for all travel expenses, including airfare, rental car, hotel, meals, etc., for up to two department personnel for the Factory Demonstration Tests on the first unit at the Vendor’s Manufacturing Facility. All tests shall be conducted in accordance with the approved test procedure of Section 3.5. All equipment shall pass the following individual tests:

667.4.3.1-Examination Tests: Each piece of equipment shall be examined carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of the Specification.

667.4.3.2-Continuity Tests: The wiring shall be checked to determine conformance with the requirements of the appropriate paragraphs in the Specifications.

667.4.3.3-Operational Tests: Each piece of equipment shall be operated long enough to permit equipment temperature stabilization, and to check and record all performance characteristics to ensure compliance with the requirements of this Specification.

Equipment functionality will be thoroughly tested to verify complete compliance with all areas of this Specification.

667.4.3.4-Consequences of Demonstration Test Failure: If any unit fails to pass its demonstration test, the unit shall be corrected and another unit substituted in its place and the test successfully repeated.
If a unit has been modified as a result of a demonstration test failure, a report shall be prepared and delivered to the Engineer prior to shipment of the unit. The report shall describe the nature of the failure and the corrective action taken.

If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or extension of the contract period.

667.4.4-Stand Alone Tests: The DMS vendor shall conduct an approved stand-alone test of the equipment installation at the field site. The test shall, as a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed as per the plans, or as directed by the Engineer.

Approved data forms shall be completed and turned over to the Engineer as the basis for review and rejection or acceptance. At least two (2) working days’ notice shall be given prior to all tests to permit the Engineer or his representative to observe each test.

667.4.4.1-Consequences of Stand Alone Test Failure: If any unit fails to pass its stand-alone test, the unit shall be corrected or another unit substituted in its place and the test successfully repeated.

If a unit has been modified as a result of a stand-alone test failure, a report shall be prepared and delivered to the Engineer prior to the re-testing of the unit. The report shall describe the nature of the failure and the corrective action taken.

If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or extension of the contract period.

667.4.5-System Test: The DMS vendor shall conduct approved DMS system tests on the field equipment with the central equipment. The tests shall, as a minimum, exercise all remote-control functions and display the return status codes from the controller. Approved data forms shall be completed and turned over to the Engineer as the basis for review and for rejection or acceptance.

667.4.5.1-Consequence of System Test Failure: If system tests fail because of any components(s) in the subsystem, the particular component(s) shall be corrected or substituted with other component(s) and the tests shall be repeated. If a component has been modified as a result of the system test failure, a report shall be prepared and delivered to the Engineer prior to retest.

667.4.6-72 Hours and 90 Days Test Failure: After the installation of the DMS system is completed and the successful completion of the System Test, the DMS system shall be subjected to one continuous 72-hour full operating test prior to a 90-day test period. The test shall consist primarily of exercising all control, monitor and communications functions of the field equipment by the central equipment.

The 90-day test period shall commence on the first day after the successful completion of the approved 72-hour continuous full operating test period.

During the 90-day test period, downtime, due to mechanical, electrical and/or other malfunctions, shall not exceed five (5) working days. The Engineer may extend the 90-day test period by a number of days equal to the downtime in excess of five (5) working days.
The Engineer will furnish the DMS vendor with a letter of approval stating the first day of the 90-day test period.

667.4.7-Final System Acceptance: Final system acceptance shall be defined as when all work and materials provided for in this item have been furnished and completely installed, and all parts of the work have been approved and accepted by the Engineer and the Dynamic Message Sign System has been operated continuously and successfully for ninety (90) calendar days with no more than five (5) working days’ downtime due to mechanical, electrical and/or other malfunctions.

667.4.8-Technical Assistance: The DMS manufacturer’s technical representative shall provide on-site technical assistance in following areas:
1. Sign housing to ground control cabinet cable termination
2. Initial sign turn on and stand alone test

The initial powering up of the sign(s) shall not be executed without the permission of the DMS manufacturer’s technical representative.

667.5-REQUIREMENTS FOR DMS CONTROL SOFTWARE:
This section describes the minimum specifications for the DMS sign control software. The contractor shall provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

667.5.1-General Specifications: DMS control software shall:
1. Operate on desktop and laptop computers with the following minimum hardware requirements: 1.5GHz processor, 1 GB RAM, and 2GB of free hard drive space.
3. Support 32 bit or 64 bit processors and operating systems
4. Provide a user-friendly multi-color graphical user interface
5. Be written using Microsoft-certified software development tools (compilers, etc.)
6. Be able to support at least 250 dynamic message signs
7. Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks
8. Support DMS communications via any combination of dedicated hardwired serial network, fiber-optic network, dial-up telephone lines, leased phone lines, dialup cellular modem, Cellular IP modem,, spread spectrum radio, Ethernet, or other as specified herein
9. Support DMS control, monitoring, and diagnostic functions as specified herein
10. Control DMS both remotely from a central location, and locally at the DMS site using a laptop computer
11. Be accompanied by an easy-to-use software installation utility
12. Contain an on-line help system that includes documentation for each feature or present in the software. It shall also be context sensitive such that pressing the help button or [F1] key on any screen will launch the help page for that particular
13. Be fully compliant with the communications protocol requirements of the NTCIP Special Provision specified herein.
14. Vendor to furnish the ITS Coordinator or their designee with software that is specific to the manufacturer. Including all license keys associated there in.

667.5.2-Software Security: DMS control software shall support the creation of user IDs and passwords for up to 100 system users. Only a “System Administrator” shall assign user creation.

The DMS control software shall support different level of rights and authorizations to control DMS, to create and modify messages within software, configuration of control software, and ability to modify DMS settings or running content on DMS.

DMS control software shall require the use of passwords and ability to modify requirements for user passwords to ensure user passwords are secure. These include requiring setting minimum password lengths and include support for minimum alpha-numeric combinations.

Before a system operator can use the DMS control software, the software shall request a “user name” and user “password.” If the correct user name and password are not provided, access to the software shall be declined.

667.5.3-Client-Server Architecture: The software shall be of a modular design including a server and multiple client modules. The server shall handle all DMS communication and shall store all configuration data, messages, schedules, communications settings, DMS status, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Client applications shall include the following functionality:

1. Login application to provide user access to system with username and password
2. Central software to manage display communications, monitoring system status, and various DMS diagnostics.
3. Message creation application for creating DMS messages
4. Message scheduler client for creating time and date schedules for activating messages
5. Administration client for DMS system configuration and administration

667.5.4-DMS Control: The DMS control software shall provide a user interface that presents the system’s DMS in both list and graphical (map) formats. The software will allow the DMS to be organized into groups as defined by the end user to allow for separating displays by region, roadway, and or any user specified category as needed by the administrator. The DMS list and map interfaces will include only the signs for the group currently selected.

667.5.4.1-List and Map Interfaces: The DMS list shall clearly display the following information about each DMS:

1. DMS ID number, as the numerical ID of the display
2. DMS name, in a descriptive text format
3. Message name or description of the message being displayed on the DMS
4. Date and time of last communication between the control software and the DMS sign controller
5. Error and warning status, including pixel errors, power failures, communication
error, etc.
6. Graphical representation (WYSIWYG) of current message displayed

The graphical map interface shall include the following:
1. Configurable bitmaps that may be used to show all or parts of the system geographically
2. Message name or description of message being displayed on DMS
3. Icons for each sign located anywhere on the map
4. Icon color changes to indicate the status of the DMS (i.e., yellow for warnings or red for errors)
5. Date and time of last communication between the control software and the DMS sign controller
6. Sign name is visible if mouse is placed over a DMS icon
7. Graphical representation (WYSIWYG) of current message displayed when hovering over the sign icon.

The display monitor interface shall display the following information:
1. DMS name, in a descriptive text format
2. Message name or description of message being displayed on DMS
3. Date and time of last communication between the control software and the DMS sign controller
4. Graphical representation of messages running on DMS
5. Ability to select the DMS visible by sign name, running messages

667.5.4.2-Direct Control Operations: The user interface shall provide a means for users to directly perform the following tasks for each sign:
1. Send and activate stored messages from the libraries
2. Blank the display
3. Activate an ad-hoc quick message that is created immediately, not loaded from a library
4. Send and activate schedules
5. Retrieve messages from the sign
6. Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate control devices, etc.
7. Perform pixel testing and report coordinates of any failed pixels with failure detection

The scenarios shall be saved to libraries where system operators may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

667.5.4.3-Polling: The software shall have a feature to poll all or a set of DMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

667.5.4.4-Scenarios: The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:
1. Send and activate stored messages from the libraries
2. Blank the display
3. Send and activate schedules
4. Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate control devices, etc.
5. Perform tests of pixels

667.5.4.5-System Monitoring: The software shall be capable of monitoring and displaying to the operator the contents of any communications in progress with DMS. The status of all outgoing and incoming data packets will be visible.

667.5.4.6-Multi-Vendor Sign Control: The software shall be capable of controlling any NTCIP-compatible DMS regardless of the manufacturer. Functionality supported shall be limited to NTCIP standard MIB objects only. Other manufacturer support many require proof of NTCIP compliance of controller to verify compatibility. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

667.5.5-Message Creation and Editing: A DMS system operator shall be able to use the DMS control software to create, edit, name, and store message files.

The message editor GUI shall present a scaled image of the DMS display matrix, including a complete and accurate representation of the display matrix type (character, line or full matrix) and the number of display pixels. The DMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the operator with the following capabilities:

Text Editing Capabilities:
1. Be able to type in message text as if typing in any word processor
2. Text entry shall be directly in message editing area, external input windows to enter text then displayed on a graphic representation is not a true WYSIWYG editor
3. Text entry includes but is not limited to text input, modification, removal, or insertion
4. Ability to select font per character
5. Ability to set flashing text and variable flashing rates per character
6. Character map functionality to insert special characters such as arrows
7. Support for many different fonts ranging in size and boldness for improved legibility of message (line and full matrix only)
8. Adjustable interline spacing in number of pixels for improved legibility of message (full matrix only)
9. Horizontal message justification on the DMS display matrix including left, center, and right
10. Vertical message justification on the DMS display matrix including top, middle, and bottom.
11. Ability to make text scrollable per line, including direction and scroll rate.
12. Ability to change inter-character spacing between individual characters
13. Ability to change text foreground and background color per character
14. Support for inserting NTCIP standard real-time fields.
Graphics Editing Capabilities (full matrix only):
1. Be able to insert text and locate anywhere on matrix display
2. Be able to insert graphic images files into message editing area
3. Be able to move the graphic text and images around within message editing area
4. Support for inserting true type font text
5. Support for enabling anti-aliasing of font text
6. Be able to resize images when inserted
7. Be able to layer images and text and change the z-order (top to bottom)
8. Be able to move shapes to the front or back within the z-order
9. Be able to insert shapes include lines, rectangles, ellipse, triangles, spheres, and diamonds
10. Be able to support drawing tools include shape fill, line color, fill color, and brush width
11. Support at least color depth of 32k for full RGB color displays
12. Time with AM/PM or am/pm (NTCIP 1203 v2

Message Properties:
1. The number of pages that the message is to contain (shall be a maximum of six)
2. Ability to turn on and off beacon per message
3. Page on and off times for each page
4. Ability to adjust message priority status per message stored in library

Editor Capabilities:
1. Include a spell checker to verify against misspelled words
2. Ability to adjust message priority status per message stored in library
3. Include a list of prohibited words and prevent from being used in message text
4. Include a library of common MUTCD symbols for easy insertion of graphic images
5. Support clipboard operations of cut, copy, and paste
6. Support undo/redo actions
7. Ability to rearrange page order for multiple page messages
   a. Ability to duplicate pages
   b. Be able to preview message as would run on display
   c. Be able to zoom in/out editing area
   d. Messages shall be able to be sent to any NTCIP DMS using standard NTCIP 1203 MULTI tags
   e. Include a most recent list of last messages edited for quick access.
   f. Support default options when creating new messages including page time on and off, line and page justification, and default font

Message Library Capabilities:
1. Top level folders shall be organized by DMS type and size
2. Be able to create folders to store messages
3. Be able to rename files and folders
4. Be able to delete files and folders
5. Be able to create multiple levels of folders
6. Be able to save the message for future use
7. Be able to edit a saved message for future changes
8. Be able to open a existing message and save as a new message
667.5.6-Message Libraries: DMS control software shall support the creation and storage of message libraries (file directories), which allow the system operator to categorize message files by:

1. DMS matrix size
2. Message subject matter

The library editor shall allow a system operator to:

1. Create a new library
2. Store the same message in multiple libraries
3. Select a message from an existing library and edit the message contents
4. Search message libraries for messages with specified text in message name or contents
5. Copy/Paste a message from one library to another
6. Delete a message file from a library
7. Rename a library
8. Delete a library
9. Save all new changes

667.5.7-Schedule Creation and Editing: DMS control software shall support the creation of message schedules, which instruct the DMS sign controller to run specific messages at predetermined times and dates.

Software shall contain an editor, which allows messages to be scheduled via:

1. Month of the year (January, February, etc.)
2. Day of the week (Monday, Tuesday, etc)
3. Day of the month (1, 2, …, 31)
4. Time of the day

The schedule editor shall provide a convenient means for the operator to:

1. Create a new schedule
2. Rename an existing schedule
3. Delete a schedule
4. Save all new changes

The schedule editor shall contain a calendar view to see the scheduled day plans. The view shall be able to view by week, month, or year.

When adding a message to a schedule, the software shall provide a visual representation of the messages. The verification ensures the user is adding the correct message to the displays schedule.

It shall be possible to store schedule files in both the DMS control computer memory and the DMS sign controller memory.

667.5.8-Display Fonts: The software shall support a minimum of twelve (12) fonts for each model of DMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of 24 fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DMS model configuration.
The software shall include a font editor to allow the operator to create custom fonts. The font editor shall allow the DMS system operator to create new fonts or modify existing fonts. The operator shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner.

Any of the fonts provided by the software vendor or created/modified by the administrator shall be downloadable to the DMS.

667.5.9-Event Logging: The software shall include an event logging system that logs all significant system events. Each logged event shall include the following fields at a minimum:
1. Event ID number
2. Operator that initiated the event
3. Time and date that the event occurred
4. Description of the event (i.e., “Diagnostic Test Performed”)
5. Source of the event (i.e., DMS sign name)
6. Additional data relevant to the event (i.e., “Failed pixel: (4, 73)”)

The events logged shall include, but not be limited to, the following:
1. User login/logout
2. Communication failures
3. Configuration changes
4. Message and schedule activation or display blanking
5. Diagnostics test results
6. Warning events sent from the sign
7. Other system errors

The system operators will have the ability to view, sort by category, and print the log file at any time.

667.5.10-System Configuration: The DMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:
1. Sign models and individual signs
2. Communication networks
3. NTCIP profiles to enable/disable MIB objects
4. System error/warning alarms
5. User security rights
6. System maps and sign icon placement
7. Default system option settings
8. Default message parameters
9. Message priority settings
10. Prohibited word list

667.5.10.1-Sign Configuration: Each sign in the DMS control software shall be configured with the following parameters:
1. Sign viewing area height and width (for full-matrix signs)
2. Number of lines and each line’s height and width (for line-matrix signs)
3. Number of lines and characters size for character matrix signs
4. Color capabilities (amber, tricolor, full-color)
5. Site name
6. DMS ID number
7. Network address
8. Communication parameters
9. Time zone and daylight savings time settings

667.5.10.2-Communication Settings: Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:
1. Network type (direct serial, dial-up, Ethernet)
2. Communication port (i.e., COM4)
3. Baud rate (ranging from 1200 to 115,200)
4. Hardware handshaking
5. NTCIP subnetwork and transport protocols
6. Communication retries and timeouts
7. IP address and port

667.5.10.3-System Alarms: Configurable settings shall allow the system administrator to determine which of the following events will trigger an audio and visual (on-screen) alarm:
1. Communication failure
2. Priority status conflict
3. Sign restart
4. Power supply failure
5. Door open

667.5.10.4-User Administration: The access rights shall be capable of four (4) levels of security
1. Limited- access to only view information
2. Standard- simple control of running messages and content
3. Power-modify display settings and configuration
4. Administrator- full rights to all software commands including adding, removing, modifying user access rights.

667.5.10.5-System Maps: It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

667.5.10.6-Message Editor Defaults: The message editor shall automatically utilize the following default settings during the creation of new message files:
1. Pixel spacing between adjacent lines of text
2. Pixel spacing between adjacent text characters
3. Display duration of a given message page
4. Beacon activation status (for DMS that contain flashing beacons)
5. Effect to be applied to text (i.e., static, scrolling, etc.)
6. Message priority classification
7. Horizontal text justification supporting left, center, or right
8. Vertical text justification supporting top, middle, and bottom
9. Default font
10. Spell check on message save
11. Force text to uppercase
12. Disable scrolling

667.5.11-Software Use and Reproduction Rights: The DMS manufacturer shall provide a DMS control software site license with the DMS supplied for this contract. Ten (10) copies of the DMS control software shall be provided to the engineer on CD-ROM within thirty (30) days of contract award. The engineer shall have the right to request or reproduce an unlimited number of software copies for use on the DMS system installed for this contract.

CONSTRUCTION METHODS

667.6-GENERAL:
Construction methods shall conform to the requirements of the Plans and the latest issue of the West Virginia Division of Highways Standard, and Supplemental Specifications, except as modified.

667.7-MAINTAINING TRAFFIC:
During the installation of the DMS appurtenances, the roadway shall be kept open to all traffic by the Contractor in such a way that both local and through traffic will be adequately and safely accommodated through the work area. See the Manual, "Traffic Control for Street and Highway Construction and Maintenance Operations", and applicable sections of the Standard Specifications.

667.8-WARRANTY:
Equipment furnished under this Specification shall be guaranteed to perform according to these specifications and to the manufacturer's published specifications. Equipment shall be warranted for a minimum of five years parts return to factory against defects and/or failure in design, materials and workmanship. Unless otherwise specified in the invitation for bids, warranty coverage shall become effective on the date of final acceptance of the system by the Department. The DMS manufacturer shall assign to the Department all manufacturer's normal warranties or guarantees, on all such electronic, electrical and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Defective equipment shall be repaired or replaced, at the manufacturer's option, during the warranty period at no cost to the Department.

After the warranty has expired, the Manufacturer shall provide lifetime technical assistance to the Department to assist the Department in trouble shooting the sign for repair. This technical assistance will be by telephone and/or Manufacturer’s representative site visit.

667.9-METHOD OF MEASUREMENT:
The Led Dynamic Message Sign will be measured as each unit furnished, installed, made fully operational, tested, as well as training to be provided in accordance with this specification.

667.10-BASIS OF PAYMENT:
The work performed and materials furnished in accordance with this Item and measured as provided under “Method of Measurement” will be paid for at the unit price bid for “LED
DYNAMIC MESSAGE SIGN.” This price shall be full compensation for furnishing, placing and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s), supplies, support, personnel training, shop drawings, documentation and incidentals necessary to complete the work.

667.11-TRAINING:

667.11.1-Description: The manufacturer/contractor shall provide training, manuals, and all other particulars regarding the DMS software in accordance with these specifications. This training shall follow the delivery of the equipment documentation.

667.11.2-General Provisions: The manufacturer shall provide training for not less than five (5) WVDOT personnel on the operation and maintenance of the variable maintenance signs(s) (DMS), controllers, systems and controller software. The manufacturer shall utilize qualified instructors regarding all aspects of the DMS training. At least 30 calendar days prior to commencement of the training, the manufacturer shall submit detailed course curriculums, draft manuals, and handouts to the Traffic Engineering Division.

Training shall not last more than eight (8) hours in any given day. Training shall be a mixture of formal classroom and hands-on training with the majority of the training being hands-on. Training shall be conducted in the Charleston, West Virginia area as required by the Traffic Engineering Division. Training shall be completed prior to the end of the 30-day testing period. Training material generated for each course shall contain manuals and other handouts for each attendee which shall serve not only as subject guidance, but also a quick reference guide for use by the attendees.

There shall be a minimum of four (4) hours of classroom training to train personnel on the operational aspects of the signs and software. This training will be more suited to operators or those who are responsible for programming messages. In addition, there will be a minimum of eight (8) hours of training to train maintenance personnel. A portion of the maintenance training shall be in a classroom environment and aimed at operation, maintenance, and trouble shooting of field equipment. At least four (4) hours of the maintenance training shall be on-site.

Personnel attending this training shall be fully trained to use all features and functions of the equipment and software including diagnosing all system functions from the central control computers. Overview shall include data communications equipment, dynamic message sign, cabinets, and auxiliary equipment. In addition, this training shall include routine maintenance and troubleshooting procedures.

Training costs, as described within these specifications, shall be incidental within the cost of the contract. This incidental cost shall include the cost of course curriculum, instructor’s handouts, manuals, installation and removal of software. Travel and per diem costs for all instructors shall also be incidental to the total contract cost.

667.12-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>667001-001</td>
<td>Led Dynamic Message Sign, Full Color</td>
<td>Each</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: __________________________

FOR

SECTION 669
ROAD WEATHER INFORMATION SYSTEMS (RWIS)

669.1-DESCRIPTION:

One component of the West Virginia Division of Highway’s (WVDOH) Intelligent Transportation System (ITS) program is the deployment of a Road Weather Information System (RWIS). WVDOH, herein known as “Department” will be soliciting Contractors/Vendors to provide a RWIS package that would compose of hardware/software/communications for one or more sites in West Virginia.

These RWIS systems will improve the ability of the WVDOH District personnel to manage State and local roadways in response to current meteorological conditions. This will increase the level of service along these routes. The described RWIS/ESS sites will also provide additional information to the National Weather Service (NWS) and the National Oceanic Atmospheric Association (NOAA), as well as media and the traveling public. This RWIS system shall provide the information to support the following activities:

1. Optimize snow removal and chemical applications, as well as severe weather changes in real-time.
2. Identify adverse weather conditions.
3. Identify roadway closure conditions.
4. Identify unique roadway conditions.
5. Provide site-specific forecasts for roadway segments.
6. Provide a mobility platform to monitor road conditions in real-time as state assets travers the roadways.

In order to provide uniformity and continuity in the deployment of RWIS technologies, the WVDOH is seeking an RWIS Contractor/Vendor to supply the Department hardware/software, as well as the installation and support for a number of sites under this contract.

669.2-VENDOR:

669.2.1-Qualifications: The RWIS Vendor shall have the following qualifications:
1. RWIS equipment manufacturing capability.
2. Meteorological expertise as needed to select optimal RWIS components.
3. Communication design and installation support capability for wireless applications. Not limited to 802.11.a/b/n and to include 4GLTE/5GLTE, Provider access to be provided by the Department.

669.2.2-Responsibilities: The Role of the Vendor shall be:
1. Furnish and Deliver RWIS/ESS hardware to contract locations
2. Assure that the installed RWIS/ESS are functioning and reporting over the specified NTCIP network.
3. Work with the ITS coordinator or their designee to configure and test all communications hardware associated contracted RWIS/ESS installation.
4. Provide site installation and calibration support for both RWIS/ESS.
5. Provide technical support, and support documentation within the contract.
6. Provide training on aspects of the RWIS/ESS system to include the following:
   a. Introduction to data acquisition
   b. Remote Processing Units (RPU) per site as needed
   c. NTCIP Compliant Software – Vendor Specific
   d. Non-Invasive Pavement Sensors
   e. Sub-Surface Pavement Sensors
   f. Current Atmospheric Weather Sensors
   g. Visibility Sensors
   h. AT&T Cingular Modem (HSPDA/HSPUA capable) _consult the Department for modem specifications
   i. Troubleshooting, Repair, Preventative Maintenance Best Practices
   j. Operational use of All Diagnostic, Testing, Calibration or Other software required to support RWIS/ESS locations.
   k. Copies of field maintenance and repair guides and manuals (physical and electronic); hands-on training at each type of operational RWIS/ESS site

669.2.3-Department Responsibilities: The role of the Department in RWIS and RWIS/ESS procurement and installation will include the following:
1. The Department will select the general location for each new RWIS or ESS site to be installed.
2. The Department will prepare site designs for construction at all new sites that will include preparation of Plans, Specifications and Estimation package for each site.
3. The Department will obtain all required right-of-way clearances at each proposed site.
4. The Department will inspect and approve all Vendor/Contractor furnished items.
5. The Department will inspect and approve all Contractor site work.
6. The ITS Coordinator or their designee will approve all Vendor RWIS/ESS related materials.
7. The Department will assist with the configuration of the communication devices, integrate them into the ITS ATMS platform and provide AT&T specific SIMs.

669.2.4-Solicitation Objectives: The objective of this solicitation is to obtain quotations from RWIS Contractors/Vendors who propose to supply the Department with a hardware package, communications system that is fully NTCIP compliant.
669.3-GENERAL COMMUNICATIONS:

Within this project, the Vendor shall be responsible for all elements and functionality of the communication at each site.

1. The Vendor shall work with the ITS Coordinator or their designee to engineer, furnish, configure, and provide installation and testing for a complete, operational communications system between each planned RWIS site and the WVDOH Transportation Management Center (TMC).

2. The Vendor shall be responsible in conducting all necessary analyses to provide a communications structure to at each site.

3. The Department will require that the communications for RWIS site communication to be wireless via cellular communications and on the AT&T wireless network. The cellular modem will incorporate HSPDA/HSPUA technology for future cellular configuration, or any other form of communication approved by the ITS Coordinator.

4. The Vendor shall procure an AT&T SIM card from the ITS Coordinator or their designee. The Vendor shall work with the ITS Coordinator.

5. Upon communications link implementation, the Vendor shall conduct a 24-hour bit error rate test (BERT) at each site and take corrective action if the BERT exceeds $10^{-6}$. Results of all these tests shall be submitted to WVDOH for verification and final approval.

6. The Vendor shall conduct a subsystem test at each site, to test both the on-site equipment and the communications links to the site.

669.4-SERVICES AND COORDINATION:

The Vendor shall be available for consultation with WVDOH during construction of each RWIS and RWIS/ESS field site and system element; to include Vendor consultation with WVDOH designated electrical or construction contractors.

The Vendor shall conduct a stand-alone test of each site. The Vendor shall submit a test plan for Department approval at least 30 days prior to testing. All testing shall be conducted in the presence of the WVDOH ITS Coordinator.

1. The Vendor shall provide internet-based information displays from each RWIS site. At a minimum, this shall be provided in both simple ASCII text format and traditional (html) format.

2. The Vendor will provide an API access to the RWIS/ESS sites.

3. The Vendor shall provide RWIS operations and maintenance training for all RWIS subsystems and components, including site equipment.

4. The Vendor shall furnish a comprehensive RWIS spare parts package for those sites addressed in the initial RWIS order. This package shall be adequate to address hardware maintenance or failure in any of the initial RWIS contract sites; a separate package shall not be required for each site.

5. The Vendor shall furnish RWIS operations and maintenance documentation.

6. The Vendor shall provide Technical Support and Warranty Services.

Sites have been designed and described based on meteorological, maintenance, and/or traffic detection applications. Certain sites may require solar power, equipped with an auxiliary wind turbine application. These sites must be approved prior to start of work by the Department. Any alternate power or communication source shall be approved prior to construction by the ITS Coordinator per site.
669.4.1-Field Components: The RWIS field components shall provide comprehensive information about roadway status, environmental conditions and/or traffic patterns to system users as prescribed per site. The RWIS field components shall collect current data at each site to support the goals of the deployment identified as below:

669.4.1.1-General Requirements: The following general requirements shall apply to all new RWIS or RWIS/ESS site components furnished by the Vendor:

1. The current-weather-measuring unit is defined as the group of meteorological measuring devices intended primarily to sense atmospheric conditions located at each RWIS site.
2. The current-weather measurements shall include temperature, relative humidity, precipitation type, precipitation intensity, precipitation quantity, wind speed, wind direction, air pressure, solar radiation, and lightning detection. Visibility shall also be measured at certain sites.
3. The Department prefers an integrated, solid-state current-weather-measuring unit with no moving parts.
4. The Department requires RWIS/ESS devices to be non-invasive.
5. RWIS cabinets and major components shall be supplied with a serial number unique to the manufacturer.
6. The Controller, Road Sensors, and/or Weather Sensors, and Remote Processing Unit shall operate during the following environmental conditions:
   a. Temperature Range: -40°F to 150°F
   b. Humidity: 0% to 100%

669.4.1.2-Tower: The following shall apply to equipment mounted on the tower(s) to be located at each total RWIS and RWIS/ESS site:

1. The RPU cabinet (unless another enclosure option is selected), antenna, pavement sensors, and atmospheric instrumentation shall be mounted on the tower at each RWIS or RWIS/ESS site. Only the antenna is mounted on the tower.
2. Each tower shall be constructed of aluminum or steel.
3. Each tower with a wind sensor shall have a minimum finished top elevation of 30 feet.
4. All towers shall be able to sustain 90 mph wind loads with a gust ratio of 1.3 factor.
5. Each tower shall be designed for installation on a concrete footing with foundation details provided by the Vendor. These towers will be collapsible for maintenance purposes.

669.4.1.3-Electrical /Surge Protection:
1. The Vendor shall furnish an air terminal (lightning rod) and surge suppressors at each tower and equipment enclosure. All wiring and conduit systems shall also conform to the WVDOH Standard Specifications for Roads and Bridges.
2. The Vendor shall provide information regarding the type and quantity of cable that is included with the equipment in the contract.
3. The Vendor shall furnish power-line surge protectors between both line conductors and the equipment ground.
4. All conductors entering and leaving the cabinet shall be protected by surge protectors and lightning arrestors. Data lines shall also contain surge protection.
5. Power line surge protection shall conform to the following requirements:
a. Peak surge current occurrences: 20 minimum
b. Peak 8 x 20 msec wave shape: 20K amps
c. Response: 250 maximum
d. Maximum current at 120-VAC, 60 Hz: 10 amps
e. Series inductance: 200 microhenries
f. Temperature: NEMA TS-1

6. Uninterruptible power supplies (UPS’s) shall be provided for all sites where AC power is utilized. All RWIS and RWIS/ESS components requiring power to operate shall be plugged into the UPS, such that the site can maintain full operation for a minimum of six (6) hours after a loss of AC power. The UPS shall have the following basic characteristics:
   a. Minimum six (6) hour backup capability for a fully equipped RWIS or RWIS/ESS site.
   b. Automatic charging, such that the UPS is fully charged whenever AC power is available.
   c. The UPS will need to be in a separate cabinet (30"x36”x16” minimum, or a custom cabinet that can be designed to house the RPU and UPS for the RWIS sites. The RWIS/ESS sites will have a minimum dimension 36”x36”x48” cabinet to store batteries in addition to the UPS cabinet.

669.4.1.4-Remote Processing Unit (RPU): The Remote Processing Unit (RPU) shall collect the data from each weather sensor at the RIWS/ESS site. The RPU is then responsible for transmitting this data to the Central Processing Unit (CPU) at the DOH facility. The RPU shall be an open system allowing for interoperability and connectivity with existing WVDOT equipment.

1. A single Remote Processing Unit shall be furnished and installed at each RWIS/ESS site.
2. The Remote Processing Unit shall gather data from all connected environmental and traffic sensors, as well as any remote pavement sensors at the site. The RPU shall then process, store and transmit this data to the CPU.
3. Data transmission to the CPU shall occur at a user-configurable sampling interval between 1 minute and 4 hours, and shall include all information collected since the last transmission. Data transmission intervals will be as provided by the RWIS Project Manager.
4. Data shall be collected at the RPU in user-configurable bin sizes where available, and in manufacturer specified bin sizes where user-configuration is not available.
5. Capability of remote reset, reconfiguration, and accepting downloads of update software from the CPU as well as field connection. At least one (2) copies of the software required to enable such connections shall be provided to the Department by the Vendor for each RWIS/ESS site. The Vendor shall supply training for the software for up to (4) individuals per copy.
6. RPU shall include and allow “Watchdog” circuitry that monitors its own operation and resets itself, if the software enters an intermediate state.
7. Each RPU shall provide the capability to accept data and control inputs, in NTCIP-ESS protocol format where applicable. The following sensor inputs shall meet or exceed the following requirements:
   a. One (1) Non-Intrusive Pavement Sensor
   b. One (1) All-in-one Atmospheric Sensor
   c. One (1) Sub-Surface Roadway Sensor
d. One (1) Visibility Sensor

669.4.1.5-Roadway Pavement Surface Sensors: The system shall be specifically designed for monitoring and displaying pavement surface conditions.
1. Only non-invasive pavement sensors shall be acceptable.
2. All sensors shall be pole or tower mounted.
3. Sensors shall be mounted such that the distance between the surface measurement location and the sensor is within the recommend distance according to the manufacturer’s specification.
4. Sensor mounting height and downward pitch angle shall be in accordance with the manufacturer’s recommendations.
5. The Vendor shall provide standardized mounting recommendations.
6. Sensors shall have no moving parts.
7. Sensors shall be able to provide and sustain performance according to Table 1 below.
8. Weather conditions shall not degrade the sensors performance.
9. All sensors shall be capable of recording and distinguishing the following conditions:
   a. Surface Conditions (dry, wet, snow, ice)
   b. Surface Temperature
   c. Precipitation Thickness (water, snow, ice)
   d. Friction Coefficient of Roadway
   e. Freezing Temperature of Roadway
10. Sensors shall provide the readings in configurable increments not to exceed 5 minutes.
11. At least (2) copies of the software and/or tool required to configure, calibrate, and update the sensors shall be provided to the Department by the Vendor for each Non-Invasive Pavement Sensor.
12. The Vendor shall supply training for the software/tool for up to (4) individuals per copy.

<table>
<thead>
<tr>
<th>Table 1-Non-Invasive Pavement Condition Sensor Performance Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Measurement</td>
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<tr>
<td></td>
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<tr>
<td>Surface Conditions</td>
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<tr>
<td>Surface Temperature</td>
</tr>
<tr>
<td>Precipitation Thickness</td>
</tr>
<tr>
<td>Friction Coefficient</td>
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<tr>
<td>Freezing Temperature</td>
</tr>
</tbody>
</table>

669.4.1.6-Roadway Sub-Surface Sensor: Sub-surface temperature probes shall be placed at designated sites. The sub-surface sensors shall follow the following requirements:
1. Sub-Surface sensors shall not be utilized on bridge decks. Sub-Surface sensors shall only be placed on the shoulder of the roadway or similar location to maximize the life of the sensors.
2. The Vendor shall recommend the depth of placement for sub-surface temperature probes.

669.4.17-Current Weather Measuring Unit: The following sections detail the specifications for the atmospheric sensors which, combined, make up the current-weather-measurement unit. Atmospheric sensors will be made up of an all-in-one weather sensor and a visibility sensor.

1. All atmospheric sensors shall be combined in an all-in-one weather sensor. The all-in-one sensor shall be able to measure the following parameters:
   a. Air Temperature
   b. Relative Humidity
   c. Precipitation Type (None, Rain, Snow)
   d. Precipitation Intensity
   e. Precipitation Quantity
   f. Wind Speed
   g. Wind Direction
   h. Air Pressure
   i. Solar Radiation
   j. Lightning Detection (Number of Lightning Events)

2. Visibility sensors shall meet the following parameters:
   a. Visibility sensors shall be placed at designated sites (see each RWIS/ESS site location for number of Visibility sensors).
   b. Visibility sensors shall not be hindered by window contamination or clogging from blowing snow.
   c. Visibility shall use forward scattering principle technology.
   d. Visibility sensors are to provide the visibility in feet.

All Current Weather Measuring Unit shall meet the following requirements:
1. Each sensor shall provide the readings in configurable increments not to exceed 5 minutes.
2. Alarms shall be configurable for each sensor if a reading falls within a certain range.
3. All sensors shall be calibrated for altitudes and magnetic bearings at each specific RWIS/ESS site.
4. All sensors shall be pole or tower mounted.
5. The Vendor shall recommend the mounting height for all atmospheric sensors.
6. The Vendor shall provide standardized mounting recommendations.
7. Sensors shall have no moving parts.
8. Sensors shall be able to provide and sustain performance according to Table 2 below.
9. Weather conditions shall not degrade the sensors performance.
10. Sensors shall support at least one of the following communication protocols to transmit data to the RPU:
    a. Serial (RS-232/RS-422/RS-485)
    b. Analog/Digital
    c. Ethernet
11. At least (2) copies of the software and/or tool required to configure, calibrate, and update the sensors shall be provided to the Department by the Vendor for each Atmospheric Sensor and visibility sensor.
12. The Vendor shall supply training for the software/tool for up to (4) individuals per copy.
<table>
<thead>
<tr>
<th>Sensor Measurement</th>
<th>Specifications</th>
<th>Typical Accuracy Range</th>
<th>Operating Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td>±0.2° C</td>
<td>-50° to +60° C</td>
<td>(-58° to +140° F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>±2 %</td>
<td>0 to 100%</td>
<td></td>
</tr>
<tr>
<td>Precipitation Type</td>
<td></td>
<td>0.1 mm/hr.</td>
<td></td>
</tr>
<tr>
<td>Precipitation Intensity</td>
<td></td>
<td>0.01</td>
<td>0.3 to 5 mm</td>
</tr>
<tr>
<td>Precipitation Quantity</td>
<td></td>
<td>1.0 m/s</td>
<td>0 to 359.9°</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>±0.3 m/s</td>
<td>0 to 75 m/s</td>
<td></td>
</tr>
<tr>
<td>Wind Direction</td>
<td></td>
<td>5 %</td>
<td>1400W/m²</td>
</tr>
<tr>
<td>Air Pressure</td>
<td>0.5 hPa</td>
<td>300 to 1200 hPa</td>
<td></td>
</tr>
<tr>
<td>Solar Radiation</td>
<td></td>
<td>'±10 %</td>
<td>5 to 10 km</td>
</tr>
<tr>
<td>Lightning Detection</td>
<td></td>
<td>10 to 2000 m</td>
<td></td>
</tr>
</tbody>
</table>

669.5-COMMUNICATIONS:

669.5.1-Communications-Road Weather Information System: The following represent the general requirements for the Vendor regarding the communications system used for the RWIS/ESS system:

1. The Vendor will coordinate with the ITS Coordinator or their designee to furnish, install and make operational a complete communications system between the RPU at each RWIS site and the WVDOH Transportation Management Center (TMC) in Charleston, West Virginia.
2. The Department requires the use a single processor as the RPU at each RWIS site.
3. The Department requires a communications system that is compatible with multiple RWIS Vendor RPU/s currently available.
4. The Department prefers a cellular communication on the AT&T network. The ITS Coordinator or their designee will provide the SIM card for network access.

669.5.2-Communications-Remote Processing Unit and the CPU: The following are specifications for communication between the RPU at each RWIS/ESS site and the WVDOH Traffic Management Center:

1. For the communication medium used at each site, the Vendor shall be responsible for all path analyses, service and license applications and costs associated with bringing these sites on-line with the WVDOH TMC.
2. The Department prefers cellular telemetry communications service to communicate with RWIS sites. Where this is not feasible, the Vendor may propose a wire line solution.
3. The Vendor is responsible for providing a communications solution compatible with each RWIS site.
4. The minimum acceptable data rate for new communication links shall be 512,000
kps. The preferred data rate for new communications links is 1MB.

5. The Vendor shall guarantee 90% availability for each RWIS site and its communications link during the warranty period.

**669.5.3-Weather Forecasting Service:** The Vendor shall offer a localized weather forecasting service option based on data derived from the RWIS sites.

**669.6-NTCIP COMPLIANCE:**

The Department intends to procure an RWIS system whose components, sub-systems and communications system use open, non-proprietary standards. The system shall be based on general-purpose hardware platforms, off-the-shelf operating systems, and public domain interfaces.

This portion of the specification defines the detailed NTCIP requirements for the:

a. Environmental Sensor System (ESS) previously referred to as either ESS or RWIS/ESS site.

b. Environmental Sensor System Management System, previously referred to as the “RWIS System’ or ‘RWIS Program’.

The Vendor shall include a detailed description of how it plans to conform with NTCIP in its proposal and how the Vendor intends to achieve the Department’s long-term equipment compatibility goals.

**669.6.1-NTCIP References:** This specification references several standards through their abbreviate names. Each ESS component shall support the most recent version of these standards, including all recommended or approved amendments. The most recent versions of these standards and known amendments, as of June 2, 2000, are shown below. These specifications reference several standards through their NTCIP designated names.

Under this contract, the Vendor shall ensure that each NTCIP component covered by these project specifications implements the most recent version of the standard at the development state of “Recommended” or Higher. The following is a list of these standards abbreviated:

1. NTCIP 1101, TS 3.2 – 1996
2. NTCIP 1101, TS 3.2 – 1996, Amendment 1 (11/2/98)
5. NTCIP 1201, TS 3.4 – 1996
6. NTCIP 1201, TS 3.4 – 1996, Amendment
7. NTCIP 1204, TS 3.7, 1998
8. NTCIP 2101, TS 3 PMPP/RS232
9. NTCIP 2103, TS 3.PPP/RS232
10. NTCIP 2201, TS 3.TP-Null
11. NTCIP 2202, TS 3.TP

**669.6.2-General Requirements:** The NTCIP standards have been designed in a layered fashion to allow for a modular design. The sections below describe requirements at each of four distinct profile levels: application, transport, subnet, and information. The Vendor must supply a list of ports that will need to be allowed access to the Departments designated endpoint.

1. Application Level
a. Each ESS shall comply with NEMA TS 3.2. Each management system and ESS shall support the user’s choice of:
   1. Compliance Level 1 (Internet compatible, inexpensive)
   2. Compliance Level 2 (Transportation specific, more bandwidth efficient)

b. The Vendor shall choose the appropriate compliance level depending on the type of communications link selected.

c. For management systems, the compliance level shall be selectable on a port-by-port basis.

d. An ESS may support additional Application profiles as the manufacturer’s option.

2. Transport Level
   a. Each ESS shall support the user’s choice of:
      1. TS 3.TP-Internet, and shall support the following options defined by the standard:
      2. UDP/IP (Internet compatible, inexpensive)
      3. TS 3.TP-Null (Transportation specific, bandwidth efficient)

   b. Each ESS may support additional Transport Profiles at the manufacturer’s option.

   c. Response datagrams shall use the same Transport Profile used in the request.

   d. Each ESS component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

   e. The Vendor shall choose the appropriate compliance level depending on the type of communications link selected.

   f. For management systems, the compliance level shall be selectable on a port-by-port basis.

3. Subnet Level
   a. Each ESS shall support the user’s choice of:

   b. TS 3.SP.PPP, with data rates of 1200, 2400, 4800, 9600, and 19,200 bits per second.

   c. TS 3.SP-PMPP, with a RS-232 physical interface and data rates of 1200, 2400, 4800, 9600, and 19,200 bits per second.

   d. If the ESS has a serial port that supports multiple Subnet Profiles, the ESS shall be configurable to allow the field technician to activate the desired Subnet profile and shall provide a visual indication of the currently selected Subnet Profile.

   e. An ESS may support additional Subnet Profiles at the manufacturer’s option.

   f. At any one time, only one Subnet Profile shall be active on a given serial port of the ESS or Management System.

   g. The Vendor shall choose the appropriate compliance level depending on the type of communications link selected.

   h. For management systems, the compliance level shall be selectable on a port-by-port basis.

4. Information Level
   a. Conformance groups are used to specify what functionality the ESS supports. Conformance Groups are groups of inter-related NTCIP objects, with an object being a single component of a conformance
group that provides the formal definition of data. By properly requiring their support, the indicated functionality will be required as well.

b. Each ESS shall support the full, standardized object range of all objects required by these procurement specifications, unless otherwise indicated below or approve the ITS Coordinator.

c. For each supported object, the ESS shall fully support the functionality indicated in the DESCRIPTION clause of the OBJECT TYPE macro for each value supported.

d. The ESS maximum response time for any object shall be 200 milliseconds unless otherwise indicated below or approved by the ITS Coordinator.

e. The required conformance groups are described below:

1. Configuration – This Global Object conformance group provides basic information that all NTCIP-compliant devices should support. This includes the type of device as well as the manufacturer name, model, and version of the device.

2. Time Management – The Time Management Conformance Group allows the ESS to store the time of day, including a daylight savings feature.

3. ESS Configuration – The SS Configuration enables the user to identify the type of station (e.g. portable, permanent, mobile, etc.) provide a textual description of the site, and describe the data as collected.

4. ESS Location – This conformance group identifies the geographic location of the station.

f. Each ESS shall support all mandatory objects of all mandatory conformance groups as defined in TS 3.4 and TS 3.7.

g. Report, as defined in TS 3.4. The Report Conformance Group shall allow a user to define certain events which the ESS will then begin logging with a time-stamp. This information can then be retrieved by subsequent messages. This feature can be useful to record a variety of events (e.g. wind gusts above a set threshold, presence of precipitation, etc.). The following list indicates the modified object requirement:

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Event Log Configurations</td>
<td>0 - 65535</td>
<td>8</td>
</tr>
<tr>
<td>Event Configuration Mode</td>
<td>1,2,3,4,5</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td>Max Event Log Size</td>
<td>0 - 65535</td>
<td>64</td>
</tr>
<tr>
<td>Max event Classes</td>
<td>0 - 255</td>
<td>8</td>
</tr>
</tbody>
</table>

The values for event configuration mode have the following meanings:

a. Other
b. A log entry will be entered when the reference value changes
c. A log entry will be entered when the object value becomes greater than the reference value


d. A log entry will be entered when the object value becomes less than the reference value

e. A log entry will be entered based on a hysteresis algorithm

STMF, as defined in TS 3.4 shall be required when compliance level of 2 of the Application Profile, is implemented.

PMPP, as defined in TS 3.4. The following list indicates the modified object requirement for this conformance group.

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Group Addresses</td>
<td>0-255</td>
<td>0-255</td>
</tr>
</tbody>
</table>

a. **Wind Data** as defined in TS 3.7. The Wind Data Conformance Group shall allow a central system to obtain data pertaining to wind (e.g. average wind speed, average wind direction, maximum wind gust speed, etc.).

b. **Enhanced Temperature Data**, as defined TS 3.7. The Enhanced Temperature Data Conformance Group shall allow the user to obtain the data identified by the Basic Temperature Conformance Group and adds the capability of obtaining data regarding the relative humidity, wet bulb temperature, and the dew point temperature. The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS Num. Temperature Sensors</td>
<td>0-255</td>
<td>0-4</td>
</tr>
</tbody>
</table>

a. **Emerging Precipitation Data**, as defined in TS 3.7. The Emerging Precipitation Data shall provide the user with the ability to obtain the data identified within the Enhance Precipitation Conformance Group as well as the water depth, roadway snow depth, ice thickness, snowfall rate and others. This group identifies objects that are used with the newest cutting edge technologies for environmental data collection.

b. **Standard Pavement Sensor Data**, as defined in TS 3.7. This conformance group identifies the objects that are typical for pavement sensor implementations. This group includes objects regarding pavement sensor location, pavement sensor type, elevation surface temperature, and status (i.e. dry, moist, etc.). The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS Num. Pavement Sensors</td>
<td>0 - 255</td>
<td>0 - 8</td>
</tr>
</tbody>
</table>

a. **Enhanced Pavement Sensor Data**, as defined in TS 3.7. This conformance group shall include objects identified within the Standard Pavement Sensor Data
Conformance group and includes objects for pavement temperature surface water depth, freeze point, and a black ice indicator. The objects identified in this conformance group require modern and emerging technologies enabling this type of data to be obtained.

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS Num. Temperature Sensors</td>
<td>0 - 255</td>
<td>0 – 8</td>
</tr>
</tbody>
</table>

a. **Standard Sub-Surface Data**, as defined in TS 3.7. This conformance group shall indicate sub-surface information and parameters (e.g. sub-surface sensor type, depth, temperature, etc.). This may be useful to detect and predict when the pavement will start freezing.

<table>
<thead>
<tr>
<th>Object</th>
<th>Standardized Object Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS Sub-Surface Sensors</td>
<td>0 – 255</td>
<td>0 – 4</td>
</tr>
</tbody>
</table>

Software shall also implement the optional objects of the following optional conformance groups.

a. **Pavement Temperature** within the Enhanced Pavement Sensor Data Conformance Group, as defined in 3.7 – indicates the current pavement temperature 2 – 10 centimeters below the pavement surface in tenths of degrees Celsius.

b. **Surface Water Depth** within the Enhanced Pavement Sensor Data Conformance Group, as defined in 3.7 – indicates the current depth of water on the surface of the roadway in millimeters.

c. **Surface Freeze point** within the Enhanced Pavement Sensor Data Conformance Group, as defined in 3.7 indicates the temperature in tenths of degrees Celsius at which the existing solution on the roadway will freeze.

d. **Surface Black Ice Signal** within the Enhanced Pavement Sensor Data Conformance Group, as defined in 3.7 – a value indicating if Black Ice is detected by the sensor.

1. Software shall also implement the following optional objects.
   a. **ESS Surface Salinity**, as defined in 3.7 – indicates the pavement salinity in parts per one hundred thousand.
   b. **ESS Surface Conductivity**, as defined in 3.7 – indicates the conductance of the ice/liquid mixture on the pavement as detected by the sensor, measured in mhos, the inverse of ohms.

2. The Vendor shall provide the WVDOH multiple copies of the software as well as multiple copies of full software documentation. One of the purposes of maintaining this information within the agency is to be able to identify what the Vendor has provided and how it has been provided.

3. The Vendor may add Vendor specific objects that are not identified by the NTCIP, to enable special functions such as video surveillance. These objects shall be identified so that he Vendor specific objects may be understood by the agency personnel for data processing and for potential future systems integration projects.
663.6.3-Management System Requirements: The ESS Management System shall support all the requirements for ESS’s as identified above. In addition, the management System shall support the requirements identified in this section

1. The ESS Management System shall support up to 255 ESS’s that are compliant with the above requirements.
2. The Management System shall be able to support thirty-two communication channels of the defined subnet profiles. The developer of the management system software shall provide a timing analysis of the communications network to demonstration that sufficient bandwidth is available.

663.6.4-NTCIP Documentation:
1. The Vendor shall supply the NTCIP software with full documentation, including a CD-ROM containing ASCII versions of the following Management information BASE (MIB) files in Abstract Syntax Notation 1 format, as listed below.
   a. The relevant version of each official standard MIB Module referenced by the device functionality.
   b. If the device does not support the full range of any given object with a Standard MIB Module, a manufacturer-specific version of the official Standard MIB Module with the supported range, indicated in ASN 1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The name of this file shall be identical to the standard MIB Module, except that it will have the extension “man”.
   c. An MIB Module in ASN.1 format containing all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
   d. An MIB containing any other objects supported by the device.
      1. The manufacturer shall allow the use of all this documentation by any party authorized by the West Virginia Division of Highways for systems integration purposes at any time, initially or in the future, regardless of what parties are involved in the systems integration effort.

663.6.5-NTCIP Support:
1. The Vendor shall provide NTCIP software upgrades at no cost to the Department through the life of the contract, for both central software and field units.
2. All modified software shall be provided with a full description of modifications.
3. Implementation of this software shall be at the discretion of the department.
   a. The vendor will provide and API for 3rd party integration.

669.7-VENDOR RESPONSIBILITY:
669.7.1-New Materials: The Vendor shall be responsible for supplying all new materials. All items supplied shall be new, unused, current production models installed and operational in a user environment, and be an item currently in distribution.

669.7.2-Training: The continued full utility of an RWIS system demands proper operation and maintenance. The Vendor shall be responsible for training as detailed below.
669.7.2.1-General Requirements:
1. The following are general training specifications that are required of the Vendor as part.
2. The Vendor shall include outlines of the proposed training program in its proposal.
3. The proposed course materials for the Vendor training program shall be approved by the Department at least thirty (30) days prior to the start of any training course.
4. Training courses will be scheduled at the WVDOH facilities.
5. Instructors shall have previous classroom experience, and shall be proficient and knowledgeable in the subject being taught.
6. Each student shall receive a handout of lecture notes and a copy of each manual discussed in the training.
7. The Vendor shall post any training materials used in the course on its website in a location accessible to WVDOH trainees.
8. The Vendor shall videotape the training sessions and provide WVDOH with ten (10) copies on USBs. The Vendor shall provide all recording equipment required to produce the training videos.

669.7.2.2-Operations Training: This training shall be geared towards individuals who utilize RWIS to schedule roadway maintenance crews. For training purposes, an overview of the system shall include discussion of the following elements:

Use of RWIS for Winter Maintenance:
1. RWIS system overview
   a. The RWIS user interface, including the web based interface.
   b. The central site computer display
   c. The web browser interface
   d. Responding to Alarms
   e. Viewing meteorological conditions
   f. Calling up archived meteorological data
2. Performing routine testing of the system.

669.7.2.3-Site Maintenance and Calibration Training: This training shall be geared towards individuals who are skilled in electronics and have responsibility for maintenance of the RWIS field sites and communications infrastructure. For training purposes, an overview of the system shall include discussion of the following elements:

1. Theory of Operation
2. Isolation of faults to board level
3. Hands-on troubleshooting
4. Calibration and use of calibration equipment
5. Programming and configuration techniques
6. Communications Troubleshooting
7. Performing routine testing of the system
8. Analysis of logs and failure alarms

Estimated attendance is ten (10) students per session, including WVDOH electronic technicians, maintenance engineers.
669.7.2.4-Software Operations and Central Training: This training shall be geared towards individuals who are skilled in computer networking and programming and have responsibility for maintenance of the RWIS communications infrastructure. For training purposes, an overview of the system shall include discussion of the following elements:

1. Theory of Operation
2. Data Management (retrieval and dissemination)
3. Isolation of software and hardware faults
4. Hands-on troubleshooting
5. Software setup and installation techniques
6. Programming and configuration techniques
7. Communications troubleshooting
8. Performing routine testing of the system
9. Analysis of logs and failure alarms

Estimated attendance is ten (10) students per session. WVDOH computer technicians, programmers, project managers, coordinators.

669.8-DOCUMENTATION:

669.8.1-Loading General Requirements: In addition to the requirements of the Standard Specifications, documentation for the RWIS Equipment shall include complete and comprehensive information on all equipment components and accessories.

1. The Vendor shall provide block diagrams, schematics, line drawings and descriptive text sufficient to allow an electronics technician to diagnose, repair and maintain the equipment and its components.
2. Software documentation shall include explanations of how operations are related to remote and local commands, all program source codes in both printed and machine readable form, detailed memory maps and detailed communications protocol documentation.
3. Computer generated text shall be printed in 12-point Arial font or larger.
4. WVDOH shall have the right to reproduce any material for WVDOH educational and maintenance purposes only.
5. At least five (5) complete copies of all documentation shall be delivered to the ITS Coordinator upon delivery of the first RWIS unit.
6. All documentation, as well as future software upgrades, patches, additional documents, etc. Shall be available via the vendor’s website.

669.9-TESTING AND CALIBRATION:

The Vendor shall fully test and perform the initial calibration for each RWIS location, as well as the full system and its components, to ensure that the system meets all operational requirements and that the system functions properly. The purpose of the test is to demonstrate that the equipment and the systems furnished and installed under this contract are in full compliance with the requirements of the contract documents.

669.9.1-Loading General Requirements

1. All test results and test reports shall be made available to the Department within 24 hours of testing
2. All testing shall be conducted in the presence of the engineer and shall be conducted in the State of West Virginia.
3. A Vendor’s representative shall conduct all tests.
4. The Vendor shall furnish all test equipment and services.
5. The Vendor shall notify the ITS Coordinator of the time, date and place of each test at least ten (10) days prior to the date on which the test is planned.
6. The cost for testing shall be considered as part of the unit cost for the item tested and no direct payment shall be made.

669.10-PROJECT ACCEPTANCE:

669.10.1-Vendor Compliance: The Department will follow a phased program of system acceptance in assessing Vendor compliance with the specifications detailed herein.
1. Acceptance testing shall be carried out at each RWIS site, as well as for the ESS Management System.
2. Before any RWIS Site or the Management System shall be accepted, the Vendor shall demonstrate thirty (30) days of continuous, trouble-free operation.
3. The Department will determine if, in its sole opinion, continuous thirty (30) day trouble free operation has occurred. Official acceptance will be in the form of written notice from the Department to the Vendor, acknowledging the successful completion of the test period.
4. Any component unit or device failing three or more times during any test period shall be deemed unsuitable. The unsuitable device shall be permanently marked as unsuitable.

669.11-WARRANTY:

669.11.1-Vendor Responsibility: The following details the responsibilities of the Vendor regarding Warranty and technical support for RWIS system components:
1. The RWIS system, consisting of all units and devices with the systems and all its peripherals, shall be warranted against all defects in materials and workmanship for a minimum of one (1) year from the date of acceptance recorded by the WVDOH. The warranty shall be a full warranty and shall include warranties of merchantability and fitness for purpose.
2. The warranty shall provide that in the event of a malfunction during the warranty period, the defective component or auxiliary device shall be replaced with a working component within five (5) working days.
3. A qualified authorized representative of the Vendor who has been adequately trained, shall perform all diagnoses and repairs during the warranty period.
4. The vendor agrees to provide all the required labor, materials and incidentals, at no cost to the Department, for the duration of this period. The Vendor agrees to remove, repair or replace, and reinstall any such defective workmanship and/or materials which become or are found to be defective during the period of this warranty.
5. The Vendor agrees to remedy all communication and product design defects.

669.11.2-Vendor Warranty: The Vendor shall warrant the following:
1. That all services perform conform to the requirements of this contract and have been performed by qualified personnel in accordance with the highest professional standards.
2. That all items furnished conform to the requirement of this contract and are new and free of defects.
669.12-OPERATIONAL SUPPORT:

It is the intent of the Department to perform routine preventative maintenance, troubleshooting, and unscheduled repair of the RWIS equipment, following the expiration of the warranty period. The Vendor shall provide spare parts and technical support to the WVDOH.

At a minimum, the Vendor’s operational support program shall include the following:

1. Maintaining a toll-free telephone support hotline available five days per week during normal working hours.
2. Providing a skilled technical support specialist to answer the hotline during normal business hours.
3. Providing a 24-hour answering service and technical support call back service within 60 minutes of a support request.
4. Maintaining a complete inventory of spare parts at the manufacturer site.
5. Providing overnight shipping of spare parts upon Department request.

Stability of the Vendor and any experience, which demonstrates that the Vendor will be able to support the equipment throughout the life of the contract and beyond, will be considered during the proposal evaluation.

669.13-BID ITEMS:

The Vendor/Contractor shall prepare a cost proposal per site for project capital costs. Each RWIS site shall be bid complete as 662041-00X “Road Weather Information System (RWIS)”, each ESS site shall be bid complete as 662041-00X “Road Weather Information System (ESS)”. All other incidentals, communications, hardware/software, training, etc. shall be bid within the 204001.000 “Mobilization”. Each site shall describe the required hardware/software and construction items for either a complete RWIS ESS or RWIS site. In addition to the individual site cost proposals, the total project cost will also include the Communications Master Plan and High Level Communications System Design.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.7-MIXING:

DELETE THE THIRD PARAGRAPH IN THE SUB-SECTION AND REPLACE WITH THE FOLLOWING:

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work and discharge shall be 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 (Form HL 411A) bearing information 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.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 603
PRESTRESSED CONCRETE MEMBERS

603.2-MATERIALS:
603.2.1-Inspection and Testing:

DELETE PARAGRAPH ONE AND REPLACE WITH THE FOLLOWING:

A representative of the Engineer shall have free entry at all times, while the work on the Contract is being performed, to all parts of the manufacturer’s works which concern the manufacture of the materials ordered. The manufacturer shall afford the representative of the Engineer, without charge, all reasonable facilities to satisfy themselves that the material is being furnished in accordance with these specifications. 

Inspection and acceptance procedures for prestressed concrete bridge members shall be in accordance with MP 603.10.40.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 401
ASPHALT BASE, WEARING, AND PATCHING AND LEVELING COURSES

401.7-ACCEPTANCE TESTING:

401.7.2-Surface Tolerance:

DELETE THE CONTENTS AND REPLACE THE FOLLOWING:

It is the intent of these specifications that projects with a total new pavement thickness of 3 inches (75 mm) or more and minimum length of two lots (1100 ft. (340 m)) shall be constructed to provide a smooth riding surface. The smoothness of the riding surface will be determined by the Engineer using an inertial profilometer or Mays Ride Meter. The smoothness testing shall be accomplished within 30 days after the project is substantially complete. On urban projects with numerous side streets where traffic must cross through the paving operation, the Engineer shall determine if it is practical to evaluate the pavement for smoothness.

The pavement will be divided into sampling Lots of one-tenth (0.1) lane-mile (0.16 km) each. Each Lot shall exhibit a smoothness measurement, expressed in inches per mile (millimeters per kilometer) equal to or less than that shown in the appropriate Table 401.7.2E or 401.7.2M. When a Lot is represented by a smoothness number greater than that shown in Tables 401.7.2E or 401.7.2M, the unit price shall be adjusted as in 401.13.2.

<table>
<thead>
<tr>
<th>TABLE 401.7.2E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total New Pavement Thickness</strong></td>
</tr>
<tr>
<td>3 inches to 4 inches</td>
</tr>
<tr>
<td>4 inches or greater</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 401.7.2M</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total New Pavement Thickness</strong></td>
</tr>
<tr>
<td>75-mm to 100-mm</td>
</tr>
<tr>
<td>100 mm or greater</td>
</tr>
</tbody>
</table>
Final smoothness testing of all new Asphalt surfaces shall be in accordance with Section 720.

When compaction is completed on the course, it shall present a uniform surface, true line and grade, conforming to the cross section shown on the Plans. When tested with a straightedge of approximately 10 feet (3 meters) in length and a template of the specified dimensions, the finished base course shall not show a deviation greater than ¼ inch (6 mm) and the finished wearing course shall not show a deviation from the required surface greater than 3/16 inch (5 mm).

The Contractor shall provide the straightedge and template for checking the surfaces and an employee to use them under the direction of the Engineer. Any irregularity of the surface exceeding the limits specified shall be corrected. Depressions which develop after the initial rolling shall be corrected by loosening the mixture and adding new material. High places shall be corrected by removing excess material.

Areas of completed courses found to be defective shall be removed and replaced with approved mixtures laid in accordance with these specifications, and no additional compensation will be allowed for materials used or work involved in replacing defective areas.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 501
PORTLAND CEMENT CONCRETE PAVEMENT

DELETE THE CONTENTS OF THE SECTION AND REPLACE THE FOLLOWING.

501.13-SURFACE TESTS:
The smoothness of the riding surface will be determined by the engineer using an inertial Profilometer or Mays Ride Meter calibrated to an inertial Profilometer. The smoothness testing will generally be accomplished within 30 days after the project is complete.

501.13.1-Sampling Units: The pavement will be divided into sampling Lots of 0.1 lane mile (0.16 lane kilometer) each. Each Lot shall exhibit a smoothness measurement, expressed in inches per mile (millimeters per kilometer).

501.13.2-Smoothness Requirement: Each sampling unit shall exhibit a smoothness equal to or less than 65 inches per mile (1000 millimeters per kilometer). Sampling units exhibiting smoothness values greater than 65 inches per mile (1000 millimeters per kilometer) shall be paid for at an adjusted price as follows:

\[ \text{Revised Unit Price} = \frac{\text{UBP} - \left(1.00 - \left(\frac{127.86 - 0.429S}{100}\right)\right) (0.18 \text{ UBP})}{100} \] English

\[ \text{Revised Unit Price} = \frac{\text{UBP} - \left(1.00 - \left(\frac{127.86 - 0.028S}{100}\right)\right) (0.18 \text{ UBP})}{100} \] Metric

Where:

UBP = Unit Bid Price
S = Smoothness in inches per mile (millimeters per kilometer).

When the measured smoothness value exceeds the specified value by 50 percent or more, the Lot shall be corrected to comply with these specifications.
501.13.3-Grinding Requirements: When the pavement requires corrective action as noted above, the diamond grinding operations shall be in accordance with section 508, except that the final pavement smoothness requirements shall be in accordance with section 501.

501.13-SURFACE TESTS:

The smoothness of the riding surface will be determined using the procedures outlined in Section 720. When corrective action is needed, the diamond grinding operations shall be in accordance with section 508.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.11-FINISHING CONCRETE SURFACES:
  601.11.4-Finishing Concrete Bridge Decks:
    601.11.4.3-Straightedge Testing of Hardened Bridge Decks:

DELETE THE SUBSECTION AND REPLACE THE FOLLOWING.

  601.11.4.3-Straightedge Testing of Hardened Bridge Decks: When finishing has been completed and the concrete has hardened sufficiently, the surface shall be given a further test for trueness with a rolling straightedge- or an inertial profiler approved by the West Virginia Department of Transportation Materials Soils, Control and Testing. When using a rolling straight edge, areas Areas showing high spots of more than 1/8 inch (3 mm) shall be marked by the Engineer. When a certified inertial profiler and certified inertial profiler operator are used, the data shall be analyzed by using the rolling straight edge simulation on the most recent version of ProVal. Areas showing more than 1/8 inch (3mm) on the rolling straight edge simulation will be mapped showing locations, and only when directed by the Engineer, such areas that are higher than 1/8 inch (3 mm) shall be ground with an approved grinding tool, utilizing carborundum stones or industrial diamond wheels; grinding shall be done to an elevation where the area or spot will not show a surface deviation in excess of 1/8 inch (3 mm) when tested with the 10 feet (3.048 meter) rolling straightedge, except that the maximum depth of grinding shall not exceed ¼ inch (6 mm). The ground areas shall be treated as directed by the Engineer. Where the initial deviation from the straightedge is ½ inch (13 mm) or more, the Contractor will be required to remove and replace the complete pour in which the areas not meeting the required tolerance are located.

After grinding, all areas either high or low, not meeting the requirements of 1/8 inch (3 mm) tolerance will be measured and disposition of these areas will be as set forth in 601.15.2
601.15-BASIS OF PAYMENT:

601.15.2- Price Adjustments:

DELETE THE SUBSECTION AND REPLACE THE FOLLOWING.

601.15.2- Price Adjustments: The Contractor will be assessed equitable deductions of twenty-five dollars ($25.00) per square foot. (two-hundred seventy dollars ($270.00) per square meter) for areas of bridge decks not meeting the specified 1/8 in (3mm) tolerance and not specified to be removed nor directed to be ground, and for any areas that have been ground but do not meet the specified tolerance. Deviations will be tested with a 10ft (3.048 meter) rolling straightedge or using an inertial profiler approved by West Virginia Department of Transportation Materials Soils, Control and Testing. Inertial profiler data will be analyzed by using the rolling straight edge simulation on ProVal.

Concrete not found in compliance with the requirements of 601.4.4 for compressive strength will be paid for at a reduced contract price in accordance with the following formula:

\[
\text{Percent Reduction} = \frac{f'_{c} - X}{0.6f'_{c} - \sigma}
\]

Where:

\[ f'_{c} = \text{Design Strength, psi (MPa)} \]
\[ X = \text{Observed Strength, psi (MPa)} \]
\[ \sigma = \text{Standard Deviation} \]

The percent reduction shall be applied to the subplot with the low strength.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 679
OVERLAYING OF PORTLAND CEMENT

679.5-FINAL BRIDGE DECK FINISH:
   679.5.1-Straightedge Test:

DELETE THE SUBSECTION AND REPLACE THE FOLLOWING.

   679.5.1-Straightedge Test: After defective or damaged concrete has been repaired and cured in accordance with 679.4.9 and before opening to traffic, the bridge deck shall be grooved perpendicular (or radial) to the centerline of the roadway. Prior to grooving, the entire deck shall be checked by the Contractor in the presence of the Engineer with an approved rolling straightedge or approved inertial profiler and inertial profiler operator as outlined in section 601.11.4.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
ADD THE FOLLOWING SECTION:

SECTION 720
SMOOTHNESS TESTING

720.1-DESCRIPTION:
To measure and evaluate the ride quality of pavement surfaces in accordance with the Inertial Roughness Index (IRI), as well as the most recent forms of AASHTO R-56, AASHTO M328, and AASHTO R-57.

720.2-EQUIPMENT:

720.2.1-High-speed or lightweight inertial profiler: Provide a high-speed or lightweight inertial profiler for measuring and evaluating the ride quality of pavement surfaces. The inertial profiler shall be certified at a facility approved by the Materials Control, Soils and Testing Division. Certification facilities shall conduct the evaluation in accordance with the most recent edition of AASHTO R-56 “Standard Practice for Certification of Inertial Profiling Systems”. All inertial profilers shall be maintained in accordance with the most recent edition of AASHTO M328 “Standard Specifications for Inertial Profiler”. The contractor shall submit equipment certification documentation after becoming certified or after recertification. A current decal provided by the certification facility shall be displayed on the inertial profiler to indicate equipment certification compliance.

720.2.2-Inertial Profiler Operator Certification: Certification through the Material Division shall be required to operate an inertial profiler in the State of West Virginia. The operator shall pass a written exam administered by the Materials Division. All operators receiving a passing score on the written exam will be placed on the Material Division’s Approved Source List “WVDOH Certified Profilers”. Certification shall be for a period of four years. Certified operators shall submit an application for certification renewal with the Materials Division, Bridge and Roadway Analysis Group Leader. After reviewing the certification renewal application, the Materials Division may issue the operator a new four-year certification or may require the operator to retest for certification renewal.
720.3-RIDE QUALITY TESTING

720.3.1-Quality Control (QC) Testing: QC testing is the responsibility of the Contractor. QC testing shall be completed within seven (7) calendar days after all stages of paving are completed. Data collection shall be done by a certified inertial profiler and certified inertial profiler operator (See 720.2.1 and 720.3). Collected profile data shall be submitted via email to dohmcsntroadway@wv.gov within five (5) calendar days of testing. Profile data shall be collected and submitted in accordance with the most recent edition of AASHTO R-57.

720.3.2-Quality Assurance (QA) Testing: QA testing is the responsibility of the Division. The Engineer shall submit a “Request Form for Bridge and Roadway Analysis Group” form to the Materials Division, within five (5) calendar days after all stages of paving are completed via email. Within ten (10) working days from receiving the request, the Division shall conduct QA testing. The Division shall use a certified inertial profiler and certified operator for QA testing.

720.3.3-Quality Assurance Verification (QAV) Testing: QAV testing is the responsibility of the Division. The Division’s profile data and the Contractor’s profile data will be compared to determine the IRI differences. Final project price adjustments will be made using the Contractor’s profile data if the IRI differences are within the allowable limits outlined in Table 720.3.3.

<table>
<thead>
<tr>
<th>Contractor’s IRI Mean (in/mi)</th>
<th>Maximum Allowable Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0 or Less</td>
<td>8.5% of Contractor’s IRI Mean</td>
</tr>
<tr>
<td>50.1 to 150.0</td>
<td>6.0% of Contractor’s IRI Mean</td>
</tr>
<tr>
<td>150.1 or Greater</td>
<td>7.0% of Contractor’s IRI Mean</td>
</tr>
</tbody>
</table>

720.3.4-Referee Testing: Referee testing is the responsibility of the Division. If the QAV testing IRI differences does not meet the maximum allowable difference from Table 720.4.3, the Division will perform referee testing using a certified inertial profiler and a certified inertial profiler operator in accordance with the most recent edition of AASHTO R56 “Standard Practice for Certification of Inertial Profiling Systems”. The profile data from the referee test shall be used in determining the final project price adjustments.

720.3.4.1- Referee Data: If the referee test data still does not meet the allowable IRI differences Materials Control and Soil Testing can recommend the contractor recertify their inertial profiler and inertial profiler operator that was used on the project.

720.4-RIDE QUALITY ANALYSIS

720.4.1-Data Location: The average international roughness index (IRI) number used in ride quality analysis shall be the average international roughness number of the two wheel paths.
720.4.2 Leave Out Sections - Bridge Structures and any sections tested which are not included in the pavement project shall be removed from the Ride Quality Analysis. These removed bridges and sections shall also include a Lead-In and Lead-Out distance to be removed from the Ride Quality Analysis. The Lead-In distance shall be two hundred (200) feet and the Lead-Out distance shall be two hundred (200) feet.

720.4.3-Sampling Lots: The pavement shall be divided into sampling lots of one-tenth (0.1) lane mile each. Each Lot shall exhibit a smoothness measurement, expressed in inches per mile (in./mi.).

720.4.3.1-Special Cases for sampling lots less than one-tenth (0.1) lane mile: In some cases, sampling, lots of one tenth (0.1) lane mile will not be attainable. These cases include areas at the end of the project as well as areas that are before the “lead in” length of bridges. If these areas are less than five-hundredths (0.05) of a lane mile that will be eliminated from Ride Quality analysis. If these areas are more than five-hundredths (0.05 mile) lane mile these areas will be included in analysis and pay adjustments will be prorated to the nearest one hundredth (.01) mile. This shall apply to all projects governed by specification 720.

720.4.4-Rounding: Rounding shall be done to round all IRI numbers to the nearest whole number. Rounding of IRI shall be done in accordance with MP 109.01.01, “Rounding of Numbers”.

720.5-NATIONAL HIGHWAY SYSTEM (NHS) PAVEMENT PROJECT:
Pavement projects located on any NHS route and greater than 0.2 miles long shall be tested with a certified high-speed or lightweight inertial profiler.

720.5.1-Schedule 1 NHS Pavement Projects: NHS pavement projects with a pavement thickness of four (4) inches or greater shall be classified as Schedule 1 NHS Pavement Projects. The final price adjustments for Schedule 1 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.1.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.0 or Less</td>
<td>+600</td>
</tr>
<tr>
<td>30.1 to 60.0</td>
<td>-20(IRI) + 1200</td>
</tr>
<tr>
<td>60.1 to 65.0</td>
<td>0</td>
</tr>
<tr>
<td>65.1 to 95.0</td>
<td>-20(IRI) + 1300</td>
</tr>
<tr>
<td>95.1 or Greater</td>
<td>Corrective Action Required</td>
</tr>
</tbody>
</table>

720.5.1.1-Corrective Action for Schedule 1 NHS Pavement Projects: Corrective action shall be required for Schedule 1 NHS Pavement Projects having an IRI greater than
95 in/mi. Corrective action shall be performed using diamond grinding or other work methods approved by the Engineer.

**720.5.2 Schedule 2 NHS Pavement Projects**: NHS pavement projects with a pavement thickness three (3) inches or greater and less than four (4) inches shall be classified as Schedule 2 NHS Pavement Projects. The final price adjustments for Schedule 2 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.2.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.0 or Less</td>
<td>+600</td>
</tr>
<tr>
<td>46.1 to 76.0</td>
<td>-20(IRQ)+1520</td>
</tr>
<tr>
<td>76.1 to 80.0</td>
<td>0</td>
</tr>
<tr>
<td>80.1 to 120.0</td>
<td>1200-15(IRQ)</td>
</tr>
<tr>
<td>120.1 or Greater</td>
<td>-600</td>
</tr>
</tbody>
</table>

**720.5.3 Schedule 3 NHS Pavement Projects**: NHS pavement projects with a pavement thickness less than three (3) inches and more than one (1) inch shall be classified as Schedule 3 NHS Pavement Projects. The final price adjustments for Schedule 3 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.3.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.0 or Less</td>
<td>+300</td>
</tr>
<tr>
<td>46.1 to 76.0</td>
<td>-10(IRQ) + 760</td>
</tr>
<tr>
<td>76.1 or Greater</td>
<td>0</td>
</tr>
</tbody>
</table>

**720.6 NON-NATIONAL HIGHWAY PAVEMENT PROJECTS**: Pavement projects located on any Non-NHS route, greater than 0.2 miles long, fifteen (15) feet or wider, with a thickness of more than one inch (1), and with a minimum Average Daily Traffic (ADT) of one hundred (100) shall be tested with equipment outlined in 720.2.1 and 720.3.

**720.6.1 Ride Quality Analysis Before and After Project Completion**: Non-NHS pavement projects shall be tested before the pavement project begins and after the pavement project is completed.

**720.6.2 Data Source Collection Before Beginning Project and**: The data collection before project begins may be collected from one of the following sources: (a) The Division’s online database, (b) The Contractor’s data if the data was collected with a certified inertial
profiler and certified inertial profiler operator, (c) The Division’s high-speed or lightweight inertial profiler.

720.6.3-Data Source Collection After Project Completion: The data source collection after project completion shall be collected by the Division’s high-speed or lightweight inertial profiler.

720.6.5-Final Price Adjustments: Final price adjustment incentives shall be calculated using percent improvement. 0.1-mile sections of after project completion data with an IRI of 170 in/mi or greater will be eligible for final price adjustment. The final price adjustments for Non-NHS Pavement Projects shall be determined using the calculations shown in Table 720.6.5.

<table>
<thead>
<tr>
<th>Percent Improvement (%)</th>
<th>Price Adjustment Incentive ($ per 0.1-mile Section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 or Greater</td>
<td>+450.00</td>
</tr>
<tr>
<td>30.00 to 59.99</td>
<td>15(Percent Improvement) - 450</td>
</tr>
<tr>
<td>29.99 or Less</td>
<td>0.00</td>
</tr>
</tbody>
</table>

720.7-PROJECT THAT DO NOT FALL UNDER PREVIOUS CHARACTERIZATIONS:
At the discretion of the Engineer pavement projects not falling into any of the other classifications shall be measured and evaluated for ride quality analysis under the direction of the Engineer. If recommended by the Engineer this shall be done by the contractor with a 10-foot straightedge. There will not be any pay adjustments based on Ride Quality for these projects.

720.7.1-New Pavement that is one (1) inch or less in thickness: Pavement projects that are less than one (1) inch will not be tested for Ride Quality.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

FOR

SECTION 619
WATERPROOFING

619.1-DISCRIPTION:

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

This work shall consist of waterproofing around the tunnel liner plate pipe. Membrane waterproofing shall consist of a contact adhesive and high-strength drainage composite made up of a nonwoven filter fabric that is bonded to the individual dimples of a molded polystyrene core to minimize fabric intrusion into the flow channels caused by backfill pressure. The work shall be done in accordance with the Specifications and as shown on the Plans.

619.2-MATERIALS:

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

619.2.1-Waterproofing Membrane:
   619.2.1.1-General: Prefabricated drain shall be a flexible rectangular hollow mat consisting of a supporting polymeric drainage core encased on one face in an engineering fabric envelope and having sufficient flexibility to withstand installation bending and handling without damage.

619.2.1.2-Core: The drainage core shall meet the following requirements:
## 619.2.1.3-Fabric:
The fabric shall be suitable for subsurface drainage applications and shall meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Standards</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent Opening Size</td>
<td>D4751</td>
<td>40 (0.425)</td>
<td>US Std Sieve (mm)</td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>D4491</td>
<td>200 (8,148)</td>
<td>gpm/ft² (l/min/m)</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>D4632</td>
<td>80 (356)</td>
<td>lbs (N)</td>
</tr>
<tr>
<td>Grab Elongation</td>
<td>D4632</td>
<td>60</td>
<td>%</td>
</tr>
</tbody>
</table>

## 619.2.1.4-System:

| Performance Index | * | 18,250 | — |

All flow rates were tested at 3600 psf.

Drainage Performance Index is a function of ASTM D4833, D4632 and D1621

1. In plane flow rate @ gradient of 1.0
2. Installed flow rate with soil overburden at vertical gradient of 1.0

## 619.2.1.5-Acceptance:

All components of the edge drain shall be approved before use. The Contractor shall furnish certified test data with the material supplied for each project. Tests for all required properties shall be performed in accordance with the procedures specified. Compliance of this data with the requirements specified will be the basis of acceptance.

## 619.3-PREPARATION OF SURFACE:

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

No waterproofing shall be done in wet weather or when the temperature is below 35° F (2° C), without written authority of the Engineer.

## 619.4-DAMPPROOFING:

DELETE THE SUBSECTION.

## 619.5-MEMBRANE WATERPROOFING:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE WITH THE FOLLOWING:
Adjacent panels should be joined together with the lateral edge of the connecting panel placed over the flanged edge of the previous panel. The fabric from the adjacent panels should overlap the preceding panel. The fabric can be adhered with Contact Adhesive. The top or terminal edge of the membrane should be sealed by wrapping the extra filter fabric around to the back side of the panel, and if there is insufficient fabric, the core shall be cut out from the fabric by a depth of 3 dimples to provide excess fabric for wrapping behind the core. This will prevent soil or other foreign construction materials from intruding into or behind the panels. A “set back” or “ledge” condition may be encountered on some construction applications. Where this condition exists, membrane panels should be installed beginning at the bottom of the wall and ending at the ledge. Subsequent courses of s membrane should be installed flat against the upper wall portion and placed so that 4 – 6” (10-15 cm) extend down and over the lower edge. The overlapping membrane sections will be pushed flush against the wall during backfilling. Place collector pipe and outlet pipe as required in plans in accordance other items of work. For installations where a collector pipe is specified, encapsulate the collector pipe in a gravel bed with a supplemental section of filter fabric as a separator/filter.

615.6-DETAILS:
DELETE THE SUBSECTION

615.9-PAY ITEMS:
ADD THE FOLLOWING ITEMS TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>619002-*</td>
<td>Membrane Waterproofing Without Protection</td>
<td>Square Yard (Meter)</td>
</tr>
</tbody>
</table>

* Sequence Number
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: _____________________________
FEDERAL PROJECT NUMBER: _____________________________

FOR

SECTION 619
WATERPROOFING

619.1-DESCRIPTION:

ADD THE FOLLOWING TO THE SUBSECTION:

619.1.1-Geocomposite Wall Drain: Prefabricated geocomposite wall drain shall consist of a polymeric drainage core encased in a nonwoven filter fabric envelope having sufficient flexibility to withstand bending and handling without damage.

619.2-MATERIALS:

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

619.2.1-Geocomposite Wall Drain: Shall conform to the following:

Core: The drainage core shall be made from an inert, polymeric material resistant to commonly encountered chemicals and substances in the roadway. Outer surface shall be smooth to prevent excessive wear of bonded filter fabric.

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength at 20% deflection</td>
<td>ASTM D162/D2412</td>
<td>Min. 40 psi after 24 hrs. at 0 degree F and at 125 degree F</td>
</tr>
<tr>
<td>Water flow rate (after 100 hr. at 10 psi normal confining pressure and gradient of no more than 1.0)</td>
<td>ASTM D4716</td>
<td>Min. 15 gal/min/ft. width (for 12-in specimen length)</td>
</tr>
</tbody>
</table>
**Physical Property** | **Test Method** | **Requirements**
--- | --- | ---
Water flow rate (after 100 hr. at 10 psi normal confining pressure and gradient of no more than 1.0) | ASTM D4716 | Min. 15 gal/min/ft. width (for 12-in specimen length)

**Filter Fabric:** Geotextile filter fabric shall be bonded to and tightly stretched over both sides if of the core. Geotextile shall not sag or block the flow channels, shall have a life equivalent to that of the core material.

Drainage fabric shall be nonwoven and clog resistant, suitable for subsurface application, and thermally and biologically stable.

Drainage fabric shall be nonwoven and clog resistant, suitable for subsurface application, and thermally and biologically stable.

Polypropylene materials are acceptable in environments with pH values between 3 and 12 inclusive; polyester material between 3 and 9 inclusive.

**Physical Property** | **Test Method** | **Requirements**
--- | --- | ---
Permittivity | ASTM D4491 | Min. 0.5 sec⁻¹
Apparent opening size | ASTM D4751 | Max. No. 50 sieve

In addition to these requirements, the geotextile shall comply with the requirements of AASHTO M288 Table 1-Geotextile Strength Property Requirements, Class 2 for grab strength.

**Shipping, Handling, And Storage Requirements:** Geosynthetic shall be permanently marked with a clearly legible print showing manufacturing plant or plant Identification Code number, located on the roll edge at least every 16 feet. Rolls shall be labeled at both ends of the outside of the roll outer wrapping and both ends of the inside of the geotextile roll core, and labels shall list the roll number, production date, AASHTO M288 class(es) the product name; if the permanent marking contains this information, the labels may be omitted.

Each geosynthetic roll shall be wrapped or otherwise packages in a manner that will project the geosynthetic, including the ends of the rolls, from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipments and storage.

During storage, geosynthetics rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage; precipitation; extended ultraviolet radiation including sunlight; strong acids or strong bases; flames including welding sparks; temperatures in excess of 160 degrees F; and other environmental conditions that may damage the physical property values of the geosynthetic. Geosynthetics that are not properly protected may be subjected to rejection.

**Testing and Documentation:** Each geosynthetic material provided to the project shall have a manufacture date within its current NT-PEP (*National Transportation Product Evaluation Program*) product 3-year evaluation cycle. The manufacturer and any subsequent private labeler facility shall be listed as compliant by NTPEP within the current
calendar year, or immediate past calendar year with an application for audit for the current calendar year.

The Department may sample and test product from a facility or project at any time to verify compliance with specification requirements. Failure may result in the product being rejected.