TENNESSEE DEPARTMENT OF TRANSPORTATION

Design-Build

Book 2 Contract

Interstate 24

Interchange at Epps Mill Road/Buchanan Road; Epps Mill Road,

From west of Capital Way to SR-2 (US-41)

Rutherford County, Tennessee

DB Contract# **2505**

October 2025

This page intentionally left blank.

Table of Contents

Design-Build Contract 1
Recitals 1
Agreement 2
1 General Contract Provisions, Defined Terms, and General Scope of Work 2
1.1 Incorporation of Recitals 2
1.2 Contract Documents 2
1.3 Effective Date 2
1.4 The Contract 2
1.5 Defined Terms and Acronyms 2
1.6 Applicable Version of Law or Standard 2
1.7 Minimum Contract Requirements 2
1.7.1 Department Supplied 2
1.7.2 Design-Builder Supplied 2
1.7.3 Management Plans 3
1.8 Utility Coordination Services 3
1.9 Design Services 3
1.9.1 License Requirements; Standard of Care 3
1.9.2 Design Documents 3
1.10 Construction Services 4
1.11 Quality Management Services 6
1.12 Project Management Services 6
2 General Standards for Performance of the Work 6
2.1 Good Faith 6
2.2 Performance Standards 6
2.3 Critical Path Method (CPM) Schedule 6
2.4 Review and Comment, or Acceptance 7
2.5 Extra Work to be Provided by the Design-Builder 7
3 Relationship and Roles of the Parties 7
3.1 Independent Entity 7
3.2 Department Representative and Contact Information 7

3.3 Design-Builder Representative 7
3.4 Key Personnel and Design Professionals 7
3.4.1 Key Personnel 8
3.4.2 Design Professionals 8
3.5 Substitution of Key Personnel and/or Design-Professionals 8
4 Date of Commencement and Completion of Services 8
4.1 Time for Performance 8
4.2 Commencement of Services 9
4.3 Completion Dates 9
5 Compensation 9
5.1 Contract Amount 9
5.2 Progress Payments 9
5.3 Adjustments to the Contract Amount 9
5.4 Payments for Extra Work 9
5.5 Deductions from Monies Due 9
6 Changes in the Work 10
7 Insurance and Bonding Requirements 10
7.1 Insurance Requirements 10
7.2 Bonding Requirements 10
7.3 Indemnification 11
8 Ownership and Use of Work Product of the Design 11
9 Project Records 11
9.1 Financial and Other Project Records 11
9.2 Record Retention Period 11
9.3 Access to Records 12
9.4 Subcontract Record Retention Requirements 12
9.5 Location 12
10 Termination or Suspension 12
10.1 Termination for Convenience and No Fault; Payment 12
10.2 Termination for Cause; Amounts Payable 12
10.3 Contract Notice of Contract Termination 13
10.4 Quality of the Work 13

10.5 Litigation 13
11 Enumeration of Contract 13
12 Order of Precedence 14
13 Design-Builder Certifications and Disclosures 14
13.1 Nondiscrimination 14
13.2 Illegal Immigrants 14
13.3 Certification Regarding Debarment, Suspension, and Other Responsibility Matters – Primary Covered Transactions 14
13.4 Certification for Grants, Loans, and Cooperative Agreements 14
14 Miscellaneous Provisions 14
14.1 Employment of Department Workers 14
14.2 Covenant Against Contingent Fees 15
14.3 Energy Policy and Conservation Act 15
14.4 Additional Employment Regulations 15
14.5 Copyrighting 15
14.6 Governing Law; Jurisdiction; Venue 15
14.7 Contract Interpretation 15
14.8 Notices 16
14.9 Disclosure of Tax Identification Number 16
14.10 Severability 16
14.11 No Waiver 16
14.12 Media Contacts; Confidentiality 16
14.13 Organizational Conflicts of Interest 16
14.14 The Department's Insurance 17
14.15 Joint Ventures and Partnerships 17
14.16 Merger Clause 17
APPENDIX A 19
APPENDIX B 20
APPENDIX C 23

DESIGN-BUILD CONTRACT

This Design-Build Contract is entered into by and between the State of Tennessee, acting by and through the Department of Transportation (the "Department") and [Enter name of Design-Builder] (the "Design-Builder"), (collectively, the **"**Parties**"**) as of the Effective Date of the Contract.

RECITALS

WHEREAS, the Department requires the improvements for the project known as the **I-24 Interchange at Epps Mill Road/Buchanan Road Rutherford** Design-Build Project (the "Project") more particularly described in **Book 3 (Project Specific Information)**. The Project will be funded with **State and Local** dollars, thereby requiring that the Design-Builder adheres to all pertinent state, federal, and local requirements; and

WHEREAS, the Parties intend for the Contract to be a lump-sum Contract, obligating the Design-Builder to perform all work necessary to complete the Project by the deadlines specified herein, for the Contract Amount, subject only to certain specified limited exceptions. To allow the Department to budget for the Project and to reduce the risk of cost overruns, the Contract includes restrictions affecting the Design-Builder's ability to make claims for an increase to the Contract Amount or an extension of the Completion Deadlines. The Department may require additional related work within the general vicinity of the Project, which, if required, shall be included in the Project and added to the Contract by Change Order; and

WHEREAS, the Department requires a Design-Builder competent to perform all work necessary to complete the Project in accordance with the terms and conditions of the Contract and able to do so within the Contract Time allocated herein. If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. The Contract therefore provides that a deduction shall be made from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, as stated in **Book 3 (Project Specific Information)**, if such completion is delayed; and

WHEREAS, Design-Builder asserts that it is competent and prepared to perform all work necessary to complete the Project in accordance with the terms and conditions of the Contract, and that it is able to do so within the Contract Time allotted herein; and

WHEREAS, the Department is authorized under Section 54-1-119 of the Tennessee Code Annotated to enter into this Contract.

NOW, THEREFORE, in consideration of the mutual promises contained herein, and for other good and valuable consideration, the Department and the Design-Builder agree as follows.

AGREEMENT

1 GENERAL CONTRACT PROVISIONS, DEFINED TERMS, AND GENERAL SCOPE OF WORK

1.1 Incorporation of Recitals

The foregoing Recitals incorporated herein and made a part hereof for all purposes as if fully set forth constitute additional promises or representations and warranties of the Parties.

1.2 Contract Documents

The Contract Documents, made a part hereof for all purposes as if fully set forth, are intended to reflect the complete understanding of the Parties concerning their respective rights and responsibilities under the Contract.

1.3 Effective Date

The Contract shall become effective on the date on which each Party has signed this Contract and all approvals have been obtained (the “Effective Date”).

1.4 The Contract

The Contract, which includes this **Book 2 (Design-Build Contract)** and all other Contract Documents, forms the entire agreement between the Parties.

1.5 Defined Terms and Acronyms

Defined terms and acronyms utilized in this **Book 2 (Design-Build Contract), Book 3 (Project Specific Information)**, and in the other Contract Documents are either set forth in the Department’s *Design-Build Standard Guidance*, or defined in the text accompanying the term.

1.6 Applicable Version of Law or Standard

All work shall be performed pursuant to the applicable law and in accordance with the standards in effect at the time of the RFP issuance, including addenda, unless otherwise specified in the Contract or by amendment.

1.7 Minimum Contract Requirements

1.7.1 Department Supplied

Among the Contract, the Department has mandated certain Contract requirements from which the Design-Builder may not deviate in the scope of the work, except as instructed by the Department. The Department has also established certain minimum Contract requirements that set a minimum standard of performance or quality that the Design-Builder must meet or exceed in performance of the Contract.

1.7.2 Design-Builder Supplied

The Design-Builder has established certain minimum Contract requirements located in Exhibit A (Design-Builder’s Technical Proposal), consisting of those provisions of its Proposal that meet or exceed minimum

Contract requirements established by the Department and upon which the Department has relied in awarding the Contract to the Design-Builder.

Any non-standard Department specification or provision shall be considered the Design-Builder-supplied Contract provisions and requires Department Review and Approval, which will obligate the Design-Builder within this the Contract.

1.7.3 Management Plans

Pursuant to the *Design-Build Standard Guidance* and Section 2 of **Book 3 (Project Specific Information)**, the Design-Builder shall submit a Project Management Plan (PMP).

1.8 Utility Coordination Services

Utility Coordination services are expected under this Contract. **Book 3 (Project Specific Information)** provides additional for information on Utility Coordination services required from the Design-Builder.

1.9 Design Services

The design services required under the Contract shall include, at a minimum, each of the following:

- Performance of all design services, including, but not limited, to all services and Work detailed in **Book 3 (Project Specific Information)**; and
- Performance of all other engineering design services required under the Contract and/or otherwise necessary to complete the work in accordance with all Contract requirements.

All Design Documents and Design Reviews shall be provided by the Design-Builder and performed in accordance with the Design Review schedule established in the Critical Path Method (CPM) Schedule, and in accordance with all Contract requirements.

All design services to be performed under the Contract are appurtenant to construction services being provided by the Design-Builder.

1.9.1 License Requirements; Standard of Care

Whether the Design-Builder is a design professional, has a design professional as a member or on staff, or will otherwise provide an outside source to perform the services of a design professional, all design services (whether constituting the practice of architecture, the practice of engineering, the practice of surveying, or the practice of other design services) referred to in this Contract shall be provided by duly licensed and competent design professionals employed or otherwise retained by the Design-Builder.

The design professionals currently designated to provide such design services are listed in Subsection 3.4. All design services shall be performed by a design professional of the appropriate professional discipline in accordance with the degree of skill and care ordinarily used by competent practitioners of the same professional discipline under similar circumstances, taking into consideration the contemporary state of the practice and the project conditions.

1.9.2 Design Documents

The Design-Builder shall generate and provide to the Department all Design Documents. The Design-Builder shall make a comprehensive design check and Design Review at the following five (5) stages of design development, stated in more detail within *Design-Build Standard Guidance*:

- Definitive design;

- Interim design;
- Readiness-for-Construction Plans, Readiness-for-Construction Specification, and quantity estimates;
- Working Plans; and
- As-Built Plans.

1.9.2.1 Readiness-for-Construction Plans and Specifications

Upon completion of the Definitive Design Reviews, Working Plan Design Reviews, Interim Design Reviews (if any), and Readiness-for-Construction Design Reviews, as specified in the *Design-Build Standard Guidance*, the Design-Builder shall finalize the Readiness-for Construction Plans and Specifications. In performing these services, the Design-Builder shall meet the following requirements:

- Readiness-for-Construction Plans and Specifications shall comply with all applicable Laws and all Contract requirements.
- Readiness-for-Construction Plans and Specifications shall be a complete, fully coordinated, integrated package, without any significant modifications or further clarifications required.
- The Design-Builder shall file all documents required for the approval of Authorities having jurisdiction over the Project, shall obtain all necessary permits not obtained by the Department, and shall pay for all associated fees, including application, filing, plan review, and appeal fees.
- The Design-Builder shall provide the Department with written certification and all Design Documents required for the Readiness-for-Construction certification, in accordance with *Design-Build Standard Guidance*.
- The Design-Builder shall submit to the Department all documentation and Design Quality Records required under the *Design-Build Standard Guidance*.
- The Design-Builder shall submit to the Department As-Built Plans and the Design-Builder Specifications, compiled and organized in accordance with all Contract requirements that incorporate all changes in the design and construction of the Project.
- The Design-Builder shall prepare and deliver to the Department all As-Built Plans, the Design-Builder Specifications, and other Design Documents, information, and data required under the Contract to be provided to the Department.

1.9.2.2 Value Engineering Cost Proposals

During development of the Design Documents, the Design-Builder and the Department may collaborate on identifying, evaluating, and implementing value engineering cost proposal (VECP) options in accordance with the *Design-Build Standard Guidance*. The Design-Builder's development of the Design Documents and completion of the Readiness-for-Construction Plans and Specifications shall not preclude further identification and implementation by the Design-Builder and the Department of additional cost reduction options during construction. VECPs adopted by the Department will be implemented through Change Orders pursuant to the *Design-Build Standard Guidance*.

1.10 Construction Services

The construction services required under the Contract shall include, at a minimum, each of the following:

- Performance of all construction services, including, but not limited to, all services and Work detailed in **Book 3 (Project Specific Information)**;

- Protection of environmental resources, including plant and animal life and associated habitats; and
- Performance of all other construction services required under the Contract and/or otherwise necessary to complete the work in accordance with all Contract requirements.

The Design-Builder shall provide all necessary work to furnish to the Department complete, fully functional road improvements specified in the *Design-Build Standard Guidance*, capable of being fully utilized for the purposes described in the Contract and constructed in compliance with all Contract requirements. The Design-Builder shall perform the construction services as follows:

- The Design-Builder shall supervise and administer all construction activities in accordance with Contract requirements.
- In the event of the existence of any dispute between the Parties under the Contract, the Design-Builder shall continue to perform in accordance with the Contract terms and seek resolution in accordance with the *Design-Build Standard Guidance*.
- The construction work shall be of good quality, free from faults and defects, and in conformance with all Contract requirements. At its own expense, the Design-Builder shall correct construction work that does not conform to these requirements.
- The Design-Builder shall utilize new materials and equipment in the work, unless otherwise specified in the Contract.
- The Design-Builder shall pay all taxes, fees, and costs associated with the acquisition of tools, equipment, materials, and the performance of the work, in accordance with the *Design-Build Standard Guidance*.
- The Design-Builder shall keep the work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.
- The Design-Builder shall deliver to the Department all notices regarding completion of the work pursuant to *Design-Build Standard Guidance,* including notifying the Department when the work or an agreed upon portion thereof has been completed.
- The Design-Builder shall maintain, on the work location, a copy of all approved Management Plans, environmental permits, approved design documents, project records, the entire Contract, and any other document required in accordance with the *Design-Build Standard Guidance.*
- As the Project constitutes "Highway construction" utilizing Federal funds, the Design-Builder shall comply with any federal requirements and appropriate Department Special Provisions as provided by the *Design-Build Standard Guidance* and **Book 3 (Project Specific Information)**, respectively.
- Consistent with the *Design-Build Standard Guidance*, the Design-Builder shall be fully responsible for initiating, maintaining, and supervising safety precautions and programs in connection with the work, including, but not limited to, taking reasonable precautions to ensure the safety of, and prevention of damage, injury, or loss to:
    - Employees of the Department present on or in the vicinity of a work location, employees of the Design-Builder and other persons performing work on or in the vicinity of a work location, and other persons, including the traveling public, who may be affected;
    - Materials and equipment to be incorporated into the Project;
    - Portions of the Project under construction or completed; and
    - Other property within or adjacent to a work location.

- The Design-Builder shall be liable for damage to or loss of property at work locations and on private property affected by the Design-Builder's activities, pursuant to the *Design-Build Standard Guidance*. This subparagraph shall in no way affect the applicability or coverage of the bonds and insurance required under Section 7 of this Contract.

1.11 Quality Management Services

Quality Management services shall include performance, at a minimum, of all activities and obligations, including preparation of all documentation, described in the *Design-Build Standard Guidance*, and as otherwise necessary to ensure that the work is performed in accordance with all Contract requirements.

1.12 Project Management Services

Project management services shall be integrated with the design services and construction services described herein and in **Book 3 (Project Specific Information)** and shall include, at a minimum, the following:

- Project Controls (including Risk Management, Scheduling, Reporting and Document Management).
- Construction management;
- Contract management;
- Safety management; and
- Traffic management.

2 GENERAL STANDARDS FOR PERFORMANCE OF THE WORK

2.1 Good Faith

The Design-Builder shall provide and perform all design services, Quality Management, project management, and construction services in good faith and as expeditiously as is consistent with the applicable standards of skill and care ordinarily exercised by members of the profession under similar conditions and circumstances and of the orderly prosecution of the work.

2.2 Performance Standards

Where specific performance standards for any aspect of the work have been established in the Department Special Provisions as stated in Appendix B, pursuant to **Book 3 (Project Specific Information)**, the work shall be performed so as to meet or exceed such standards.

2.3 Critical Path Method (CPM) Schedule

The CPM Schedule establishes the schedule and deadlines for Contract performance, with which the Design-Builder must comply. The CPM Schedule, as it may be modified during the course of the Project pursuant to the *Design-Build Standard Guidance* and **Book 3 (Project Specific Information)** shall anticipate and accommodate such periods of time as may be required for the Department's review of Design Documents, and for approval by Authorities having jurisdiction over the Project of any required submissions, including but not limited to, applications for permits and environmental impact evaluations. Since time is of the essence in the Design-Builder's successful completion of its assignment, the Design-Builder agrees to begin work on each work location immediately after receiving authorization from the Department to proceed with its work efforts.

2.4 Review and Comment, or Acceptance

The Department's consideration, Review and Comment, or Acceptance of any matters, or the Department's authorization of any action, will not be deemed or construed as relieving the Design-Builder of its sole responsibility for, and its complete and exclusive control over, the means, methods, sequences, and techniques for performance of the work in accordance with the terms of the Contract.

2.5 Extra Work to be Provided by the Design-Builder

The Design-Builder shall perform Extra Work in accordance with the *Design-Build Standard Guidance*.

3 RELATIONSHIP AND ROLES OF THE PARTIES

3.1 Independent Entity

The Design-Builder is an independent entity and not an officer, employee, or agent of the Department.

3.2 Department Representative and Contact Information

The Department's representative for this Project is:

Miller Bernhardt, PE
Alternative Delivery Division Representative

Address: Tennessee Department of Transportation
6601 Centennial Blvd
Nashville, TN, 37243

E-mail: **Miller.bernhardt@tn.gov**

Telephone Number: **615-840-3954**

3.3 Design-Builder Representative

The Design-Builder's representative for this Project is:

[Enter Design Builder's Project Manager Name]
Design-Builder's Project Manager

Address: [Enter Design-Builder Name]
[Enter address line 2, Physical Address]
[Enter City, State, and Zip Code]

E-mail: [Enter e-mail address]

Telephone Number: [XXX-XXX-XXXX] Fax Number: [XXX-XXX-XXXX]

3.4 Key Personnel and Design Professionals

The Design-Builder's Key Personnel, Design Professionals, shall perform the functions established under the Contract for the duration of the Contract and are listed below.

3.4.1 Key Personnel

Design-Builder's Project Management Personnel (Level "1" Personnel) shall consist of the following:

Design-Builder Project Manager: _____

Design Manager: _____

Construction Manager: _____

Safety Manager: _____

Quality Manager: _____

3.4.2 Design Professionals

The Design-Builder's design professionals (Level "2" Personnel) shall consist of the following:

Design Lead Engineer – Structures: _____

Design Lead Engineer – Roadway: _____

Design Lead Engineer – Geotechnical: _____

Design Lead Engineer – Maintenance of Traffic _____

Erosion Prevention/Sediment Control Inspector: _____

Utility Coordination Lead: _____

Construction Lead – Structures _____

Construction Lead – Maintenance of Traffic _____

3.5 Substitution of Key Personnel and/or Design-Professionals

The Parties agree that each Key Personnel, Design Professional, and Subcontractor is unique, and that the Department has relied upon their qualifications in selecting the Design-Builder to perform the Contract. Therefore, the Design-Builder shall not replace any Key Personnel or Design Professional during the term of the Contract. Notwithstanding the foregoing, in those limited circumstances in which the Department elects to consider substitutions, the process shall be governed by the provisions of the *Design-Build Standard Guidance*.

In the event the Department approves a substitution request, the Department retains the right to strictly enforce this Section 3.5 in the event of future requests for substitution. No individual substitution approval or pattern of substitution approvals shall constitute a waiver of this requirement. Should the Department, in its sole discretion, elect to authorize a substitution, such authorization shall not relieve the Design-Builder of its sole responsibility under the Contract to complete all work and deliver the Project in accordance with all Contract requirements.

4 DATE OF COMMENCEMENT AND COMPLETION OF SERVICES

4.1 Time for Performance

The Contract shall take effect on the Effective Date and shall be performed by the Parties according to its terms, unless earlier terminated, until Final Acceptance by the Department in accordance with the *Design-Build Standard Guidance*.

4.2 Commencement of Services

The Design-Builder is authorized to commence the work within the Contract for post-award submittals pursuant to the *Design-Build Standard Guidance*. The Design-Builder shall not perform any services beyond post-award submittal until the issuance of first Notice to Proceed (NTP) and for each subsequent phase requiring a Review and Approval NTP.

4.3 Completion Dates

The Design-Builder shall complete all work to be done under the Contract, except for punch list and plant/vegetation establishment, by the established completion date from the Design-Builder's proposal but no later than September 30, 2029. The Design-Builder shall, unless otherwise approved in writing by the Department, achieve project acceptance from the Department no later than 180 Days after obtaining substantial completion.

5 COMPENSATION

5.1 Contract Amount

The Department agrees to compensate the Design-Builder for all work performed under the Contract for a fixed price of $[**Enter** Contract Amount] (the "Contract Amount"). The Contract Amount includes the entire cost of completing the Project in accordance with all Contract requirements as contemplated by the Parties under the Contract, and further includes all contingencies and the Design-Builder's overhead and profit.

5.2 Progress Payments

The Department shall make progress payments to the Design-Builder in accordance with the *Design-Build Standard Guidance*. Progress payments shall be based upon the Design-Builder's Schedule of Items, which shall include the cost of all work. The Department's payment of progress payments shall not be deemed by either Party to constitute Acceptance or Approval of any Pay Item covered by such payment, or a waiver of a claim or demand for repair of any defects therein.

5.3 Adjustments to the Contract Amount

The Contract Amount shall only be adjusted through issuance of properly-authorized Change Orders.

5.4 Payments for Extra Work

The Department will make payments for Extra Work in accordance with the provisions of the *Design-Build Standard Guidance***.**

5.5 Deductions from Monies Due

The Department may deduct from monies due or to become due the Design-Builder, as follows:

- Amounts representing price adjustments authorized under the provisions specified in **Book 3 (Project Specific Information)**;
- Amounts representing recoupment of damages, including, but not limited to, Liquidated Damages as stated in **Book 3 (Project Specific Information)**;
- Amounts assessed by Authorities (e.g., fines and penalties) for which the Design-Builder is responsible under the terms or the Contract or by law;

- Amounts the Department is compelled by court order or other legal mandate to withhold and/or tender to Authorities or third parties; and
- Any other amounts authorized under the Contract or by law to be deducted.

6 CHANGES IN THE WORK

Changed work and Extra Work shall be authorized by the Department only under the circumstances set forth in, and pursuant to the terms of, the *Design-Build Standard Guidance*. The Design-Builder shall not begin performance of any Changed work or Extra Work until the Department has issued a properly authorized Change Order, and the Design-Builder shall perform all such work strictly in accordance with the terms of the Change Order.

7 INSURANCE AND BONDING REQUIREMENTS

7.1 Insurance Requirements

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense and from insurers holding a current certificate of authority to transact the business of insurance in the State of Tennessee, all of the insurance coverages required under the *Design-Build Standard Guidance* and this Section 7.1.

- **Commercial General Liability:** The Design-Builder agrees to maintain commercial general liability insurance to be no less than $1,000,000 per occurrence, $2,000,000 general aggregate limit, and $2,000,000 completed operations aggregate.
- **Professional Liability:** The Design-Builder, being an independent contractor, agrees to maintain professional liability (errors and omissions) insurance in such an amount **($1,000,000.00 minimum)** and form as are agreeable to the Department.
- **Automobile Liability Insurance:** The Design-Builder agrees to maintain automotive liability insurance to be a combined single limit per policy period of not less than **$5,000,000.00** per accident or shall be scheduled under the excess or umbrella liability policies. Subcontractors' policies shall have a combined single limit of no less than $1,000,000 per accident.
- **Worker's Compensation:** The Design-Builder agrees to maintain and shall require all Subcontractors (of all tiers) to obtain and maintain a policy or policies of insurance providing workers' compensation statutory benefits and employer's liability in conformance with the laws of the State.
- **Umbrella or Excess Liability Insurance:** The Design-Builder agrees to maintain an umbrella or excess liability insurance to provide total per occurrence and aggregate limits of not less than **$5,000,000.00** (including limits provided in any primary policy), that will provide bodily injury, personal injury and property damage liability coverage at least as broad as the primary coverages set forth above, including commercial general liability in excess of the amounts set forth herein.

7.2 Bonding Requirements

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense and from Sureties licensed to do business in Tennessee and listed on the United States Department of the Treasury Financial Management Service list of approved bonding companies (Circular 570), Performance and Payment Bonds in the full Contract Amount. The Parties understand and agree that the obligation of the

Design-Builder's Surety for the faithful performance of the Contract shall include not only all construction, but also the performance of all design services under the Contract.

7.3 Indemnification

The Design-Builder shall, at all times, observe and comply with all applicable federal, state and local laws, ordinances and regulations and shall indemnify and hold harmless the State of Tennessee and all of its officers, agents and servants against any claim of liability or assessment of fines or penalties arising from or based upon the Design-Builder's and/or its employees' or agents' violations of any such law ordinance or regulation.

The Design-Builder shall hold harmless and indemnify the Department for all claims and damages which result from the failure of the Design-Builder to perform its engineering and design duties in conformance with the reasonable standard of care within the State of Tennessee. Said indemnification shall include, but not be limited to, costs for the redesign of plans and the preparations of new specifications as well as the costs for repairs to the construction work itself.

The Design-Builder shall be responsible for any and all injury or damage to persons or to property arising from the prosecution of the work and due to any act, omission, neglect or misconduct in its manner or method of prosecuting the work or due to its non-execution of the work or due to defective work or materials. The Design-Builder shall indemnify and hold harmless the State, the Department, and all of its officers, agents, and employees from all suits, actions or claims of any character arising from the Design Builder's acts or omissions in the prosecution of the work, use of unacceptable materials in constructing the work, infringement of patent, trademark or copyright, or claims for Workers' Compensation.

If any such suit, action or claim is filed, the Department may retain from the monies due to the Design-Builder under this Contract a sum deemed sufficient by the Department to protect the Department from loss therefrom. Upon resolution of the suit, action or claim, any remaining retained funds will be released.

These requirements of indemnification shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

8 OWNERSHIP AND USE OF WORK PRODUCT OF THE DESIGN

All work product of the Design-Builder arising from performance of the Contract shall be the exclusive property of the Department, as more particularly provided for under the *Design-Build Standard Guidance*.

Plans, specifications, and any maps prepared or obtained under the terms of this Contract shall be delivered to and become the property of the Department pursuant to the *Design-Build Standard Guidance*. Basic design notes and sketches, charts, computations, all original drawings, and other data prepared or obtained under this Contract shall be made available, upon request, to the Department without restriction or limitation of their use.

9 PROJECT RECORDS

9.1 Financial and Other Project Records

The Design-Builder shall maintain complete Project Records as described in the *Design-Build Standard Guidance*, in the manner required under the terms of the Contract. The Design-Builder shall keep full and detailed accounts and exercise such controls as may be necessary for proper financial management of the Project. The accounting and control systems shall be satisfactory to the Department.

9.2 Record Retention Period

The Design-Builder shall retain and preserve all Project Records in accordance with the process described in the *Design-Build Standard Guidance* and for a period of 5 years after final payment, or for such longer period as may be required by law (the "Record Retention Period").

9.3 Access to Records

The Department, the Department's representatives, and FHWA (if applicable) shall be afforded reasonable and regular access to the Project Records for the duration of the Contract and the Record Retention Period. This requirement to make Project Records available to the Department shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

9.4 Subcontract Record Retention Requirements

The Design-Builder shall require each Subcontractor to retain its Project Records for the Record Retention Period, and to provide equivalent access to Project Records to the Department, the Department's representatives, and FHWA (if applicable). The Design-Builder shall require each Subcontractor to include in lower-tier subcontracts the same Project Record retention and access requirements.

9.5 Location

The Design-Builder shall maintain all Project Records at the locations required under the terms of the Contract for the duration of the Contract. Subsequent to Contract completion, the Project Records shall be maintained for the Record Retention Period with suitable security, protection against damage and casualty loss, and access to the Department and FHWA (if applicable).

10 TERMINATION OR SUSPENSION

10.1 Termination for Convenience and No Fault; Payment

The Contract may be terminated for convenience by the Department in accordance with Department Standard Specifications, as amended. In such case, the Department will make payment in accordance with the *Design-Build Standard Guidance*. However, the amount to be paid to the Design-Builder shall in no event exceed the Contract Amount.

10.2 Termination for Cause; Amounts Payable

The Contract may be terminated by the Department for default in accordance with Department Standard Specifications, as amended, and the *Design-Build Standard Guidance*. In addition to the acts listed in the above documents the following shall also be considered defaults for which the Contract may be terminated:

- The Design-Builder or its Design Professionals no longer hold the licenses or certificates required to perform the work or any portion thereof;
- The Design-Builder so fails to perform any agreed-upon portion of the work or Contract item or applicable standard of care as to materially affect the Design-Builder's performance under the Contract in accordance with its terms, and such breach, default, or failure is not cured within the requirements of the *Design-Build Standard Guidance*; or
- The Design-Builder made knowing or reckless misrepresentations, concealed facts, or failed to disclose information in Design-Builder's Proposal. Such shall constitute fraudulent inducements and shall entitle the Department to recover reliance damages, in addition to any other available remedies to which it may show itself entitled.

In case of termination for cause, the Department will make payment consistent with the payment provisions included in the *Design-Build Standard Guidance* and at the Department's option, including payment for materials left on hand, in accordance with Department Standard Specifications, as amended.

10.3 Contract Notice of Contract Termination

The Department may terminate the Contract, in whole or in part, immediately upon notice to the Design-Builder, or at such later date as the Department may establish in such notice, in accordance with Department Standard Specifications, as amended.

10.4 Quality of the Work

In the event of the Department's termination of the Contract, regardless of reason, the Design-Builder shall remain responsible for the quality of the work performed through the date of termination.

10.5 Litigation

In the event of litigation instigated by the Design-Builder in accordance with the Contract or by the Department for breach of contract or fraudulent inducement, the Department may pursue both recoupment and set-off in addition to its other available remedies.

11 ENUMERATION OF CONTRACT

The Contract includes the following:

1. ***BOOK 2 (DESIGN-BUILD CONTRACT);***
2. ***BOOK 3 (PROJECT SPECIFIC INFORMATION);***
3. ***DESIGN-BUILD STANDARD GUIDANCE AND ADDENDUM;***
4. ***THE DEPARTMENT STANDARD SPECIFICATIONS;***
5. ***THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;***
6. ***THE DEPARTMENT DESIGN GUIDELINES AND ADDENDUM;***
7. ***THE DEPARTMENT CONSTRUCTION CIRCLULAR LETTERS;***
8. ***THE DEPARTMENT STANDARD DRAWINGS;***
9. ***THE DEPARTMENT MATERIAL AND TEST STANDARD OPERATING PROCEDURES;***
10. ***EXHIBIT A (TECHNICAL PROPOSAL);***
11. ***CHANGE ORDERS;***
12. ***FORCE ACCOUNT WORK ORDERS;***
13. ***WRITTEN ORDERS AND AUTHORIZATIONS ISSUED BY THE DEPARTMENT;***
14. ***ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER DOCUMENTS; IN ANY FORM, REQUIRED TO BE SUBMITTED TO THE DEPARTMENT PURSUANT TO THE TERMS OF APPLICABLE CONTRACT.***
15. ***ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.***

12 ORDER OF PRECEDENCE

All Contract Documents are intended to be complementary. Conflicts, if any, will be resolved utilizing the following descending order of precedence.

1. ***BOOK 3 (PROJECT SPECIFIC INFORMATION) AND ADDENDA;***
2. ***BOOK 2 (DESIGN-BUILD CONTRACT), including the Special Provisions listed in Appendix B;***
3. ***THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;***
4. ***THE DEPARTMENT STANDARD SPECIFICATIONS;***
5. ***THE DEPARTMENT DESIGN GUIDELINES AND ADDENDUM;***
6. ***THE DEPARTMENT STANDARD DRAWINGS;***
7. ***DESIGN-BUILD STANDARD GUIDANCE;***
8. ***THE DEPARTMENT CONSTRUCTION CIRCLULAR LETTERS;***
9. ***ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER CONTRACT DOCUMENTS;***
10. ***ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.***

13 DESIGN-BUILDER CERTIFICATIONS AND DISCLOSURES

13.1 Nondiscrimination

The Design-Builder shall follow the nondiscrimination provisions as provided in this **Book 2 (Design-Build Contract)**.

13.2 Illegal Immigrants

The Design-Builder shall attest to the Illegal Immigrant provisions as provided in Form AT in Appendix C. The Contract includes a completed/executed Form AT in Appendix C.

13.3 Certification Regarding Debarment, Suspension, and Other Responsibility Matters – Primary Covered Transactions

The Design-Builder shall follow the debarment, suspension, and other responsibility matters provisions as provided in this **Book 2 (Design-Build Contract)**.

13.4 Certification for Grants, Loans, and Cooperative Agreements

The Contract includes a completed/executed Form LC in Appendix C.

The Design-Builder agrees that if any funds other than federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Contract, the Design-Builder shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

14 MISCELLANEOUS PROVISIONS

14.1 Employment of Department Workers

The Design-Builder shall not engage, on a full, part-time, or other basis during the period of this Contract, any professional or technical personnel who are or have been at any time during the period of the Contract in the employ of the Department, except regularly retired employees, without the written consent of the Department.

14.2 Covenant Against Contingent Fees

The Design-Builder warrants that it has not employed or retained any company or person other than a bona fide employee working solely for the Design-Builder to solicit or secure this Contract, and that it has not paid or agreed to pay any company or person, other than a bona fide employee working solely for the Design-Builder, any fee, commission, percentage, brokerage fee, gifts, or any other consideration, contingent upon or resulting from the award or making of this Contract. For breach or violation of this warranty, the Department shall have the right to deduct from the Contract Amount or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gifts, or contingent fee.

14.3 Energy Policy and Conservation Act

Under this Contract, the Design-Builder shall give due consideration to and, as applicable, comply with the standards, orders, and requirements relating to energy efficiency contained in the Department energy conservation plans issued in compliance with the Energy Policy and Conservation Act (P.L. 94-165).

14.4 Additional Employment Regulations

The Design-Builder shall comply with the Vocational Rehabilitation Act of 1973 as approved by Congress on September 26, 1973, herein incorporated by reference, which prohibits employment discrimination against physically handicapped persons. Further, the Design-Builder shall comply with Section 2012 of the Vietnam Era Veterans Readjustment Act of 1974 which requires the Design-Builder to take affirmative action to employ and advance in employment qualified veterans of the Vietnam Era.

14.5 Copyrighting

The Design-Builder shall be prohibited from copyrighting any papers, reports, forms, or other material which is a part of any work under this Contract without written approval from the Department. Publication rights to any documents produced are reserved by the Department.

14.6 Governing Law; Jurisdiction; Venue

The Design-Builder is assumed to be familiar with and observe and comply with those federal, state, and local laws, ordinances, and regulations in any manner affecting the conduct of the work and those instructions and prohibitive orders issued by the Department and federal government regarding fortifications, military, and naval establishments and other areas. The Design-Builder shall observe and comply with those laws, ordinances, regulations, instructions, and orders in effect as of the date of this Contract.

This Contract shall be governed by and construed in accordance with the laws of the State of Tennessee. The Design-Builder agrees that it will be subject to the exclusive jurisdiction of the courts of the State of Tennessee in actions that may arise under this Contract. The Design-Builder acknowledges and agrees that any rights or claims against the Department or its employees hereunder, and any remedies arising there from, shall be subject to and limited to those rights and remedies, if any, available under TCA § 9-8-101 through 9-8-407.

14.7 Contract Interpretation

Notwithstanding anything in the Contract to the contrary, no field explanations or interpretations provided by the Department at any meetings, and no comments by the Department on Design Documents or Construction Documents, shall be deemed, construed or interpreted to (a) amend, supersede or alter the terms, requirements, limitations or meaning of any Contract Document or (b) release or relieve the Design-Builder from full responsibility for the design of the Project in accordance with the Contract. However, written interpretive engineering decisions from the designated Department contact person(s) pursuant to the Contract may be relied upon to provide information and interpretations of ambiguous or uncertain requirements set forth in the Contract.

14.8 Notices

Notices to be given hereunder shall be given in writing by personal delivery, facsimile, e-mailing or mailing the same, postage prepaid, to the Design-Builder or the Department at the addresses or numbers set forth in Sections 3.2 and 3.3, or as either Party may hereafter indicate pursuant to this Section. Any notice delivered by facsimile and email shall be deemed to be received when confirmation of successful transmission is generated by the transmitting machine. Any notice so mailed, personally delivered, facsimile or e-mail transmission shall be the sole responsibility of the Design-Builder to track and confirm receipt by the Department and shall be confirmed by telephone notice to the Department for the Project. Any notice shall be effective as to the Design-Builder upon delivery into the possession of one of the Design-Builder's designated management personnel, and as to the Department, upon delivery to the Department. Regular, day-to-day communications may be transmitted through one of the methods set forth above, in person, by e-mail, or by other similar electronic transmission.

14.9 Disclosure of Tax Identification Number

The Design-Builder shall provide its federal tax identification number to the Department. The tax identification number provided pursuant to this authority will be used for the administration of state, federal, and local tax law.

14.10 Severability

The Parties agree that if any term or provision of the Contract is declared by a court of competent jurisdiction to be illegal or otherwise invalid, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the Parties shall be construed and enforced as if the Contract did not contain the particular term or provision held to be invalid.

14.11 No Waiver

The failure of the Department to enforce any provision of the Contract shall not constitute a waiver by the Department of that provision or any other provision of the Contract.

14.12 Media Contacts; Confidentiality

Unless otherwise specifically authorized in writing, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project without the Department's prior written authorization. The Design-Builder shall require this clause within all Subcontractors agreements.

14.13 Organizational Conflicts of Interest

The Design-Builder shall identify all relevant facts relating to past, present, or planned interest(s) of the Design-Builder's (including the Major Participants, proposed Design-Builder members, and their respective

chief executives, directors, and Key Personnel) which may result, or could be viewed as, an organizational conflict of interest in connection with this Project.

The Design-Builder shall disclose:

1. Any current contractual relationships with the Department (including identification of the Department contract number and project manager);
2. Present or planned contractual or employment relationships with any current Department employee;
3. Any current relationships between the Major Participants, Key Personnel, and/or Design Professionals of the Design-Builder on other Department projects (including identification of the Department contract number and project manager); and
4. Any other circumstances that might be considered to create a financial interest in the Contract by any current Department employee if the Design-Builder is awarded the Contract.

The Design-Builder must also disclose any current contractual relationships where the Design-Builder is a joint venture. The foregoing is provided by way of example and shall not constitute a limitation on the disclosure obligations.

For any fact, relationship, or circumstance disclosed in this Section 14.13, the Design-Builder must identify steps that have been or will be taken to avoid, neutralize, or mitigate any organizational conflicts of interest.

All Organizational Conflicts of Interest shall be addressed on Form COI in Appendix C.

14.14 The Department's Insurance

The State of Tennessee is self-insured, and such insurance shall cover the Department's operations and activities under the Contract.

14.15 Joint Ventures and Partnerships

If the Design-Builder is a joint venture or a partnership, each joint venture member or partner is executing this Contract on behalf of both itself and the Design-Builder, and each joint venture member or partner and Design-Builder shall be jointly and severally liable under this Contract.

14.16 Merger Clause

The Contract constitutes the entire Contract between the Parties on the subject matter addressed herein. The terms of this Contract cannot be waived or amended, in any manner whatsoever, except by written instrument signed by the Parties and containing all required State of Tennessee approvals. Any waiver, if made, shall be effective only in the specific instance and for the specific purpose given. There are no understandings, agreements, or representations, oral or written, regarding this Contract except as contained or incorporated by reference herein.

THIS CONTRACT is executed in three (3) original copies, of which one is to be delivered to the Design-Builder, and the remainder to the Department.

The Design-Builder's authorized representative, by his/her signature below, hereby acknowledges that he/she has read this Contract, understands it, and can affirm that the Design-Builder agrees to be bound by its terms and conditions. This Contract may be executed in several counterparts, each of which shall be an original, and all of which shall constitute but one and the same instrument.

IN WITNESS WHEREOF, the Parties have executed this Contract, which shall be effective as of the Effective Date.

Design-Builder Name: _____

_____	_____	_____
Company Officer Signature	Printed Name and Title	Date

State of Tennessee
Department of Transportation

This Contract is accepted this _____ day of _____ , _____ , and

Is effective on the _____ day of _____ , _____ .

_____
Will Reid, P.E., Commissioner

_____
Leslie South, General Counsel
Approved as to Form and Legality

APPENDIX A

SUPPLEMENTAL SPECIFICATIONS TO THE STANDARD SPECIFICATIONS

The following, revised as noted, incorporates the Supplemental Specifications by reference for bidding purposes and will be printed with the contract after award. These Supplemental Specifications may be obtained from the Department's website at:

https://www.tn.gov/tdot/tdot-construction-division.html

Supplemental Specifications to the Standard Specifications Revision Date

Supplemental Specification to Section 100	----------	01-08-2025
Supplemental Specification to Section 200	----------	07-14-2025
Supplemental Specification to Section 300	----------	08-28-2024
Supplemental Specification to Section 400	----------	12-26-2024
Supplemental Specification to Section 500	----------	12-27-2023
Supplemental Specification to Section 600	----------	01-08-2025
Supplemental Specification to Section 800	----------	12-26-2024
Supplemental Specification to Section 900	----------	12-26-2024

S T A T E **O F** **T E N N E S S E E**

(Rev. 9-7-21)
(Rev. 12-15-21)
(Rev. 12-19-22)
(Rev. 6-1-23)
(Rev. 8-21-23)
(Rev. 12-27-23)
(Rev. 5-30-24)
(Rev. 12-26-24)
(Rev. 1-8-25)

January 1, 2021

Supplemental Specifications – 100SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 101.03, (pg. 5), 8-21-23; **Terms;** Revise:

Change Directive. A written document issued by the Department that provides the Contractor with additional compensation, time, or both as determined to be fair and reasonable by the Department and that does not require the consent or signature of the Contractor or Surety. The Change Directive becomes a part of the Contract when properly executed and approved by the Department.

Subsection 101.03, (pg. 7), 12-26-24**; Definition and Terms;** Revise Holidays definition:

Holidays. Holidays recognized by the State of Tennessee occur as follows:

New Year's Day	January 1
Martin Luther King Jr. Day	Third Monday in January
Presidents' Day	Third Monday in February
Good Friday	Friday before Easter
Memorial Day	Last Monday in May
Juneteenth	June 19
Independence Day	July 4
Labor Day	First Monday in September
Columbus Day	Second Monday in October
Veterans Day	November 11
Thanksgiving Day	Fourth Thursday in November
Christmas Day	December 25

All days appointed by the Governor of this State, or by the President of the United States, as days of fasting or thanksgiving.

Plan notes precluding restrictions to traffic on holiday weekends, unless specifically noted otherwise, do not apply to weekends associated with Martin Luther King Jr. Day, Presidents' Day, Juneteenth, Columbus Day, and Veterans Day

Subsection 102.09, (pg. 17), 12-19-22; **Rejection of Proposals;** Revise No. 10:

10. The apparent low bidder fails to complete and submit the Department form "Certification Regarding Subcontractor Bid Quotes" (Bidders List) electronically before the close of business (4:30 PM Central Time) within five (5) calendar days after the date on which bids are required to be submitted.

Subsection 102.09, (pg. 17), 12-26-24**; Rejection of Proposals;** Revise No. 10:

10. ~~The apparent low~~A bidder fails to comply with the "Instructions to Bidders" regarding the "Mandatory Submittal Of Subcontractor Bid Quotes (Bidders List)".~~complete and submit the Department form "Certification Regarding Subcontractor Bid Quotes" (Bidders List) electronically before the close of business (4:30 PM Central Time) within five (5) calendar days after the date on which bids are required to be submitted.~~

Subsection 104.03.B & C, (pg. 23-24), 9-7-21; **Contract Change Notification; B & C;** Revise subsections:

B. Written Acknowledgement by Engineer

The Engineer will provide written acknowledgement of the Contractor's written notice within ten (10) calendar days.

C. Written Response by Engineer

The Engineer will provide a written response within the specified number of calendar days based on the requested contract change:

1. For requested changes to the contract time in excess of one hundred eighty (180) days or requested changes that alter the original contract amount by more than $200,000, the Engineer will respond within thirty (30) days of receiving the Contractor's written notice.

2. For requested changes to the contract time in excess of ninety (90) days but less than or equal to one hundred eighty (180) days, or requested changes that alter the original contract amount by more than $100,000 but less than or equal to $200,000, or by more than ten percent (10%) of the original contract, whichever is less, the Engineer will respond within twenty-one (21) days of receiving the Contractor's written notice.

3. For all other requested changes to the contract, the Engineer will respond within fourteen (14) calendar days of receiving the Contractor's written notice.

The written response to the Contractor's written notice will include one of the following:

1. Confirmation that a change is necessary in accordance with **104.02**, and direction on how the Work will proceed.

2. A denial of the request for a change, which will include references to the Contract as to why the condition does not represent a change.

3. A request for additional information stating the specific information needed and the date by which it must be received. The Engineer will respond to the additional information provided within fourteen (14) calendar days.

When a change is necessary, the Engineer will make appropriate adjustments to the Contract price and time, if warranted, in accordance with **108.07**, **109.04**, **109.05.A**, and **109.06**. If the Contractor disagrees with the Engineer's decision or does not agree with the Contract adjustments, the Contractor may pursue the issue as a claim in accordance with **105.16**.

Subsection 104.03.C, (pg. 24,25), 8-21-23; **Written Response by Engineer;** Add 3rd Paragraph and Revise 4th Paragraph:

The Contractor will, upon request, have an opportunity to discuss the Contract change by informal meeting with the Department's Regional representatives associated with the change prior to the issuance of the Engineer's written response. If such a meeting is held, the Contractor shall use the opportunity to present relevant information and respond to any information provided by the Engineer or other Department officials with knowledge of the Work.

When a change is necessary, the Engineer will make appropriate adjustments to the Contract price and time, if warranted, in accordance with **108.07, 109.04**, **109.05.A**, and **109.06**. If the Contractor disagrees with the Engineer's decision or does not agree with the Contract adjustments, the Contractor may pursue the issue as a Request for Equitable Adjustment in accordance with **105.16**. At this time, the Department may issue a Change Directive even if the Contractor does not pursue a Request for Equitable Adjustment.

Subsection 104.04, (pg. 25-26), 12-27-23; **Maintenance of Traffic;** Revise 2nd and 5th Paragraph:

The Department will pay for materials used at the direction of the Engineer to construct and maintain approaches, crossings, intersections, and other features at contract unit prices unless the Contractor is responsible for the damage. Open cuts of roadways and streets shall be safely maintained for traffic during the Work. This includes, but is not limited to, placing and compacting a bituminous mix in the open cuts or placing metal plates over the open cuts, where allowed, before returning traffic to the roadway. Tie-ins for sideroads shall be safely maintained for traffic by paving to the binder course, striping, and placing temporary or permanent signs as needed, at minimum, unless otherwise directed by the Engineer. Maintenance of traffic control features, mowing, and pothole patching (cold mix) are incidental to the work and the responsibility of the Contractor.

Do not close lanes or restrict traffic on the following days without the Engineer's written consent:

- Easter: After 6:00 pm on the Thursday preceding Good Friday through Easter Sunday until the following Monday at 6 am.
- Memorial Day: After 12:00 noon on the preceding Friday through Memorial Day until the following Tuesday at 6 am.
- Independence Day:
  a. Monday: After 12:00 noon on the preceding Friday through Independence Day until the following Tuesday at 6 am.
  b. Tuesday: After 12:00 noon on the preceding Friday through Independence Day until the following Wednesday at 6 am.
  c. Wednesday: After 12:00 noon on the preceding Tuesday through Independence Day until the following Thursday at 6 am.
  d. Thursday: After 12:00 noon on the preceding Wednesday through Independence Day until the following Monday at 6 am.
  e. Friday: After 12:00 noon on the preceding Thursday through Independence Day until the following Monday at 6 am.
  f. Saturday: After 12:00 noon on the preceding Thursday through Independence Day until the following Monday at 6 am.
  g. Sunday: After 12:00 noon on the preceding Friday through Independence Day until the following Tuesday at 6 am.
- Labor Day: After 12:00 noon on the preceding Friday through Labor Day until the following Tuesday at 6 am.
- Thanksgiving: After 12:00 noon on Wednesday before Thanksgiving through Sunday following Thanksgiving until the following Monday at 6 am.
- Christmas/New Year's Day: December 24 through January 1 and any preceding and/or following days that fall on a weekend.

Subsection 105.16, (pg. 49-55), 8-21-23; **Claims for Adjustment and Disputes;** Revise Subsection:

105.16 Request for Equitable Adjustment (REA) and Disputes

This subsection details the optional REA process for receiving, reviewing, and deciding on REAs submitted to the Department. If such REAs cannot be successfully negotiated or resolved within this process, the Contractor has the right to submit a formal claim through the Tennessee Claims Commission as acknowledged in this subsection.

All events or conditions that have a potential or anticipated effect on the Project's progress or schedule and that may result in a REA by the Contractor shall be documented contemporaneously with the event or

discovery of the pertinent condition(s), or immediately thereafter. REAs that are submitted without proper documentation will not be reviewed by the Department.

A. Notice of Intent to File a REA

If the Contractor has followed the process under **104.03** to request additional compensation, time, or both under **104.02 or 108.07** and the Contractor disagrees with the Engineer's decision or the Contract adjustments made by the Department, the Contractor may provide notice of intent to file a REA. The Contractor shall provide such notice in writing within thirty (30) calendar days of receiving the Engineer's decision as provided in **104.03**.

After submitting the notice of intent to file a REA, if the subject work is not yet complete, the Contractor shall maintain adequate records related to the REA, including records of the disputed labor, equipment and materials, and schedule updates per **108.03** showing compensable delays to the completion date. If applicable, update and disclose this information to the Department monthly. The Department may audit REA records at any time. Unless the Engineer suspends in writing the affected work, the Contractor shall continue to perform the disputed work. If such notice to file a REA is not given, or if the Engineer is not given sufficient opportunity for keeping strict account of the Contractor's actual Work, then the Contractor waives any claim for additional compensation under the REA process. Such notice by the Contractor and the Engineer's accounting of the cost shall not, in any way, prove or substantiate the validity of the REA. Nothing in this Subsection shall be construed as establishing any REA contrary to the terms of **104.02 or 108.07**.

B. Submission of REA

Within sixty (60) calendar days after submitting the notice of intent to file a REA, or within sixty (60) calendar days after completion of the disputed Work, whichever is later, or within such time agreed upon by the parties in writing, the Contractor shall submit a complete REA package. The REA package shall include all documents supporting the REA and provide sufficient detail to enable the Department to ascertain the basis and amount of the REA. If requested by the Contractor, the Department may extend the sixty (60) calendar day period in writing. As a minimum, the following information shall be submitted with each REA:

1. A REA certification containing the language shown in Figure 105.16-1; this figure can be found on the Department's Construction Division website.

2. A detailed factual statement of the REA for additional compensation, time, or both, providing all necessary dates, locations, and items of work affected by the REA, including:

a) Each aspect of the Project affected by matters related to the REA.

b) The specific Project locations where Project work has been so affected;

c) The number of people working on the affected aspects of the Project at the pertinent time(s);

d) The types and number of pieces of equipment working on the affected aspects of the Project at the pertinent time(s); and

e) If applicable, any other request for relief that the Contractor intends to file or has reason to believe that it may file against the Department that would be impacted by the matters related to the REA.

3. The specific provisions of the Contract that support the REA and a statement of the reasons why such provisions support the REA;

4. If an extension of contract time is sought, a schedule analysis as required by **108.07**;

5. If additional compensation is sought, the amount and specifics of the compensation in accordance with the following:

a) Compensable Items: Must be compensable under **109.04**,

b) Compensable Delay related costs: Must be compensable under **109.06**; and

c) Non-Recoverable Costs: Per **109.07**, non-recoverable costs shall not be considered in a REA.

6. Any worksheets used to prepare the REA, which indicate the cost components of each item of the REA, including but not limited to the pertinent costs of labor, benefits and insurance, materials, equipment, and compensable subcontractor costs, as well as all documents which establish the relevant time periods, individuals involved, and the Project hours and the rates for the individuals.

The Contractor and its subcontractors and suppliers involved with the REA shall cooperate with any inquiries or requests by the Department for clarification and data supporting the submitted documentation.

C. REA Informal Meeting

Within thirty (30) calendar days of receiving the Contractor's REA submittal, the Department will contact the Contractor in writing to schedule a meeting to afford the Contractor an opportunity to discuss the disputed matters informally with the Department. If the Contractor elects to participate in a meeting, the Contractor shall use this opportunity to present relevant information and respond to any information provided by the Engineer or other Department officials with knowledge of the Work. Proceedings in any REA meeting are compromise negotiations and are not admissible in litigation in accordance with Tennessee Rule of Evidence 408.

D. Department Decision

When the Contractor properly files a REA and allows for reasonable and timely access to the Contractor's relevant books and records**,** the Department will review the REA and render a written decision to the Contractor to either affirm or deny the REA package, in whole or in part**,** within sixty (60) calendar days after receipt of the REA package or after the informal meeting. If more time is needed for review, the Department will notify the Contractor in writing of the additional time required.

The Department will assemble and maintain the REA record consisting of the REA and all other information considered by the Department in reaching a decision. Once the Department assembles the REA record, the submission and consideration of additional information or data, other than for clarification and support of previously submitted documentation, will not be permitted. The Department will provide a copy of the REA record and the written decision to the Contractor describing the information considered by the Department in reaching a decision and the basis for that decision.

If as a result of the REA documentation or REA Informal Meeting, the Department and the Contractor reach an agreement to resolve the REA, the Department will prepare a Change Order setting forth the terms of any additional compensation or time, or both, as agreed, and the Change Order will be processed for approval in accordance with the Department's standard procedures.

If the Department agrees that the Contractor is due additional compensation, time, or both, but the Department and the Contractor cannot agree on the amount, the Department may issue a Change Directive providing for additional compensation, time, or both, as the Department determines to be fair and reasonable. The Contractor may continue to pursue a claim as acknowledged in this Subsection.

If the Department denies the REA, the Contractor may either accept the Department's decision as final or submit to the Department a written notice of intent to file a claim with the Tennessee Claims Commission to the Department. The Contractor may file a claim with the Tennessee Claims Commission in accordance with TCA § 9-8-307.

Subsection 106.06.A.1, (pg. 61), 12-15-21; **Field Laboratory, Type A;** Revise No. 1:

1. Scales of appropriate capacity and design to weigh the required samples. Scales are to be sensitive to within 0.1% of the sample to be weighed. Provide standard weights for scale calibration. Scale calibration shall be completed annually, by an independent source.

Subsection 107.13, (pg. 75), 1-9-23; **Legal Responsibilities of the Contractor;** Add New 3rd Paragraph:

The Contractor certifies that it is not currently engaged in, and covenants that it will not, for the duration of the Contract, engage in a boycott of Israel, as that term is defined in Tenn. Code Ann. § 12-4-119. This certification does not apply to a Contract with a value of less than two hundred fifty thousand dollars ($250,000) or if the Contractor has fewer than ten (10) employees.

Subsection 107.20, (pg. 78), 12-19-22; **Certified Payrolls;** Revise Subsection:

As specified by Minimum Wage Scales for Federal-Aid and State Funded Construction contract provisions, submit and certify payrolls for each week in which any contract work is performed. All payrolls shall be submitted electronically through the website using AASHTOWare Project Civil Rights & Labor (CRL) software.

Register for payroll access and develop a method of import prior to the Preconstruction Conference. Ensure each subcontractor, including all Disadvantaged Business Enterprises (DBE), certified Small Business Enterprises (SBE), and DBE or SBE haulers, has registered in CRL for payroll access and developed their method of import prior to commencing Work.

Assume all responsibility for ensuring all payrolls and all subcontractor payrolls are submitted and certified electronically in CRL for each week in which any contract work is performed. If all payrolls are not received in this timeframe, the progress payment shall be withheld until all necessary payrolls have been received.

Once Work begins for the Contractor or subcontractor, if in any week the Contractor or subcontractor does not perform Work, check the box "No Work Until Further Notice" in CRL.

Subsection 108.01, (pg. 79, 80), 12-15-21; **Subletting of Contract;** Revise Item list:

Item 105-01 – Construction Stakes, Lines and Grades
Item 202-01 – Removal of Asbestos
Item 203-40 – Rock Anchors, Anchor Blocks, Tie Back Anchors
Item 209 – Project EPSC
Item 411-12 - Scoring
Item 411-33 – Stamped Asphalt
Item 501-03 – Concrete Shoulder Rumble Strip
Item 503-01 – Grinding Concrete Pavement
Item 602-03 – Steel Structures
Item 602-04 – Steel Structures
Item 602-10.81 – Heat Straightening
Item 603-02 – Repainting Steel Structures
Item 603-05 – Containment and Disposal of Waste
Item 604-04.01 – Applied Texture Finish (New Structures),
Item 604-04.02 – Applied Texture Finish (Existing Structures)
Item 604-04.10 – Graffiti Protection
Item 604-04.20&.21 – Painting or Staining Concrete Surfaces
Item 604-04.62 – Clean and Texture Finish Median Barrier
Item 604-05.31 – Bridge Deck Grooving (Mechanical)
Item 604.07 – Retaining Wall
Item 604-42.01 – Underwater Divers
Item 606-26.05 – Core Drilling for Piles (Abandoned)
Item 617 – Bridge Deck Sealant
Item 619 – Polymer Modified Concrete Overlay
Item 624 – Retaining Wall
Item 625-01.08,10,11 – Inclinometer, Camera Drilled Shaft Inspections
Item 705 – Guardrail
Item 706 – Guardrail Adjusted, Removed and Reset
Item 707 – Fences
Item 712 – Temporary Traffic Control
Item 713 – Highway Signing
Item 714 – Roadway and Structure Lighting
Item 716 – Pavement Markings
Item 721 – Landscape and Irrigation
Item 724 – Landscape Lighting
Item 725 – ITS items
Item 730 – Traffic Signals
Item 740 – Geosynthetics
Item 79* – Utilities
Item 801 – Seeding
Item 802 – Landscape Plantings
Item 803 – Sodding
Item 805 – Erosion Control
Item 806 – Project Mowing

Subsection 108.01, (pg. 79, 80), 12-19-22; **Subletting of Contract;** Add to & Revise Item list:

Item 108-03 – CPM Project Schedule

Item 203-11 – Scaling and Trimming
Item 203-40 – Anchors
Item 406 – High Friction Surface Treatment
Item 617 – Bridge Deck Sealant and Thin Epoxy Overlay

Subsection 108.03.A, B, & C, (pg. 81,82,85,87,88), 9-7-21; **Contract Change Notification;**
A & B; Revise Heading,
C.1.c; Add new No.vi, **C.3;** Revise last paragraph, **C.4;** Revise last paragraph & add sentence**:**

A. Project Durations Less Than 9 Months

B. Project Durations 9 Months to 24 Months

C.1.c Narrative report in PDF file format fit to 8.5x11 inch paper and including:…

vi. The quantity and estimated daily production rate for controlling activities;

vii. Description of the calendars including identification of workdays per week, holidays, number of shifts per day, and number of hours per shift;

viii. Description of how the schedule accommodates adverse weather days for each month; and

ix. Description of execution plan, including number and type of crews, a list of subcontractors' crews, and expected equipment, but not limited to large equipment transport and delivery, transportation permits for oversized/overweight loads, and availability.

3. Baseline CPM Schedule.

The Engineer and Contractor will review the draft baseline CPM schedule at a meeting specific for the review of the schedule. The Engineer will accept the draft baseline CPM schedule, provide review comments, or request additional information. Make appropriate adjustments or provide additional information within 14 calendar days. The Engineer's acceptance is based solely on whether the baseline schedule meets the requirements of **108.03**. Review comments made by the Engineer on the initial schedule will not relieve the Contractor from compliance with the Contract. The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with the Contract requirements.

4. Schedule Updates.

Submit the updated schedule electronically to the Engineer in accordance with the requirements of this subsection. The Engineer reserves the right to reject any schedule updates because of changes in relationships between activities on the critical path, inadequate or inaccurate narrative updates, or other deficiencies in the schedule updates as required in this subsection.

The Department will measure and pay for CPM Project Schedule in accordance with **108.11** and **108.12** respectively.

Subsection 108.03.C, (pg. 84, 87-88), 6-1-23; **Prosecution of Construction, Project Durations Greater Than 24 Months or When Required By Contract;** Revise 1st Paragraph, **C.4**; Revise 1st and Relocate last Paragraph:

Develop a Critical Path Method (CPM) project execution schedule and subsequent updates as required or as specifically requested by the Engineer. Generate the CPM schedule using Primavera Project Management (P6) scheduling software. The Department will measure and pay for CPM Project Schedule in accordance with **108.11** and **108.12** respectively.

C.4. Schedule Updates. Update the CPM schedule on a quarterly (3 months) basis to show current progress. Include the following with each update:

~~The Department will measure and pay for CPM Project Schedule in accordance with **108.11** and **108.12** respectively.~~

Subsection 108.03.C, (pg. 87-88), 12-26-24**; Prosecution of Construction, Project Durations Greater than 24 Months or When Required by Contract;** Add as last Paragraph, **C4.** Revise 1st Paragraph:

Review and acceptance by the Engineer will not constitute a waiver of any Contract requirements and will in no way assign responsibilities of the work plan, scheduling assumptions, and validity of the work plan or schedule to the Department. Failure to include in the Progress Schedule any element of work required for timely completion of the Contract shall not excuse the Contractor from his contractual obligations.

C.4. Schedule Updates – Update the CPM schedule on a quarterly (3 month) basis to show current progress. If actual construction falls behind the plan of operations or schedule by more than 3 months, update the schedule on a monthly basis at no additional cost to the Department. Continue to submit monthly updates until project completion or the schedule is no longer behind by 3 months or more. Include the following with each update:…

Subsection 108.03.D, (pg. 88-89), 6-1-23; **Schedule Revisions;** Revise 1st Paragraph and Revise No. 2:

The Engineer will determine the progress of the Contract by either the time versus money straight line method or the schedule updates submitted by the Contractor. If actual construction falls behind the plan of operations or schedule by more than 15% or 60 calendar days, whichever is less, submit for approval a revised schedule that reflects timely completion. The Engineer may request a revision of the schedule at any time if a critical circumstance regarding the scheduling, sequencing, or prosecution has changed with planning or progress of the Work. Circumstances that may lead to such a request include the following:

2. A difference of 60 calendar days between the actual sequence or duration of work and that depicted in the schedule; or

Subsection 108.09, (pg. 95), 12-19-22; **Failure to Complete Work on Time;** Revise Table 108.09-1:

Table 108.09-1: Liquidated Damages for Failure to Complete the Work on Time

Original Contract Amount ($)			Daily Charge ($/day)
0	to	500,000	500.00
> 500,000	to	1,000,000	600.00
> 1,000,000	to	2,000,000	800.00
> 2,000,000	to	10,000,000	1,000.00
>10,000,000	to	20,000,000	1,600.00
>20,000,000			2,500.00

Subsection 108.09, (pg. 7), 1-8-25**; Failure to Complete the Work on Time;** Revise Table 108.09-1:

Table 108.09-1: Liquidated Damages for Failure to Complete the Work on Time

Original Contract Amount ($)			**Daily Charge ($/day)**
0	to	500,000	500.00
> 500,000	to	1,000,000	600.00
> 1,000,000	to	2,000,000	800.00
> 2,000,000	to	10,000,000	1,000.00
>10,000,000	to	20,000,000	1,600.00
>20,000,000			2,2500.00

Subsection 108.11, (pg. 99), 9-7-21; **Method of Measurement;** Add subsection 108.11:

108.11 Method of Measurement

The Department will measure construction CPM Project Schedule as a percentage of the lump sum price bid for the completion of the work specified in **108.03.C** and partial payment will be made according to the schedule in Table 108.11-1.

Table 108.11-1: Payment Schedule for CPM Project Schedule

Estimate Number or Percent of Total Contract Amount of Previous Estimate	Total Percent of CPM Project Schedule Lump Sum Bid Item
Estimate # 1	20%
Estimate # 3	40%
20%	50%
40%	60%
60%	70%
80%	80%
95%	100%

Subsection 108.11, (pg. 99), 6-1-23; **Method of Measurement;** Revise Table 108.11-1:

Table 108.11-1: Payment Schedule for CPM Project Schedule

Requirement or Percent of Total Contract Amount of Previous Estimate	Total Percent of CPM Project Schedule Lump Sum Bid Item
Initial Project Schedule	10%
Baseline CPM Schedule	40%
20%	50%
40%	60%
60%	70%
80%	80%
95%	100%

Subsection 108.12, (pg. 99), 9-7-21; **Basis of Payment;** Add subsection 108.12:

108.12 Basis of Payment

The Department will make partial payments for CPM Project Schedule on the basis of a percentage of the lump sum price bid in accordance with the schedule shown in Table 108.11-1.

If the Contractor fails to provide monthly schedule updates or address the Engineer's comments regarding the monthly schedule update, within 10 calendar days following the progress estimate pay period cutoff date, the Engineer will withhold payment for CPM Project Schedule and may withhold up to an additional 5% of the monthly estimate payment, until such time as an acceptable update has been provided.

No additional payments will be made for schedule revisions as requested per **108.03.D**.

Such payment is full compensation for meeting all requirements of **108.03.C** and **D**.

Subsection 108.12, (pg. 99), 6-1-23; **Basis of Payment;** Add new 2nd Paragraph and Revise existing 2nd and 3rd Paragraphs:

If the Contractor fails to provide an Initial Project Schedule or a Baseline CPM schedule, or address the Engineer's comments regarding the Initial Project Schedule or Baseline CPM schedule, within 10 calendar days following the progress estimate pay period cutoff date, the Engineer will withhold payment for CPM Project Schedule and may withhold up to an additional 10% of that month's estimate payment, until such time as an acceptable Initial Project Schedule or Baseline CPM schedule has been provided and accepted.

If the Contractor fails to provide quarterly CPM schedule updates, or address the Engineer's comments regarding the quarterly schedule update, within 10 calendar days following the progress estimate pay period cutoff date, the Engineer will withhold payment for CPM Project Schedule and may withhold up to an additional 5% of that month's estimate payment, until such time as an acceptable update has been provided and accepted.

No additional payments will be made for Engineer requested schedule revisions as requested per **108.03.D**.

Subsection 109.02, (pg. 105-106), 5-30-24; **Scope of Payment;** Revise & Relocate Paragraph 5 to Paragraph 4 and Revise Paragraphs 6 & 7:

Ensure each subcontractor, including all certified Disadvantaged Business Enterprises (DBE), certified Small Business Enterprises (SBE), and DBE or SBE haulers or material suppliers has registered for AASHTOWare Project Civil Rights & Labor (CRL) prior to commencing Work.

The Department requires...

Document within CRL the actual amount paid to all subcontractors, material suppliers, and haulers during the monthly estimate period for which the certification is being made. All subcontractors, DBE or SBE material suppliers, and DBE or SBE haulers shall acknowledge payment entry in AASHTOWare Project Civil Rights & Labor (CRL) within fourteen (14) calendar days from the date of posting. The Department will withhold estimate payments if the required information is not submitted or if subcontractors, at any tier, material suppliers, or haulers are not paid after the thirty (30) calendar daytime period. Any delay or postponement of payment beyond the thirty (30) calendar day timeframe will be subject to terms listed in TCA §12-4-707(b).

The Contractor, subcontractors, at any tier, material suppliers, or haulers shall not withhold any retainage from progress payments made to their subcontractors. The Contractor, subcontractors at any tier, material suppliers, or haulers shall not withhold progress payments due to subcontractors at any tier, material suppliers, or haulers for work or services performed under the Contract to offset any amounts that may be owed with respect to any agreement other than the Contract.

Subsection 109.06, (pg. 116), 8-21-23; **Compensable Delay Costs;** Revise 2nd Paragraph:

Compensable delay costs will not be paid unless the compensable delay causes completion of the Work to exceed the original or previously adjusted Contract completion date. Compensable delay costs will not be considered for previously negotiated Change Orders or for costs that have already been included in bid items, negotiated prices, or force account payments described in **109.04**; no additional consideration will be given for home office overhead and/or field office overhead. The Department will not pay for delay costs incurred by subcontractors.

Subsection 109.06.D, (pg. 117), 8-21-23; **Extended Field Overhead;** Revise 3rd Paragraph:

Compute these costs on a calendar day basis using actual costs incurred due to the delay to provide project specific general supervision, field office facilities and supplies, maintenance of field operations, traffic control maintenance, and extended erosion control inspection. If the Contractor and the Department cannot agree on additional field overhead costs, the Department may consider, at its sole discretion, calculating a daily extended field overhead rate as a percentage (in accordance with Table 109.06-1) of the original Contract amount divided by the Contract duration.

Subsection 109.07, (pg. 118,119), 8-21-23; **Non-Recoverable Costs;** Revise No. 5 & 6 and Add No. 7 & 8:

5. Attorney fees, claim preparation expenses, and cost of litigation;

6. Consequential and/or incidental damages, including but not limited to, interest of monies in dispute, loss of bonding capacity, any indirect costs or expenses, interest on investment or any resultant insolvency;

7. Loss of bidding opportunities; and

8. Reduction of bidding capacity.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-27-23) January 1, 2021
(Rev. 7-14-25)

Supplemental Specifications – 200SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 203.04.E, (pg. 145), 12-27-23; **Borrow Areas;** Revise 2nd Paragraph:

Borrow materials shall not contain acid producing materials. Representative samples of the proposed borrow material shall be independently tested for pH (EPA600/2-78-054 or ASTM D4972). Material with a pH less than 5 is considered acid producing and will not be accepted.

Subsection 205.04.C, (pg. 178), 7-14-25**; Degradable Rock;** Revise 2nd, 3rd, and add 4th paragraphs:

Place degradable rock in 10-inch maximum loose lifts and provide a minimum of three passes with the static roller and two passes with the vibratory roller. The Engineer may direct additional passes with either or both rollers until satisfactory breakdown and compaction is accomplished. ~~Do not place degradable rock in the top 2~~5 feet of an embankment unless approved by the Engineer~~.~~

If embankment composed of degradable rock does not contain sufficient moisture to compact properly, ~~the Engineer will require the Contractor to~~ apply water in sufficient quantities to achieve the approximate optimum moisture for the particular material involved. Uniformly mix the added water with the material for the entire depth of the lift by blading, discing, or other approved methods.

Do not place degradable rock in the top 3 feet of an embankment, and only use approved materials.

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-17-23)
(Rev. 12-27-23)
(Rev. 8-28-24)

January 1, 2021

Supplemental Specifications – 300SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 307.02, (pg. 242), 8-28-24**; Materials;** Revise Materials list:

Grading A, ACRL, AS, B, BM, BM2, C, CM, CS, or CW…**903.06**

Subsection 307.03.A, (pg. 243, 244), 8-28-24**; Composition of Mixtures, General;** Revise Table 307.03-01 and Table 307.03-2:

Table 307.03-1: Mixture Composition

Mixtures	Proportions of Total Mixture, Percent by Weight	
	Combined Mineral Aggregate, %	Asphalt Cement, % (1)
Grading AS and ACRL	96.3 - 97.7	2.3 - 3.7
Grading A	95.8 - 96.7	3.3 - 4.2
Grading B, BM, and BM2	93.8 - 95.8	4.2 - 6.2
Grading C, CM, and CW	93.8 - 95.8	4.2 - 6.2
Grading CS	92.3 - 94.7	5.3 - 7.7

(1) If the effective combined specific gravity of the aggregate exceeds 2.80, the Engineer may adjust the proportions specified.

Table 307.03-2: Mixture Design Properties

Mix (1)	Stability (minimum) lbf (2)	Design Void Content % (2)	Production Void Content, % (2)	VMA (minimum) % (2)	Dust-Asphalt Ratio (3)
307-B	2,000	4.0±0.2	3-5.5	11.5	0.6-1.5
307-BM	2,000	4.0±0.2	3-5.5	13.5	0.6-1.5
307-BM2	2,000	4.0±0.2	3-5.5	13.5	0.6-1.5
307-C	2,000	4.0±0.2	3-5.5	13.0	0.6-1.5
307-CM	2,000	4.0±0.2	3-5.5	13.0	0.6-1.5
307-CS	2,000	3.0±0.5	1-5	---	---
307-CW	1,500	4.0±0.2	3-5	13.0	0.6-1.5

(1) To identify critical mixes and make appropriate adjustments, the mix design shall meet these design properties for the bitumen content range of Optimum Asphalt Cement ±0.25%.

(2) Tested according to AASHTO T 245 with 75 blows with the hammer on each end of the test specimen, using a Marshall Mechanical Compactor.

(3) The dust-asphalt ratio is the percent of the total aggregate sample that passes the No. 200 sieve, as determined by AASHTO T 11, divided by the percent asphalt in the total mix.

Subsection 307.03.B.1, (pg. 245), 12-27-23; **Recycled Asphalt Pavement (RAP);** Revise Table 307.03-3:

Table 307.03-3: Mixtures Using RAP

Mix Type	% RAP (Non-processed) (1)	Maximum % RAP (Processed) (2)	Maximum % RAP Processed & Fractionated (3)	Maximum Particle Size (inches)
307-ACRL	0	00	-	-
307-AS	0	10	10	-
307-A	15	20	35	1-1/2
307-B	15	30	35	1-1/2
307-BM	15	30	35	3/4
307-BM2	15	30	35	3/4
307-C	15	30	35	3/8
307-CW	15	30	35	1/2
307-CS	0	15	25	5/16

(1) "Non-processed" refers to RAP that has not been crushed and screened or otherwise sized prior to its use.

(2) "Processed" refers to RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed in Table 307.03-3 prior to entering the dryer drum.

(3) "Fractionated" refers to RAP that has been processed over more than one screen, producing sources of various maximum particle sizes (e.g., ¾ to ½ inch, ½ inch to #4, etc.). The Contractor may use the larger percentages of fractionated RAP specified only if the stockpile meets the consistency requirements set forth in Departmental procedures for approval of asphalt mix designs.

Subsection 307.03.B.1, (pg. 245), 8-28-24**; Recycled Asphalt Pavement (RAP);** Revise Table 307.03-03:

Table 307.03-3: Mixtures Using RAP

Mix Type	% RAP (Non-processed) (1)	Maximum % RAP (Processed) (2)	Maximum % RAP Processed & Fractionated (3)	Maximum Particle Size (inches)
307-ACRL	0	00	-	-
307-AS	0	10	10	-
307-A	15	20	35	1-1/2
307-B	15	30	35	1-1/2
307-BM	15	30	35	3/4
307-BM2	15	30	35	3/4
307-C	15	30	35	3/8
307-CM	15	30	35	1/2
307-CW	15	30	35	1/2
307-CS	0	15	25	5/16

(1) "Non-processed" refers to RAP that has not been crushed and screened or otherwise sized prior to its use.

(2) "Processed" refers to RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed in Table 307.03-3 prior to entering the dryer drum.

(3) "Fractionated" refers to RAP that has been processed over more than one screen, producing sources of various maximum particle sizes (e.g., 3/4 to 1/2 inch, 1/2 inch to #4, etc.). The Contractor may use the larger percentages of fractionated RAP specified only if the stockpile meets the consistency requirements set forth in Departmental procedures for approval of asphalt mix designs.

Subsection 307.03.C, (pg. 248), 8-28-24**; Anti-Strip Additive;** Revise 1st sentence:

Check asphaltic concrete mixtures (Grading A, AS, ACRL, B, BM,BM2, C, CM, CS, and CW) for stripping by the following methods:

Subsection 307.07, (pg. 250), 8-28-24; **Thickness and Surface Requirement;** Revise Table 307.07-1:

Table 307.07-1: Maximum Surface Deviation

Mixture	Maximum Deviation (inches)
Grading A, ACRL, and AS	1/2
Grading B, BM, BM2, C, CM, CS, and CW	3/8

Revise 307.09, (pg. 251), 10-17-23**; Basis of Payment;** Revise Table 307.09-01:

Table 307.09-1: Asphalt Cement Content

Mix Type	Asphalt Content
307 A	4.0%
307 AS	3.5%
307 ACRL	3.5%
307 B	4.3%
307 BM	5.0%
307 BM2	5.0%
307 C	5.0%
307 CW	5.0%
307 CS	6.5%

Subsection 307.09, (pg. 251), 8-28-24; **Basis of Payment;** Revise Table 307.09-1:

Table 307.09-1: Asphalt Cement Content

Mix Type	Asphalt Content
307 A	4.0%
307 AS	3.5%
307 ACRL	3.5%
307 B	4.3%
307 BM	5.0%
307 BM2	5.0%
307 C	5.0%
307 CM	5.0%
307 CW	5.0%
307 CS	6.5%

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021
(Rev. 12-19-22)
(Rev. 10-17-23)
(Rev. 12-27-23)
(Rev. 8-28-24)
(Rev. 12-26-24)

Supplemental Specifications – 400SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 403.04, (pg. 285), 12-15-21; **Preparing Surface;** Revise Paragraph:

Prepare the designated surface as specified in **405.05**. Ensure that the surface is dry when applying tack coat.

Subsection 403.04, (pg. 285), 12-27-23; **Preparing the Surface;** Revise Paragraph:

Prepare the designated surface as specified in **405.05**. Ensure that the surface is swept clean and dry when applying tack coat.

Subsection 403.05.C, (pg. 286), 12-15-21; **Fog Sealing;** Revise 1st Paragraph:

When the Contract requires bituminous material for fog sealing of shoulders, provide emulsified asphalt meeting **403.02** or an item from QPL 40A. Apply diluted emulsified asphalt at a rate of 0.10 to 0.15 gallons per square yard based on a dilution rate of one-part emulsified asphalt to one part water. This application may require two equal increments if run-off occurs. Apply fog seal when the ambient air temperature or the surface temperature is a minimum of 50°F.

Subsection 405.06.A, (pg. 290), 12-27-23; **Applying Bituminous Material;** Revise 3rd Paragraph:

At least 7 working days before the scheduled start of construction of any bituminous seal coat, submit a starting aggregate spread rate and emulsion shot rate as determined by AASHTO R 102 or an equivalent design method. Apply emulsified asphalt by pressure distributor at a uniform rate in accordance with Table 405.06-1 below. The exact rate will be established by the Engineer.

Subsection 407.03.E.1, (pg. 310), 10-17-23; **Tensile Strength Ratio;** Revise Table 407.03-4:

Table 407.03-4: Criteria for Stripping and Moisture Susceptibility

Asphalt Cement	Minimum Tensile Strength	Minimum TSR
Polymer Modified	100 psi	80%
Non-Polymer Modified	80 psi	80%
411 OGFC	50 psi	70%

Subsection 407.06.B, (pg. 324), 12-19-22; **Material Transfer Devices (MTDs);** Revise 2nd Paragraph:

The MTD shall have a minimum storage capacity of 15 tons and shall be equipped with mixing augers in the bottom of the storage hopper that are capable of remixing or re-blending the material as the material is removed from the storage hopper. The mixing augers shall be operational and used at all times during placement of the asphalt mixes. The MTD shall have a rear discharge conveyor that swivels to allow feeding the paving machine from the front, side or rear.

Subsection 407.09, (pg. 326-327), 12-15-21; **Weather Limitations;** Revise No. 2 & 3:

2. The bituminous plant mix is placed according to the temperature limitations specified in Table 407.09-1 and when weather conditions otherwise allow the pavement to be properly placed, compacted, and finished. Placement may proceed if either the air or surface temperature is met except for 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures.

   Measurement of the surface temperature shall be done on pavement that is shaded from direct sunlight unless no shaded location exists. If paving based on the air temperature, stop work once the air temperature falls below the minimum threshold. Do not start paving if the surface temperature does not meet the requirements and the air temperature is forecast to fall below the minimum temperature within 4 hours of starting work.

Table 407.09-1: Temperature Limitations

Compacted Thickness	Minimum Air or Surface Temperature (°F)	
	Unmodified mixes (PG 64, 67)	Modified mixes (PG 70, 76, 82)
≤ 1.5 inches	45	55
> 1.5 inches to < 3.0 inches	40	50
≥ 3.0 inches	35	45

3. For 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures, placement shall proceed only when the pavement surface temperature and the air temperature are a minimum of 55° F and rising. Stop paving if the air temperature falls below 55°F immediately. Placement of these mixtures is restricted to the period between April 1 and October 31.

   For all other mixtures, do not place bituminous plant mix, with a compacted thickness of 1.5 inches or less, between November 30 and April 1. Do not place bituminous plant mix, with a compacted thickness greater than 1.5 inches, between December 15 and March 16. If the temperature meets the above requirements, outside of normal paving season, a request for a seasonal limitation waiver may be submitted for Departmental consideration. Requests shall be submitted in writing at least one week before the anticipated need.

Subsection 407.09, (pg. 326-327), 12-27-23; **Weather Limitations;** Revise Table 407.09-1, No. 3, and Remove No. 4:

Table 407.09-1: Temperature Limitations

Compacted Thickness	Minimum Air or Surface Temperature (°F)	
	Unmodified mixes (PG 64, 67)	Modified mixes (PG 70, 76, 82)
< 2.0 inches	45	55
≥ 2.0 inches	35	35[1]

[1]If compacted thickness < 3 inches and Temperature is < 55 degrees, an approved Warm Mix Additive is required in the mix.

3. For 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures, placement shall proceed only when the pavement surface temperature and the air temperature are a minimum of 55°F and rising. Stop paving if the air temperature falls below 55°F immediately. Placement of these mixtures is restricted to the period between April 1 and October 31.

~~4. If determined necessary by the Department, the Contractor….~~

Subsection 407.13, (pg. 331), 8-28-24; **Mixing;** Revise 5th Paragraph No. 5:

5. The Contractor may store bituminous mixtures of Gradings A, AS, ACRL, and B for up to 48 hours, and Gradings BM, BM2, C, CS, CM, CW, D, E, and F for up to 96 hours, in a storage silo by complying with the following:

   (a) Add an approved silicone additive to the asphalt cement for mixes to be stored beyond the day of mixing.
   (b) Keep the stored bituminous mixture sealed at all times during storage.

(c) Fill the storage silo to at least 90% of capacity.

Subsection 407.15.A, (pg. 334), 12-19-22; **Compaction, General;** Revise Table 407.15:

Table 407.15 – Roller Requirements by Mix Type

Mix Type	Roller Requirements
307-A, 307-B, 307-BM-2, 307-C, 307-CW (except surface)	3 Rollers (Intermediate roller shall be Pneumatic)
307-AS, 307-ACRL, 411-D, 411-E, 307-CW (surface), 313-Asphalt Treated Permeable Base	3 Rollers (unspecified)
411-TL, 411-TLD, 411-TLE (when lift thickness > 1 inch)	3 Rollers (unspecified)
411-TL, 411-TLD, 411-TLE, 307-CS (when paved as a continuous layer)	2 Rollers (unspecified)
411-OGFC	2 Rollers (both rollers shall be static steel double drum, 10 Ton minimum
Any mix used for scratch paving	2 Rollers (breakdown shall be pneumatic)

Subsection 407.15.A, (pg. 334), 8-28-24; **Compaction, General;** Revise Table 407.15:

Table 407.15 – Roller Requirements by Mix Type

Mix Type	Roller Requirements
307-A, 307-B, 307-BM-2, 307-C, 307-CM, 307-CW (except surface)	3 Rollers (Intermediate roller shall b Pneumatic)
307-AS, 307-ACRL, 411-D, 411-E, 307-CW (surface), 313-Asphalt Treated Permeable Base	3 Rollers (unspecified)
411-TL, 411-TLD, 411-TLE (when lift thickness > 1 inch)	3 Rollers (unspecified)
411-TL, 411-TLD, 411-TLE, 307-CS (when paved as a continuous layer)	2 Rollers (unspecified)
411-OGFC	2 Rollers (both rollers shall be static steel double drum, 10 Ton minimum
Any mix used for scratch paving	2 Rollers (breakdown shall be pneumatic)

Subsection 407.15.B, (pg. 336), 12-27-23; **Density Requirements;** Revise Table 407.15-1:

Table 407.15-1: Density Requirements for Bituminous Pavement

Mix Type	% of Maximum Theoretical Density (Lot Average)	No Single Test Less Than, % (Sub Lot)
Travel Lanes ADT <1,000 A, B, BM, BM-2, C, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	90.0	87.0
Travel Lanes 1,000 <ADT <3,000 A, B, BM, BM-2, C, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	91.0	89.0
Travel Lanes ADT >3,000 A, B, BM, BM-2, C, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	92.0	90.0
Travel Lanes and Shoulders Any ADT CS,, OGFC TL, TLD, TLE (lift thickness <= 1 inch)	NA	NA
Shoulders B, BM, BM-2, D, E TL, TLD, TLE (lift thickness > 1 inch)	88.0	85.0

Subsection 407.15.B, (pg. 336), 8-28-24; **Compaction, Density Requirements;** Revise Table 407.15-1:

Table 407.15-1: Density Requirements for Bituminous Pavement

Mix Type	% of Maximum Theoretical Density (Lot Average)	No Single Test Less Than, % (Sub Lot)
Travel Lanes ADT <1,000 A, B, BM, BM-2, C, CM, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	90.0	87.0
Travel Lanes 1,000 <ADT <3,000 A, B, BM, BM-2, C, CM, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	91.0	89.0
Travel Lanes ADT >3,000 A, B, BM, BM-2, C, CM, CW, D, E TL, TLD, TLE (lift thickness > 1 inch)	92.0	90.0
Travel Lanes and Shoulders Any ADT CS, OGFC TL, TLD, TLE (lift thickness <= 1 inch)	NA	NA
Shoulders B, BM, BM-2, D, E TL, TLD, TLE (lift thickness > 1 inch)	88.0	85.0

Subsection 407.15.C, (pg. 336-337), 12-15-21; **Test Strips;** Revise 1st Paragraph:

Construct test strips for all mixtures that require density testing to establish rolling patterns, to accommodate the Department to calibrate nuclear gauges, to verify that the base course or surface course mixture meets the density requirements of the specifications, and for mix design and production verification as required. Adjustments to the roller pattern may be made at the direction of the Engineer for mixtures that do not require density testing.

Subsection 407.20.B.2.a, (pg. 342), 12-27-23; **Defective Materials, Acceptance or Rejection;** Revise 3rd Paragraph:

All acceptance samples will be split, and half of the sample will be retained by the Inspector. If the results of an acceptance test are questioned, the Central Laboratory will test the remaining half of the acceptance sample. The Department will use the results obtained by the Central Laboratory to evaluate the quality of the lot. The Contractor may submit a written request to have the split sample tested at a Regional Laboratory.

Subsection 407.20.C.3, (pg. 346-347), 12-15-21; **Loss on Ignition (LOI);** Revise 2nd & Remove 4th Paragraph:

If the percent of LOI in the aggregate differs by plus or minus 2% from the LOI indicated in the JMF, the Department will make a payment deduction in the price bid for the mix applied to the entire days production, not as a penalty but as liquidated damages. The percent of total payment to be deducted will be 5 times the percent that the LOI exceeds the JMF tolerance of plus or minus 2%.

~~To determine the deduction, the Department will use lots of approximately 5,000 square yards. The Department inspector will perform sampling and testing to establish the LOI according to the Department's sampling and testing procedures. If the initial tests indicate a variation in the LOI of plus or minus 2% than the value shown on the mix design, the Contractor shall perform the additional sampling necessary to establish the LOI of the aggregate in each lot, with the cost of the sampling being included in the contract unit prices bid for the paving items.~~

Subsection 410.06, (pg. 349), 12-26-24**; Preparing Designated Surface;** Revise Sentence:

Prepare the designated surface upon which the material is to be placed as specified in **405~~4~~.05**.

Subsection 410.11, (pg. 350), 12-26-24**; Maintenance;** Revise Sentence:

Perform maintenance as specified in **405~~4~~.09**.

Subsection 411.06, (pg. 361), 12-26-24**; Preparing the Designated Surface;** Revise 1st Sentence:

Prepare the designated surface upon which the material is to be placed as specified in **405~~4~~.05.**

Subsection 411.03.B, (pg. 353), 12-15-21; **Proportioning;** Revise Table 411.03-01:

Table 411.03-1: Proportions of Total Mixture, Percent by Weight

Surface Course	Effective Combined Mineral Aggregate	Asphalt Cement
Grading D	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (2)	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (shoulders)	93.5 – 94.0	6.0 – 6.5 (1)
Grading TL	92.5 – 94.3	5.7 – 7.5 (1)
Grading TLD	93.0 – 94.3	5.7 – 7.0 (1)
Grading TLE	93.0 – 94.3	5.7 – 7.0 (1)
Grading TLE (shoulders)	93.5 – 94.0	6.0 – 6.5 (1)
Grading OGFC	92.0 – 94.0	6.0 – 8.0 (1)

(1) If the effective combined specific gravity of the aggregate exceeds 2.80, the above proportions may be adjusted as directed by the Engineer. The upper limit for flow values shall not apply to mixes with modified asphalt liquids.

(2) The minimum allowable asphalt cement content for 411E low volume mixtures is 5.3%.

Subsection 411.03.B.4, (pg. 356), 10-17-23; **Grading OGFC;** Revise Table 411.03-5:

Table 411.03-5: Mixture Properties (Grading OGFC)

Mix	Minimum Void Content % (1)	Voids in Coarse Aggregate % (2)	Max. Cantabro Abrasion Loss % (2) (3)	Drain Down Loss % (4)
411OGFC	17	$VCA_{DRC} > VCA_{MIX}$	20	<0.3%

(1) Determined using the "Volume Method" described in Section 6.2.2. of AASHTO T 269.

(2) As described in National Asphalt Pavement Association (NAPA) Publication IS-115, "Design, Construction and Maintenance of Open-Graded Friction Courses."

(3) Cantabro Abrasion Loss specimens shall be aged as loose mix for 4 hours at lab compaction temperature.

(4) Tested in accordance with AASHTO T 305.

Subsection 411.03.C.1, (pg. 357), 12-27-23; **Recycled Asphalt Pavement;** Revise Table 411.03-6:

Table 411.03-6: Use of Recycled Asphalt Pavement

Mix Type	% RAP (Non-processed) (1)	Maximum % RAP (Processed) (2)	Maximum % RAP Processed and Fractionated (3)	Maximum Particle Size (inch)
411-D (PG64-22, PG67-22)	0	15	20	½
411-D (PG70-22, PG76-22, PG82-22)	0	10	15	½
411-E & 411-TLE (Roadway)	0	15	20	½
411-E & 411-TLE (Shoulder)	15	30	35	½
411-TL (PG64-22, PG67-22)	0	15	15	5/16
411-TL (PG70-22, PG76-22, PG82-22)	0	10	10	5/16
411-TLD (PG64-22, PG67-22)	0	15	15	5/16
411-TLD (PG70-22, PG76-22, PG82-22)	0	10	10	5/16

(1) "Non-processed" refers to RAP that has not been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that listed above prior to entering the dryer drum.

(2) "Processed" refers to RAP that has been crushed and screened or otherwise sized such that the maximum recycled material particle size is less than that above prior to entering the dryer drum.

(3) "Fractionated" refers to RAP that has been processed over more than one screen, producing sources of various maximum particle sizes (e.g., ¾ to ½ inch, ½ inch to #4, etc.). The Contractor may use the larger percentages of fractionated RAP specified only if the stockpile meets the consistency requirements set forth in Departmental procedures for approval of asphalt mix designs.

Subsection 411.03.C.1, (pg. 358), 12-15-21; **Recycled Asphalt Pavement;** Revise 2nd Paragraph:

All mixes shall contain at least 80% virgin asphalt, except for 411E Shoulder and 411TLE Shoulder Mixtures, which shall have at least 65% virgin asphalt.

Subsection 414.03.B, (pg. 367), 12-19-22; **Micro-Surfacing;** Revise Table 14.03-3:

Table 414.03-3: Micro-Surfacing

Test	Requirement
Mixing Time Test, seconds at 77 °F (T-102)	120 min
Mix Time, at 50 and 100 °F	(informational)
Set Time Tests: 30 minutes (T-139)	12 kg-cm min
Early Rolling Traffic Time: 60 minutes (T-139)	20 kg-cm min
Wet Stripping Test, % coating (T-114)	90% min
Wet Track Abrasion Test, loss in g/ft^2 (T-100)	75 max 6 days 50 max 1 hour
Measurement of Excess Asphalt (T-109)	50 $grams/ft^2$ max Sand Adhesion, 1,000 Cycles at 125 lbs
Classification Compatibility (T-144)	11 pt. min

Subsection 414.06.B, (pg. 377), 12-19-22; **Quality Control;** Add Subsection 5:

5. Aggregate Gradation. Prior to the start of production and at a minimum of once per day of production, perform a washed gradation (AASHTO T 27 with AASHTO T 11) of the stockpiled aggregate to ensure the gradation meets the mixture control tolerances of Table 903.12-2.

Subsection 415.03, (pg. 382), 12-19-22; **General Requirements;** Revise 1st Paragraph:

Coordinate operations so that vertical longitudinal faces do not exceed height requirements indicated by plans in areas to be used by public traffic. Taper transverse faces in a manner approved by the Engineer to avoid creating a traffic hazard. Perform cold planing in the direction of traffic.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-19-22) January 1, 2021
(Rev. 12-27-23)

Supplemental Specifications – 500SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 501.13, (pg. 399), 12-19-22; **Testing Concrete;** Revise 2nd Paragraph:

The Engineer will determine the 28-day compressive strength of the concrete under construction by conducting tests during the progress of work in accordance with **604.15**. The method of making and curing test specimens will be in accordance with AASHTO R 100. Furnish the concrete necessary for the Engineer to conduct the field tests and provide a storage facility with watertight tanks of satisfactory size and number to accommodate the cylinder specimens. The Engineer may allow concrete that fails to meet the specified strength to remain in place, but the Department will pay for such concrete at a reduced price as specified in **604.31** to compensate for the loss of strength. Any reduction in payment because of low strength will be in addition to any reduction in payment related to deficiencies in pavement thickness or rideability.

Subsection 501.17.B, (pg. 409), 12-27-23; **Pay Factor and Required Corrective Action;** Revise 4th Paragraph:

A grinding strategy plan is required before any corrective action begins. Software such as ProVAL is required to generate a grinding plan. Submit a copy of the grinding plan for approval to the Engineer at least 5 days prior to starting any work. The grinding plan must include existing profile, proposed profile, start and stop grinding locations, length of proposed grinding, and direction of grinding. Perform required corrective work with approved grinding equipment or removing and replacing pavement as directed by the Engineer. Perform all corrective action at no cost to the department. Grinding equipment must meet **604.27.C**.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021
(Rev. 12-19-22)
(Rev. 12-27-23)
(Rev. 12-26-24)
(Rev. 1-8-25)

Supplemental Specifications – 600SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 602.04.A, (pg. 429), 12-15-21; **Shop Inspection;** Revise A:

Fabricators of steel bridges shall hold the following certifications in accordance with the AISC Certification Program – Bridge QMS Certification:

1. As a minimum, all fabricators shall be certified in the category of Certified Bridge Fabricator – Intermediate Bridge (IBR) with applicable supplemental requirements.

2. Fabricators of advanced type bridges, as defined in the AISC Standard for Steel Bridges, shall be certified in the category of Certified Bridge Fabricator – Advanced (ABR) with applicable supplemental requirements.

3. Fabricators of diaphragms, cross-frames, floor beams, stringers (rolled beams) and laterals shall be certified in the category of Certified Bridge Fabricator – Intermediate Bridge (IBR), as a minimum.

4. Fabricators of bridge bearings, expansion joints, sign structures and other metal highway components as listed in the AISC standard shall hold certification under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator – Intermediate Bridge (IBR).

Subsection 602.04.B, (pg. 429), 12-27-23; **Quality Assurance (QA) Shop Inspection;** Revise 1st & 3rd and Remove 2nd Paragraphs:

At least 6 weeks before starting shop fabrication, provide written notification to the Materials and Tests Division, with a copy to the Engineer, as to the location and schedule of the fabrication of structural steel, so that the Department may arrange for QA shop inspection.

Subsection 602.18.B, (pg. 460), 12-27-23; **Visual Inspection and Repair of Plate Cut Edges;** Revise Paragraph:

Visually inspect and repair plate cut edges in accordance with Article 5.2.6 of the AASHTO/AWS *Bridge Welding Code*, D1.5, current edition.

Subsection 602.19, (pg. 460, 461), 12-27-23; **Welds;** Revise Numbers 1 thru 9 and Add Table 602.19-1:

The following are revisions to the AASHTO/AWS *Bridge Welding Code*:

1. Add the following sentence to Article 8.1.1.1:

   After fabrication, Quality Control (QC) shall mark each piece (girders, beams, diaphragms, X-frames, bearings, etc.) with the fabricator's logo and the CWI Number of the QC Inspector accepting the piece. These stamps will signify that Quality Control (QC) has inspected the piece and that it meets the requirements of the plans and specifications.

2. Delete Article 8.1.3.1(3).

3. Delete Article 8.1.3.2.

4. Delete the last sentence in Article 8.1.3.4 and substitute the following:

   Only individuals certified for NDT Level II may perform nondestructive testing.

5. Delete 8.1.3.4(1) and 8.1.3.4(2).

6. Delete the period at the end of Article 8.6.1 and add the following:

   and access to all records necessary to verify conformance to plans and specifications.

7. Delete Article 8.7.1 and substitute the following:

   Complete joint penetration groove welds in main members, as identified in the contract documents shall be QC tested by nondestructive testing.

   Radiographic and ultrasonic testing shall both be performed using methods and frequencies required in the revised AWS Table 8.1 specified in Table 602.19-1.

   Longitudinal butt joints in beam or girder webs shall be 100% QC tested by nondestructive testing.

8. Add the following Article 8.22.4:

   Each Ultrasonic Unit shall be certified for general operational performance at a minimum time interval of 12 months with a method approved by the instrument manufacturer.

Table 602.19-1: NDT Methods and Frequency (revised AWS Table 8.1)

Weld Type	Joint Type	Process	Member Design Stress Type	NDT Method	Frequency
CJP groove welds	Butt joints other than in webs of flexural members	Other than ESW or EGW	Tension or reversal	RT and UT	100% of each joint
			Compression or shear	RT and UT	25% (See 8.7.4)
		ESW or EGW	Tension or reversal	RT and UT	100% of each joint
			Compression or shear	RT and UT	25% (See 8.7.4)
	Butt joints in webs of flexural members, transverse to the direction of bending stress	Other than ESW or EGW	Tension	RT and UT	1/6 of the web depth beginning at the tension flange or flanges for each joint
		ESW or EGW		RT and UT	
		Other than ESW or EGW	Compression	RT and UT	25% of the remainder of the web depth for each joint
		ESW or EGW		RT and UT	
	Butt joints in webs of flexural members, parallel to the direction of bending stress	Other than ESW or EGW	Shear	RT and UT	100% of each joint
		ESW or EGW		RT and UT	
	T- or corner joints	Any	Tension or reversal	UT	100% of each joint
			Compression or shear (including web to either flange)		25% (See 8.7.4)
PJP groove welds and fillet welds, Grade HPS 690W (HPS 100W)	Any	Any	Any	MT	100% of each joint
PJP groove welds and fillet welds, all other grades					10% (See 8.7.4)

Subsection 602.29, (pg. 465), 12-XX-23; **Annealing and Stress Relieving;** Revise 4th Paragraph:

Stress relieve members, such as bridge shoes, pedestals, or other parts that are built up by welding sections of plate together, according to Section 6.4 of AASHTO/AWS *Bridge Welding Code* D1.5 when required by the Contract.

Subsection 602.39, (pg. 470), 12-XX-23; **Erection, Shear Stud Connectors;** Revise 1st Paragraph:

After erecting the beams, attach the shear stud connectors in compliance with OSHA standards. Install the studs in the locations shown on the Plans. Install and test shear studs in accordance with the latest version of AASHTO/AWS D1.5, Chapter 9 Stud Welding. Clean the surface receiving the stud by shot blasting or grinding to a bright metal surface immediately before welding. Weld studs using automatically timed stud welding equipment only. At the beginning of each day or shift, each individual welder/operator and equipment must complete the Production Control/Pre-production Testing described in paragraph 9.7.1 of AASHTO/AWS D1.5. Only allow individuals, who repeatedly demonstrate satisfactory installation, to install the shear studs. The Contractor is responsible for the quality of all welds.

Subsection 603.01.B, (pg. 481), 12-26-24**; Certification Requirements;** Revise Subsection:

All contractors or subcontractors involved in field surface preparation or coating application shall be certified according to the Association for Materials Protection and Performance (AMPP) ~~Society for Protective Coatings (SSPC) Painting Contractor Certification Program (PCCP) or NACE International Institute Contractor Accreditation Program (NHCAP~~).

Contractors or subcontractors performing field coating application shall be certified according to ~~SSPC~~AMPP QP1, Field Application. ~~or equivalent, including NHCAP AS-1 Field.~~

Contractors and subcontractors performing field surface preparation of existing structures shall be certified according to ~~SSPC~~AMPP QP2, Field Removal of Hazardous Coatings. ~~or equivalent, including NHCAP AS-2 Hazard Waste Removal.~~

Ensure that all contractors and subcontractors that perform field surface preparation or field coating application are certified to the requirements of ~~SSPC~~AMPP; QP1 or QP2~~, or NHCAP; AS-1 Field or AS-2~~ before Contract award and remain certified for the duration of the Project. If a contractor's or subcontractor's certification expires or is suspended, do not allow that contractor to perform any work until the certification is reissued or reinstated. The Department will not consider any requests for time extensions for any delay in the completion of the Project due to an inactive certification and may apply liquidated damages. Provide a copy of the certifications to the Engineer before beginning work and notify the Engineer of all changes in certification status.

Subsection 603.06.A, (pg. 484), 12-26-24**; Schedule of Painting, New Structures;** Revise Table:

Table 603.06-1: System A – Inorganic/Organic Zinc

Paint System	Specification	Minimum Dry Film Thickness (mils)	Maximum Dry Film Thickness (mils)
Primer (shop coat)	Inorganic/Organic Zinc Silicate Paint, **910.03**	2.5	5.0
Intermediate Tie Coat	**910.03**, as modified below	2.0	5.0
Finish Coat (color coat)	Urethane Finish, **910.03** (match color shown on the Plans)	2.0	5.0

Subsection 604.03.A.1.a, (pg. 502), 12-19-22; **Design and Production Parameters;** Revise Table 604.03-1 and 4th paragraph:

Table 604.03-1: Composition of Various Classes of Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)	Slump (inches)
A	3,000	564	0.45	6 ± 2	3 ± 1 (1)
D, DS (2, 3)	4,000	620	0.40	7 (3)	8 max
L (3, 4)	4,000	620	0.40	7 (3)	8 max
S (Seal)	3,000	682	0.47	6 ± 2	6 ± 2
X (5)					

(1) For slip forming, the slump shall range from 0 to 3 inches.

(2) Use Class D concrete in all bridge decks except box and slab type structures unless otherwise shown on the Plans. Use Class DS concrete in bridge decks with polish-resistant aggregate described in **903.03** and **903.24**.

(3) Design Class D, Class DS, and Class L concrete at 7% air content. Acceptance range for pumping and other methods of placement is 4.5-7.5%. Sampling will be at the truck chute.

(4) The unit weight of air dried Class L concrete (lightweight concrete) shall not exceed 115 pounds per cubic foot as determined according to ASTM C567.

(5) Plan specific requirements

Include chemical admixtures in the concrete mixture based on the ambient air temperature and expected weather conditions.

If using chemical admixtures, the allowable slump shall be a maximum of 8 inches. Do not exceed the water cement ratio.

Subsection 604.03.A.1.a, (pg. 502), 12-26-24; **Design and Production Parameters;** Revise Table 604.03-1 and Add Tables 604.03-1(a) and 604.03-1(b) after the last paragraph:

Table 604.03-1: Composition of Various Classes of Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)	Slump (inches)
A	3,000	564	0.45	6 ± 2	3 ± 1 (1)
D, DS (2, 3, 6, 7)	4,000	620	0.40	7 (3)	8 max
L (3, 4, 6)	4,000	620	0.40	7 (3)	8 max
S (Seal)	3,000	682	0.47	6 ± 2	6 ± 2
X (5)					

(1) For slip forming, the slump shall range from 0 to 3 inches.

(2) Use Class D concrete in all bridge decks except box and slab type structures unless otherwise shown on the Plans. Use Class DS concrete in bridge decks with polish-resistant aggregate described in **903.03** and **903.24**.

(3) Design Class D, Class DS, and Class L concrete at 7% air content. Acceptance range for pumping and other methods of placement is 4.5-7.5%. Sampling will be at the truck chute.

(4) The unit weight of air dried Class L concrete (lightweight concrete) shall not exceed 115 pounds per cubic foot as determined according to ASTM C567.

(5) Plan specific requirements

(6) Class D, Class DS and Class L require the surface resistivity in accordance with AASHTO T 358 for design approval, acceptance, and verification requirements in accordance with Table 604.03-1(a) and Table 604.03-1(b).

(7) Class D and Class DS shall have a minimum supplementary cementitious material(s) replacement of 25% and in accordance with Table 604.03-4.

Table 604.03-1(a): Surface Resistivity Requirements for Mix Design Approval

Chloride Ion Penetration	Apparent Surface Resistivity[a] 4 by 8 in. (100 by 200 mm) Cylindrical Specimens (kΩ·cm) a = 3.8 cm	Action
High	< 12	Not approved; must redesign
Moderate	12 - 36	Approved with project verification
Low	≥ 37	Fully approved

[a] Wenner probe tip spacing; determined from 28-day acceptance cylinders

Table 604.03-1(b): Surface Resistivity Requirements for Project Acceptance and Verification

Chloride Ion Penetration	Apparent Surface Resistivity[a] 4 by 8 in. (100 by 200 mm) Cylindrical Specimens (kΩ·cm) *a* = 3.8 cm	Action
High	< 12	Redesign before next pour
Moderate	12 - 20	Monitor results
Low	≥ 21	Mix Design is verified

[a] Wenner probe tip spacing; determined from 28-day acceptance cylinders

Subsection 604.03.A.1.d, (pg. 504), 12-19-22; Add Subsection d:

d. **Performance Engineered Mixtures (PEM) Design and Production Parameters**

Proportion the concrete based on a water-cement ratio that does not exceed the maximum shown in Table 604.03-3. The fine aggregate shall not exceed 50% by volume calculation of the total aggregate volume. The volume of paste shall not exceed 25%. The Contractor may elect to use PEM as an alternate/option in replacement of Class A concrete.

Document mixture adjustments, for moisture corrections, on the daily concrete report. Ensure that the adjusted mix complies with all the performance criteria specified in Table 604.03-3.

Table 604.03-3: Composition of Performance Engineered Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)
PEM (1,2,3,4,5)	3,000(1)	-	0.45	6 ± 2

(1) Or as shown on the Plans or approved shop drawings.
(2) Air Content must be accompanied with the Super Air Meter (SAM) number AASHTO T 395 for data collection only.
(3) Resistance of Concrete to Rapid Freezing and Thawing AASHTO T 161 for data collection only.
(4) Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration AASHTO T 358 for data collection only.
(5) Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction ASTM R80 for data collection only.

All Standards of Practice for Developing Performance Engineered Concrete Pavement Mixtures AASHTO R 101 are for data collection only.

Include chemical admixtures in the PEM mixture based on the ambient air temperature and expected weather conditions. Dosage rates for any admixtures incorporated into the concrete shall be stated during the mix design submittal process. All admixtures shall be compatible and incorporated into the concrete in accordance with the manufacturer's recommendations. Concrete mixtures utilizing multiple admixture manufacturers shall prove compatibility in accordance with the Departmental procedures.

Subsection 604.03.A.1.d, (pg. 504), 12-26-24; **Performance Engineered Mixtures (PEM) Design and Production Parameters;** Revise Table 604.03-3:

Table 604.03-3: Composition of Performance Engineered Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design ± production tolerance)
PEM (1,2,3,4,5)	3,000(1)	-	0.45	6 ± 2

(1) Or as shown on the Plans or approved shop drawings.
(2) Air Content must be accompanied with the Super Air Meter (SAM) number AASHTO T 395 for design approval.
(3) Resistance of Concrete to Rapid Freezing and Thawing AASHTO T 161 for data collection only.
(4) Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration AASHTO T 358 for design approval, acceptance, and verification requirements in accordance with Table 604.03-1(a) and Table 604.03-1(b).
(5) Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction ASTM R80 for data collection only.

All Standards of Practice for Developing Performance Engineered Concrete Pavement Mixtures AASHTO R 101 are for data collection only.

Subsection 604.03.A.2, (pg. 504-505), 12-19-22; **Mix Design Submittal;** Revise 1st and 3rd Paragraphs, and Add 6th Paragraph:

2. **Mix Design Submittal.** Submit, for approval, the proposed design in accordance with Departmental procedures at least 14 days prior to use. Develop the design using saturated surface dry aggregate weights. The design shall be prepared in an approved testing laboratory by a TDOT Certified Concrete Mix Design Technician. The TDOT Certified Concrete Mix Design Technician shall certify that the information contained on the design submittal is correct and is the result of information gained from the actual trial batch. Build trial batches for design no more than 90 days before submitting the design. The trial batch shall produce an average compressive strength to

indicate that the specified 28-day strength can be obtained in the field. Make all strength determinations using equipment meeting the requirements of, and in the manner prescribed by, AASHTO T 22. The design shall provide concrete of the strength specified in all applicable Special Provisions, Plans, and Specifications. The approved mix design will expire at the end of each calendar year or if it does not meet the minimum 28-day strength requirements. Assume responsibility for all costs of concrete design, preparation, and submittal.

Self-consolidating concrete (Classes SCC, SH-SCC, and P-SCC) shall be verified prior to placement either at the ready mix, precast, or prestressed facility. The concrete producer shall notify Regional Materials and Tests a minimum of 1 business day prior to performing a trial batch verification of the submitted design. The trial batch will ensure that all batched quantities and target admixture dosage rates are acceptable and meet specification prior to design approval. All quantities and identified admixture target dosage rates shall meet the tolerances specified in **604.11**.

Performance engineered concrete (Class PEM) shall be verified prior to placement. The concrete producer shall perform trial batching in the presence of a Headquarters Materials and Tests representative. All quantities and admixture dosage rates shall meet the tolerances specified in **604.11**. Gradations shall be submitted with each request.

Subsection 604.03.A.2, (pg. 505), 1-8-25; **Mix Design Submittal;** Add 7th Paragraph:

For Class D, Class DS, Class PEM, and Class L concrete mixtures, surface resistivity values shall be submitted in accordance with Table 604.03-1(a) and Table 604.03-1(b).

Subsection 604.03.A.3, (pg. 506), 12-19-22; **Partial Cement Replacement with Fly Ash or Slag Cement;** Revise 3rd Paragraph, Table 604.03-03, and 4th Paragraph:

When designing Portland cement concrete with Type I or Type IL cement modified by the addition of fly ash and/or slag cement, meet the maximum cement replacement rates (by weight) and minimum substitution ratios (by weight) specified in Table 604.03-4 for the applicable type of modifier.

Table 604.03-4: Type I or Type IL Cement Modified by Fly Ash or Slag Cement

Modifier	Maximum Cement Replacement Rate % (by weight)	Minimum Modifier Cement Substitution Rates (by weight)
Slag Cement (Grade 100 or 120)	35.0	1:1
Class “F” Fly Ash	25.0	1:1
Class “C” Fly Ash	25.0	1:1

The Contractor may use ternary cementitious mixtures (mixtures with Portland cement, slag cement, and fly ash) for Class A, Class D, Class DS, Class PEM concrete provided that the minimum Portland cement content is 50%. The maximum amount of fly ash substitution in a ternary cementitious mixture shall be 20%. The Department will allow Type IS cement with ternary cementitious mixtures. When using a Type IS cement, do not use any additional slag cement as a partial replacement for the hydraulic cement. The Department will allow a maximum of 20% fly ash as a partial hydraulic cement replacement in Class A concrete using only Type IS cement.

Subsection 604.03.B, (pg. 507-510), 12-19-22; **Quality Control and Acceptance of Concrete;** Revise 2nd and 5th Paragraphs, Add Sentence after 5th Paragraph, Revise Nos. 7,8,10,11, and 9th Paragraph:

The minimum size of a batch shall be 2.5 cubic yards. If less than 2.5 cubic yards is needed, the concrete must be provided by a Volumetric Continuous Mixer as specified in **604.04.C.**

The concrete producer shall develop for the Engineer's approval and maintain at the plant a plant-specific Process Control Plan that shall apply to all Department contracts for the calendar year. Communicate all changes made to the Process Control Plan during the year to the Regional Materials and Tests Supervisor. Develop for the Engineer's approval a placement site Process Control Plan stating the procedures for sampling, testing, and inspection of the concrete. Maintain a record of all tests and inspections performed at the facility and placement site. Provide these documents to the Engineer upon completion of the Project for inclusion in the Project records. Provide a binder of current records in accordance with Departmental procedures.

No water shall be added in the field for Class PEM concrete.

7. Conduct slump AASHTO T 119 or slump flow ASTM C1611 and air tests AASHTO T 152. For Class PEM provide the Super Air Meter (SAM) number for informational purposes only.

8. Conduct yield tests AASHTO T 121. If yield varies more than plus or minus 2% from that shown on the design, stop all batching operations until the problem has been identified and corrected or a new concrete design has been obtained. Additionally for Class PEM only, determine Unit Weight by AASHTO T 121.

10. Conduct tests for concrete and ambient air temperatures AASHTO T 309.

11. Provide a daily report to the Engineer that identifies the date, Contract and Project, Item number(s), batch weights, aggregate gradations, moisture corrections, admixtures, slump, air content, temperatures, and similar pertinent information.

The Department or its representative will be responsible for performing all acceptance tests. A TDOT Concrete Field-Testing Technician or ACI equivalent will sample and test in accordance with Departmental 604.04 510 procedures. The Department will ensure the Contractors initial curing conditions are properly maintained during the initial curing period as specified in **722.09** and all acceptance cylinders are transported according to AASHTO R 100.

Subsection 604.03.B, (pg. 507-510), 1-8-25; **Quality Control and Acceptance of Concrete;** Revise 5th and 6th Paragraphs, Revise No. 7, and 10th Paragraph:

The concrete producer shall develop for the Engineer's approval and maintain at the plant a plant-specific Process Control Plan that shall apply to all Department contracts for the calendar year. Communicate all changes made to the Process Control Plan during the year to the regional Materials and Tests Field Services Team Lead. Develop for the Engineer's approval a placement site Process Control Plan stating the procedures for sampling, testing, and inspection of the concrete. Maintain a record of all tests and inspections performed at the facility and placement site. Provide these documents to the Engineer upon completion of the Project for inclusion in the Project records. Provide a binder of current records in accordance with Departmental procedures.

No water shall be added in the field for Class PEM concrete above the approved water-cement ratio submitted and approved during trial batching.

7. Conduct slump AASHTO T 119 or slump flow ASTM C1611 and air tests AASHTO T 152. For Class D, Class DS, Class PEM, and Class L provide the Sequential Air Meter (SAM) AASHTO T 395 number for design approval and Surface Resistivity AASHTO T 358 for design approval, acceptance, and verification requirements in accordance with Table 604.03-1(a) and Table 604.03-1(b).

The Department or its representative will be responsible for performing all acceptance and verification tests. A TDOT Concrete Field-Testing Technician or ACI equivalent will sample and test in accordance with Departmental 604.04~~-510~~ procedures. The Department will ensure the Contractors initial curing conditions are properly maintained during the initial curing period as specified in **722.09** and all acceptance cylinders are transported according to AASHTO R 100.

Subsection 604.04.A.1, (pg. 511), 12-19-22; **Batching Plant, Multi-Aggregate Feed System, and Equipment, General;** Revise 2nd Paragraph:

All producers of concrete shall be on the Department's Producer List.

Subsection 604.04.B.3, (pg. 513), 12-19-22; **Truck Mixers and Truck Agitators;** Revise 1st Paragraph:

Ensure that truck mixers used for mixing and hauling concrete, as well as the truck agitators used for hauling central-mixed concrete, meet all the applicable requirements specified in **604.04.B.1**. Truck mixers shall have a manufacturer's plate indicating the various uses for which the equipment is designed, the gross volume of the drum, and the minimum and maximum speed of rotation of the drum or blades for charging, mixing and agitating. Equip truck mixers with an approved device for recording the number of revolutions of the drum or blades.

Subsection 604.15.A, (pg. 532), 12-19-22; **Compressive Strength Tests of Concrete, General;** Revise 2nd Paragraph:

The frequency of testing for compressive strength to determine when forms may be removed, or when a structure may be put into service, shall be as requested by the Contractor or as deemed necessary by the Engineer in accordance with **604.15.C** or **604.15.D**.

Subsection 604.15.B, (pg. 532-533), 12-19-22; **Concrete Acceptance Cylinders;** Revise 1st, Remove 2nd and Revise 3rd, 5th, and 6th Paragraphs:

The Department will test the specimens for compressive strength according to AASHTO T 22. Provide the necessary concrete for making test specimens and adequate curing and storage facilities specified in **722.09** at no additional cost to the Department. Provide hourly temperature data for each day the specimens were kept in the initial curing environment.

~~Concrete cylinders submitted for testing beyond 28 days shall comply with the design strength requirements specified in **604.03** or the Plans.~~

If the acceptance cylinders fail to meet the specified strengths, the Contractor must provide QC data from the batching operation for the suspect concrete delivered and a letter of intent to core the suspect location. When these requirements are met, the Contractor may then elect to drill a minimum of two or maximum of three concrete core samples per set of cylinders from the hardened concrete. The cores shall be obtained in accordance with Departmental procedures. Obtaining the concrete cores and repairing the concrete core holes shall be at no cost to the Department.

The Engineer will not accept cores submitted for testing beyond 56 days.

The average compressive strength of all the cores taken to represent the failing concrete acceptance cylinders will be considered to be the acceptance strength of record for the in-place concrete. Any core that fails to meet the standard for cores in the Departmental procedures will be discarded untested and not considered in the average compressive strength. In accordance with **604.31**, the Engineer will accept at a reduced pay concrete that meets the required strengths specified in **604.03** or the Plans for the respective class.

Subsection 604.15.B, (pg. 532-533), 1-8-25; **Concrete Acceptance Cylinders;** Revise 1st and Add 6th Paragraph:

The Department will test the specimens for compressive strength according to AASHTO T 22 and surface resistivity for Class D, Class DS, Class PEM, and Class L according to AASHTO T 358 and Table 604.03-1(b). Provide the necessary concrete for making test specimens and adequate curing and storage facilities specified in **722.09** at no additional cost to the Department. Provide hourly temperature data for each day the specimens were kept in the initial curing environment.

If acceptance cylinders fail to meet the specified surface resistivity values for Table 604.03-1(b) for Class D, Class DS, Class PEM, and Class L concrete mixtures, the entire surface shall be sealed with an approved penetrating sealer listed on the Department's Qualified Producer List at no additional cost to the Department.

Subsection 604.15.C, (pg. 534), 12-19-22; **Compressive Strength Tests of Concrete, Early Break Cylinders;** Revise 1st Paragraph**:**

Make and cure all test specimens according to AASHTO R 100, and the applicable procedures therein defined for Field Cured Specimens, unless otherwise specified by the Engineer. The Department will test the specimens for compressive strength according to AASHTO T 22. Provide the necessary concrete for making test specimens at no additional charge to the Department.

Subsection 604.15.D, (pg. 534), 12-19-22; **Compressive Strength Tests of Concrete, Maturity Method;** Add Subsection D:

D. Maturity Method

Strength of concrete in-place may be estimated by the Standard Practice for Estimating Concrete Strength by the Maturity Method AASHTO T 325 and Departmental procedures for critical activities. (open pavement to traffic, removing forms, post tension, shipping, cold weather).
The Department will break a set of cylinders made from the pour in question to verify the strength-maturity relationship, the concrete will be accepted on the basis of the 28 day strength as defined by the strength-maturity relationship. If the cylinders break within 10% of the estimated strength based on the strength-maturity relationship, the concrete will be accepted on the basis of the 28 day strength as defined by the strength-maturity relationship. If the cylinders break outside of the 10% tolerance, the 28 day cylinders will be broken and the concrete will be accepted per **604.15.B**.

Subsection 604.16.E, (pg. 539), 12-27-23; **Placing Concrete, Joints;** Remove 4th and Revise 5th Paragraphs:

For box culvert construction, place the concrete in the walls and allow to set at least 4 hours before constructing the top slab.

Subsection 604.19, (pg. 541), 12-19-22; **Removal of Forms and Falsework;** Revise 3rd Paragraph:

Release and remove falsework and supports under concrete structures only when the following conditions are met:

1. Representative specimens of the concrete, made and cured in accordance with **604.15.C**, attain a compressive strength of 3,000 pounds per square inch or when Strength Maturity relationship indicates the concrete has achieved 3000 pounds per square inch and has been verified per **604.15.D**.

2. The concrete has been in place a minimum of 7 days, not counting days of 24 hours each in which the temperature falls below 40 °F, or 21 calendar days, whichever occurs first.

Subsection 604.27.C, (pg. 551), 12-27-23; **Pay Factor and Required Corrective Action;** Revise 3rd Paragraph:

A grinding strategy plan is required before any corrective action begins. Software such as ProVAL is required to generate a grinding plan. Submit a copy of the grinding plan for approval to the Engineer at least 5 days prior to starting any work. The grinding plan must include existing profile, proposed profile, start and stop grinding locations, length of proposed grinding, and direction of grinding. Perform corrective action, including grinding of bridge decks and approach slabs, removal of pavement tie-ins, resurfacing, and application of sealants, at no additional cost to the Department.

Subsection 604.31, (pg. 557), 12-19-22; **Basis of Payment;** Revise 6th & 7th Paragraphs and Revise Equation:

Where concrete mixture does not meet the specified strength but is allowed to be included in the permanent construction as specified in **604.20** or the acceptance strength of record fails to meet the strength specified in **604.15**, the Department will use the following equation to determine the price deduction for the invoiced price of the defective concrete mixture.

$$PD = (3 \times Ds) \text{ x } IP \text{ x } Q$$

Where:

PD = Price Deduction by the Dollar

$$Ds = \left[\frac{(\text{Specified Strength-Actual Strength})}{\text{Specified Strength}}\right]$$

IP = Invoice Price by the Cubic Yard

Q = Quantity of Defective Concrete by the Cubic Yard

The price deduction shall only apply to the invoiced delivery cost of the defective concrete mixture. The deduction shall not apply to incidental items associated with the bid items such as labor, reinforcing steel, etc. Supply the Engineer with a certified invoice from the producer for the defective concrete mixture. The certified invoice will be for the cost of the concrete mixture with taxes and fees delivered to the project.

Subsection 607.02.B, (pg. 579), 12-15-21; **Materials, Pipe Culverts, Cross Drains, Side Drains, & Storm Drains;** Remove 1st Sentence:

B. Pipe Culverts, Cross Drains, Side Drains, & Storm Drains

~~Where Pipe Culverts (Cross Drains & Median Drains) are specified, provide them in accordance with the following:~~

Subsection 607.07, (pg. 582), 12-15-21; **Joining Pipe:** Revise 5th paragraph.

HDPE, PP, SRTRP, and PVC pipe shall be joined in accordance with ASTM D3212 and meet the performance requirements for water-tight. Install joints so that the connection of pipe sections, for a continuous line, will be free from irregularities in the flow line.

Subsection 615.09, (pg. 624), 12-19-22; **Proportioning and Mixing of Concrete;** Revise 5th Paragraph:

Make concrete test specimens for Class P and Class P-SCC, in accordance with AASHTO R 100 and ASTM C1758 respectively, to determine the adequacy of the concrete design and the minimum time at which the stress may be applied to the concrete. Cure the test specimens used to determine the time at which stress may be applied in the same manner and under the same conditions as the bridge members. The initial curing of specimens to determine the design strength of the concrete shall be specified above with additional curing water, as provided in AASHTO R 100. The compressive strength of the concrete will be estimated using the Maturity Method in accordance with **604.15.D.** The frequency of sampling and testing will be in accordance with Departmental procedures.

Subsection 619.04.A, (pg. 652-653), 12-15-21; **Volumetric Continuous Mixers;** Revise No. 3 & Ticket List:

3. The volumetric mixing plant shall be operated and calibrated by a Volumetric Mixer Operator with a TDOT Concrete Field Testing Technician Certification or equivalent. In the presence of the Engineer, perform the calibration of gate settings according to the manufacturer's recommendations for the mix design to be used before starting work. The calibration procedure shall account for the moisture content of the aggregates. The yield shall be maintained within a tolerance of plus or minus 1% and verified using a minimum 2 cubic feet container every 50 cubic yards. Recalibrations will be necessary when indicated by the yield checks, and at any other times the Engineer deems necessary to ensure proper proportioning of the materials.

Each load of concrete produced by a volumetric continuous mixing plant shall be accompanied by a Concrete Delivery Ticket. The ticket shall include as a minimum the following:

a. Date
b. Contract number
c. County
d. Class of concrete
e. Concrete design number
f. Number of cubic yards
g. Load number
h. Truck number
i. Maximum water allowed by design
j. Total water added
k. Water-cementitious materials ratio
l. Time loaded
m. Time discharged
n. Signature of producer's Volumetric Mixer Operator

Subsection 619.04.A, (pg. 653), 12-19-22; **Volumetric Continuous Mixers;** Revise Ticket List:

Each load of concrete produced by a volumetric continuous mixing plant shall be accompanied by a Concrete Delivery Ticket. The ticket shall include as a minimum the following:

a. Date
b. Contract number
c. County
d. Class of concrete
e. Concrete design number
f. Number of cubic yards
g. Load number
h. Truck number
i. Maximum water allowed by design
j. Total water added
k. Water-cementitious materials ratio

l. Time discharged
m. Signature of producer's Volumetric Mixer Operator

Subsection 622.03.A, (pg. 665), 12-19-22; **Proportioning and Quality Assurance of Shotcrete, Proportioning;** Revise 3rd Paragraph:

Shotcrete shall meet the performance requirements specified in Table 622.03-1 and meet the requirements for cement replacement in **604.03.A.3**.

Subsection 623.02.C.1, (pg. 673), 12-15-21; **Modular Roadway Expansion Joints, Fabrication and Construction;** Revise No. 1:

1. Construct the expansion joint systems as shown on the shop drawings. Meet the tolerance requirements included in AASHTO specifications. Perform all welding according to AWS specifications and by certified welders only. Ensure that fabricators are certified under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator - Intermediate Bridge (IBR).

Subsection 623.03.C.2, (pg. 676, 677), 12-15-21; **Strip Seal Expansion Joints, Fabrication and Construction;** Revise No. 2:

2. Shop drawings shall also supply information regarding material specifications, geometry, a table of variable temperature and dimensions, and a bill of material. The maximum joint opening shall be 4 inches. Construct the expansion joint systems in accordance with the details shown on the shop drawings. Tolerance requirements shall be in accordance with AASHTO Specifications. Perform all welding in accordance with AWS specifications and by certified welders only. Ensure that fabricators are certified under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator - Intermediate Bridge (IBR).

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021
(Rev. 12-19-22)
(Rev. 12-26-24)

Supplemental Specifications – 700SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 702.02, (pg. 688), 12-19-22; **Materials, Revise 4th Paragraph:**

The Department will make compressive strength test specimens in accordance with AASHTO R 100.

Subsection 705.06, (pg. 697-698), 12-19-22; **Installation of Posts; Revise 1st, 2nd, Nos. 1,2,3, & 4 and 4th Paragraphs:**

Before beginning any excavation or driving any guardrail post, determine the location of all underground electrical, drainage, and utility lines in the vicinity, and conduct work to avoid damaging these facilities. Dig or drill holes to the depth shown on the Plans and/or the approved Shop Drawings and to a size that will allow proper setting of the posts and sufficient room for backfilling and tamping. Drive posts using approved methods and equipment, provided the posts are erected in the proper position and are free of distortion, burring, or other damage.

If solid rock is encountered while installing guardrail posts to the minimum depth required. The installation of guardrail posts shall meet requirements that are detailed in the Departments Standard Drawings or approved Shop Drawings for drilling post holes.

If solid rock is encountered when installing end terminals using tubes, install posts 1 and 2 to full depth or a minimum of 36 inches into the solid rock. Backfill the holes around the steel tube with the cutting spoils.

See approved shop drawings for additional information concerning post depth and hole size.

Backfill dug holes with selected earth or other suitable materials in layers not to exceed 4 inches in thickness. Thoroughly tamp each layer. After backfilling and tamping is complete, hold the posts or anchors securely in place.

Subsection 705.06, (pg. 698), 12-15-21; **Installation of Posts; Add new 7th Paragraph:**

When an underground structure or utility prevents proper post installation for a run of guardrail, posts may be omitted along the run of guardrail only as detailed in the Department's Standard Drawings. A post will not be omitted from any end terminal or transition. If the conditions noted for omitting posts cannot be used, then the use of a guardrail footing or weak post attachment to culvert may be used as detailed in the Department's Standard Drawings

Subsection 705.10, (pg. 700), 12-15-21; **Basis of Payment; Add new 7th Paragraph:**

When posts are omitted from a run of guardrail, payment shall be as noted in the Standard Drawings.

a. For 1 post being omitted, the Department will pay the contract unit price for W Beam Guardrail (Type 2) MASH TL-3.
b. For 2 or 3 posts being omitted, the Department will pay for the linear feet of nested W Beam rail as detailed in the Standard Drawings at a rate equal of 1.5 times the contract unit price for W Beam Guardrail (Type 2) MASH TL-3.
c. If a guardrail footing or attachment to culvert was used, the Department will pay for work as noted in the Standard Drawings.

Subsection 710.06, (pg. 723), 12-19-22; **Aggregate Underdrains (with Pipe); Revise 1st Paragraph:**

Excavate the trench to receive the pipe at the locations shown on the Plans or as directed by the Engineer. If the Plans do not show dimensions, construct the width of the trench to be not less than 12 inches. Make the trench deep enough to intercept the water-bearing strata and to allow installation of the pipe and cover material. Unless otherwise shown on the Plans, spread a 2-inch layer of aggregate on the bottom of the trench, compact it, and bring to a uniform grade.

Subsection 712.02, (pg. 731-732), 12-15-21; **Materials; Revise List:**

Aluminum..... 916.02
Paint..... 910.02
Cold Rolled Carbon Steel -16 gauge ..... ASTM A1008
Non-metallic Drums and Barricades .....QPL
Reflective Sheeting..... 916.06

Subsection 712.02.B, (pg. 732), 12-15-21; **Temporary Pavement Marking Material; Revise 1st Paragraph:**

Unless otherwise specified, the material for pavement marking shall be either temporary pavement marking tape listed on the Department's QPL, or reflectorized paint with raised reflective pavement markers placed as shown on the Plans

Subsection 712.02.E, (pg. 733), 12-15-21; **Portable Impact Attenuators; Revise Heading & 1st Paragraph:**

E. Temporary Work Zone Crash Cushions

Temporary work zone crash cushions shall be in accordance with the Plans and Specifications, meet the requirements for the appropriate test level, and meet the requirements of and be listed on the Department's QPL or Standard Drawings.

Subsection 712.04 & D, (pg. 734 & 737), 12-26-24**; General, Signs;** Revise 4th Paragraph, & **D;** 5th Paragraph:

During periods of non-use, remove warning signs and other devices from the work area, and cover or otherwise position them so they do not convey their message to the traveling public and do not present a safety hazard to drivers. If covered, maintain the covering material in a neat and workmanlike manner during its use. The method of covering the sign face shall not deface or damage the retroreflective sheeting of the sign. Plastic bags shall not be allowed to cover signs.

D. Signs

Cover all existing signs or portions of a sign(s) that are not applicable to the Traffic Control Plan so as not to be visible to traffic, or remove such sign(s) from the roadway when not in use. Signs shall be covered with an opaque, form fitting, tear resistant material that fully obscures the sign text and shall not deface or damage the retroreflective sheeting of the sign. Plastic bags shall not be allowed to cover signs.

Subsection 712.04.B, (pg. 735-736), 12-15-21; **THP Troopers and Uniformed Law Enforcement Officers; Revise 2nd Paragraph:**

When a THP Trooper is not available, the Contractor may provide a Uniformed Law Enforcement Officer if approved by the Engineer and the Regional Safety Coordinator or Regional Operations Office. All Uniformed Law Enforcement Officers shall provide a marked Federal, State, County, City, or Metropolitan government law enforcement vehicle equipped with blue lights and have the authority to write traffic tickets and make arrests within the project site. The Uniformed Law Enforcement Officer shall maintain a detailed written log of enforcement activities and shall submit the log to the Engineer for verification each month.

Subsection 712.06, (pg. 743), 12-15-21; **Temporary Marking; Revise Heading, Add No. 2, & Revise No. 1 & 3:**

712.06 Temporary Pavement Marking

Unless otherwise specified, install temporary pavement marking as follows:

1. Provide 4-inch wide pavement marking (line) for center, edge, lane and barrier lines as shown on the Plans for projects that will have traffic maintained overnight. For temporary pavement markings (line) on intermediate layers of pavement, use reflective tape, reflectorized paint, and raised pavement markers, or a combination thereof as shown on the Plans or as required by the Engineer, and install meeting **716, 910.02, 919.04**, or Department's QPL at the end of each day's work. Short, unmarked sections will not be allowed. Preserve established no-passing zones, if any, on the existing pavement; if no-passing zones have not previously been established, establish them before beginning the work. Mark two-lane, two-way highways with 10-foot long center lines applied on 40-foot centers and appropriate no-passing barrier lines.

2. When required, provide temporary pavement markings at intersections for temporary pavement markings on intermediate layers of pavement. The Department will require temporary intersection pavement markings to be reflectorized paint, or removable pavement marking meeting **716, 910.02, 919.04**, and or Department's QPL.

3. Where required on the completed permanent pavement surface, meet **716.03**.

Subsection 712.09, (pg. 744, 745), 12-15-21; **Method of Measurement; Revise No. 5, 7, 8 & Add 9:**

5. Warning Lights and Flashing Arrow Boards by the unit, Changeable Message Signs per each for the type designated. Payment will be based on the maximum number in place at one time.

7. Temporary Work Zone Crash Cushion based on the initial installation of each. No additional payment will be made for removal, moving, and reinstalling at other locations on the Project as directed by the Engineer. Payment will be based on the maximum number in place at one time.

8. Temporary pavement marking (line) for edge, center, lane and barrier lines will be measured as listed in the plans, complete in place and accepted, as Painted Pavement Marking (Line) regardless of whether the lines are painted, taped markings, or raised pavement markers, or a combination of the above as shown on the Plans or as required by the Engineer. Only the marked line will be measured for payment.

9. Temporary pavement markings at intersections will be measured as listed in the plans complete in place and accepted as Painted Pavement Marking (Description) or Removable Pavement Marking (Description)

Subsection 712.10, (pg. 746, 747), 12-15-21; **Basis of Payment; Revise Item List & Paragraphs 4, 5, 9, Remove Paragraph 8:**

Item	*Pay Unit*
Traffic Control	Lump Sum
Portable Barrier Rail	Linear Feet
Temporary Work Zone Crash Cushion	Each
Signs	Square Feet
Flexible Drums	Each
Temporary Barricades (Type)	Linear Feet
Removable Pavement Marking (Description)	Linear Feet
Changeable Message Sign Unit	Each
Arrow Board (Type C)	Each
Barrier Rail Delineator	Each
Temporary Flexible Tubular Delineator	Each

Payment for Temporary Work Zone Crash Cushion will be made at the contract price, complete in place, with total payment based on the maximum number in place at one time as specified in **712.09**.

Payment for Signs (Construction) is full compensation for providing sign panels with proper sheeting and legend, erecting on proper supports, furnishing all mounting hardware, covering when not in use, relocating, handling, and maintaining until Project completion. Vertical Panels will be paid as Signs (Construction).

Payment for Removable Pavement Marking items shall be full compensation for the installation, maintenance, and removal of the marking line when it is no longer required.

Subsection 714.02, (pg. 757-758); 12-26-24, **Materials**; Revise subsection:

Provide materials as specified in **917** and as follows:

Portland Cement Concrete, Class A..... **604**
Crushed Stone Grading D..... **903.05**
Steel Bar Reinforcement for Concrete Structures..... **907.01**
Welded Steel Wire Fabric..... **907.03**
Gray Iron Castings..... **908.07**
Inorganic Zinc Paint..... **910.03**
Cement Concrete Curing Materials..... **913**
Conduit ..... **917.05** or **917.07**

Within 30 days after the issuance of the work order, submit to the Engineer ~~four collated~~one digital set~~s~~ of the manufacturer's descriptive literature and technical data, fully describing the types of lighting equipment proposed for use. In the descriptive literature, identify the manufacturer and model, and include sufficient information for the Engineer to determine if the equipment or material meets the requirements of the Plans and these Specifications. Include with the~~se~~ set~~s~~ of submittal data a list of the materials submitted along with descriptive material for, but not limited to, the following items when applicable.

1. Complete photometric data of luminaires as published by the manufacturer with independent testing laboratory results.

~~2. Computer printouts showing illumination levels throughout each interchange area where high mast luminaires are to be installed.~~

2~~3~~. General details of light standards, breakaway bases, and bracket arms. For light standards ~~taller than~~with a mounting height from 30 feet to 50 feet, submit one set of design calculations and ~~six~~ one digital print~~s~~ of "Design" or "Shop" drawings to the Traffic Design Division ~~of Structures~~ for approval purposes. The Department will review these drawings at the earliest possible date and will return ~~two~~ digital prints marked "Approved for Fabrication," or "Returned for Revisions as Noted." Respond by taking appropriate action to ensure the earliest possible correction of these items so as not to delay the installation.

3~~4~~. Highmast tower details with a set of design calculations for each height including access hole, base, anchorage, head frame, and lowering device. Include specification references for materials and location, type, size, and extent of welds. In addition to the set of design calculations, submit ~~six~~one digital print~~s~~ of "Design" or "Shop" drawings for each highmast tower height to the Traffic Design Division ~~of Structures~~ for approval purposes~~,~~ in a manner similar to that specified in Item 2~~3~~ above for light standards ~~taller than~~with a mounting height from 30 feet to 50 feet.

4~~5~~. Dimension sheets and performance data on all related equipment.

The Engineer will retain one copy and forward one copy each to the local entity (city or county engineer) and the Traffic Design ~~Operations~~ Division for their review.

Also include with the submittal set~~s~~ detailed scale drawings of all non-standard or special equipment and of all proposed deviations from the Plans. Deviations from the Plans or Specifications require approval from the Traffic Design ~~Operations~~ Division. Include a letter requesting deviations or alternate materials in the submittal for Traffic Design ~~Operations~~ Division approval. Upon request, submit for approval sample articles of materials proposed for use. The Department will not be liable for any materials purchased, labor performed, or delay to the Work prior to such approval.

In addition to the above, include with each submittal a notarized letter certifying that all lighting system materials listed in the submittal conform to the Plans and Specifications. Also submit to the Engineer a statement from the Maintaining Agency that all lighting system materials listed in the submittal are acceptable to the Agency.

Subsection 714.03, (pg. 758); 12-26-24, **Codes**; Revise subsection:

Furnish material and perform all work in strict accordance with the latest revision of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the Illuminating Engineering Society (IES) publications, ANSI standards, and the codes, regulations, and rules prevailing in the area in which the Work is being performed, as applicable.

Subsection 714.05.A.1, (pg. 759-761); 12-26-24, **Underground Conduit, General**; Revise 1st, 4th, 5th, and 6th Paragraphs, Add new **1.c**:

Underground conduit shall ~~consist of~~be placed as: encased, ~~or~~ direct burial conduit, or by direction boring method. Install conduit in a trench excavated to the dimensions and lines specified.

Obstructions encountered when excavating trenches for underground conduit may require minor changes, such as in locations of conduit runs and pull boxes. Obtain the Engineer's approval before making such changes. Where possible, contact the utility companies to have clear distance required by the specific utility company's standards and specifications to keep electric conduits and pullboxes away from ~~provide a minimum of 12 inches between the finished lines of conduit runs and~~ utility facilities, such as gas lines, water mains, and other underground facilities not associated with the electrical system. Where the conduit run is adjacent to concrete walls, piers, footings, and similar structures, maintain a minimum of 4 inches of undisturbed earth or firmly compacted soil between the conduit and the adjacent concrete or, when the conduit is encased, between the encasement and the adjacent concrete.

Unless shown on the Plans, do not excavate trenches in existing pavement or surfaced shoulders to install conduit. If it is necessary to place a conduit under an existing pavement, install the conduit by ~~jacking~~directional boring ~~or~~ other approved means with galvanized rigid steel conduit or schedule 80 PVC conduit.

Keep ~~jacking and~~ drilling pits at least 10 feet from the edge of the paved shoulder or sidewalk unless otherwise directed by the Engineer. When the Plans specifically allow excavation of a trench through an existing pavement or surfaced shoulder, restore the pavement and/or surface and base to their original condition. Do not leave boring pits open for extended periods of time.

c. **Directional Boring Conduit**. To be used under existing: roads, sidewalks, and business drive.

Subsection 714.05.B, (pg. 762); 12-26-24, **Conduit On Structures**; Revise 1st, & Add New Last Paragraph:

Existing bridges i~~I~~nstall conduits, conduit fittings, hangers, expansion fittings, and accessories as shown on the Plans and, unless otherwise specified, in accordance with the following:…

Proposed bridges provide structural lighting item materials for the bridge designer to include in the proposed bridge superstructure and substructure when lighting is required.

Subsection 714.08.A.3, (pg. 766); 12-26-24, **Wood Poles**; Revise Paragraph:

3. **Wood Poles (For Utility Use Only).** Excavate for wood poles as specified for prestressed concrete butt base pole foundations in **714.08.A.2**. Dig or drill the holes to the depth shown on the Plans and in such diameter to allow satisfactory use of mechanical tamping equipment.

Subsection 714.10, A & B, (pg. 767-769); 12-26-24, **Luminaires, A. High Intensity Discharge (HID), B. Light Emitting Diode (LED)**; Revise 1st Paragraph, Remove **A.**, **B**; Revise 1st Paragraph & No. 3:

The Department only ~~U~~uses Light Emitting Diode (LED)~~the following~~ luminaires ~~types on the~~ for roads and bridges: ~~High Intensity Discharge (HID) which includes High Pressure Sodium (HPS) and Metal Halide (MH); Fluorescent and Induction lamps; and Light Emitting Diode (LED).~~

~~A. High Intensity Discharge (HID)~~

~~High Intensity Discharge (HID) luminaires shall meet IES standards from LM-51-00 to LM-35-02. The HID luminaire shall be covered by a one-year written warranty starting from the system acceptance date. All the other electrical and mechanical component parts of the HID shall be covered by a five-year written warranty starting from the system acceptance date. The signed warranty certificate shall be submitted prior to final payment.~~

~~**B.**~~ **Light Emitting Diode (LED)**

Light Emitting Diode (LED) luminaires shall be manufactured in accordance with ANSI C136.37-2011 (or recent version). All testing and data sheets for proposed LEDs shall be included in the submittal package and shall include, but not limited to, the following: Illuminating Engineering Society ~~of North America~~ (IES~~NA~~): LM-79-08, LM-80-08, RP-8-14, TM-3-95, and TM-15-07 (all should be up-to-date versions). In addition to these requirements, the LEDs shall meet the following requirements:

3. Optical Assembly. The LED optical assembly package shall have a minimum Ingress Protection rating of IP 66 according to ANSI/IEC 60529. The luminaire shall have a standardized refractor/reflector to meet the required optical distribution as required by the plans. The optical assembly shall utilize high brightness, long life, minimum 70 color rendering index (CRI), (3000 K-5700 K) color temperature ~~(+/- 300 K)~~ LEDs binned according to ANSI C78.377. Lenses shall be UV-stabilized acrylic or glass. Provisions for house-side shielding shall be provided when specified.

Subsection 714.14, (pg. 770-771); 12-26-24, **Control Center**; Revise subsection:

Furnish and install a service pole or poles of the design, type, size, and class, and at the locations shown on the Plans, for the electric connection use. Install the service pole(s) as specified in **714.08** and as shown on the Plans. Set the service pole(s) plumb.

Notify the power company, at least 30 days before connection, of the need to furnish power to operate the lighting system.

Unless otherwise specified, furnish and install all the control center equipment and electrical supply facilities. The electrical supply facilities shall include the necessary service conduit from the control cabinet to the ~~delivery point~~proposed light poles designated on the Plans.

Construct a concrete slab for all proposed light control centers, unless the utility company wants to place the proposed light control center on a pole, of the dimensions and thickness indicated, around the

service pole foundation. Construct the slab of Class A concrete meeting the requirements of **604**, and reinforce the slab, if specified, as shown on the Plans.

Construct a 6-foot chain-link fence and gate, if the utility company requests, of the size specified around the control center as shown on the Plans and as specified in **707.**

Subsection 714.20.F, (pg. 774); 12-26-24, **Luminaires**; Revise Paragraph:

The Department will measure Luminaires of the size, type, and design specified by the unit, per each., ~~regardless of their classifications (i.e. LED, HID).~~

Subsection 714.21.E, & **F,** (pg. 777-778); 12-26-24, **Light Standards & Luminaires**; Revise Paragraphs:

E. Light Standards

The Department will pay for Light Standards of the type specified at the contract unit price per each, complete in place. Such payment is full compensation for furnishing and installing the complete light standards, including the ~~foundation,~~ standard, bracket arm or arms, associated hardware and wiring, grounding materials, excavation, backfilling materials, and backfilling. The Department will measure foundations for typical light standard (30 feet to 50 feet) and high mast towers separately.

F. Luminaires

The Department will pay for Luminaires of the size and type specified at the contract unit price per each, ~~regardless of their classifications (i.e. LED, HID),~~ complete in place. Such payment is full compensation for furnishing and installing the complete luminaire, including the ballast(s) or driver(s), lamp(s), glare shields where required, and associated hardware and wiring.

Subsection 716.03.B, (pg. 790), 12-15-21; **Application; Revise No. 3 & Add No. 4:**

3. **Temporary Pavement Marking (Line).** When thermoplastic is used on the final pavement surface, the Contractor may use reflectorized paint for the center, edge, lane and barrier lines installed meeting **716.07** and **910** at the end of each day's work and then install the permanent pavement marking after the paving operation is completed. Short, unmarked sections are not allowed. The Department will not directly measure and pay for temporary markings for the final surface and will consider the costs thereof to be incidental to the item for the permanent thermoplastic pavement markings (line).

4. **Temporary Pavement Markings at Intersections**. When required, temporary pavement markings at intersections are to be installed with reflectorized paint meeting **716.07** and **910**. The Department will measure and pay as noted in **712.09** and **712.10,**

Subsection 716.07.A, (pg. 793), 12-15-21; **Application; Revise 11th Paragraph:**

When reflectorized paint is required for temporary or final marking, install the paint meeting **910.02** at the end of each day's work. Do not leave any short, unmarked sections.

Subsection 717.03, (pg. 799-800), 12-19-22; **Basis of Payment; Revise Subsection:**

The Department will pay for Mobilization on a lump sum basis.

The Department will make partial payments for Mobilization based on the amount bid for mobilization and the total original contract amount for all items of work. If the amount bid for the item of Mobilization exceeds 10% of the total amount bid for the Contract, the Department will pay that portion exceeding 10% on the last partial pay estimate. Payments will be made according to Table 717.03-1.

Table 717.03-1: Payment Schedule for Mobilization

Payment Estimate Number or Completion of Contract	Payment Amount whichever is least	Accumulated Payment whichever is least
Estimate # 1	25% Lump Sum Item or 2.5% Contract Price	25% Lump Sum Item or 2.5% Contract Price
5% of Contract (Excluding previous mobilization payments and stockpile payments per 109.09)	25% Lump Sum Item or 2.5% Contract Price	50% Lump Sum Item or 5.0% Contract Price
10% of Contract (Excluding previous mobilization payments and stockpile payments per 109.09)	25% Lump Sum Item or 2.5% Contract Price	75% Lump Sum Item or 7.5% Contract Price
50% of Contract (Including previous mobilization payments and stockpile payments per 109.09)	25% Lump Sum Item or 2.5% Contract Price	100% Lump Sum Item or 10.0% Contract Price
Last Partial Pay Estimate	Portion Exceeding 10%	Portion Exceeding 10%

If 50% or more of the total original contract amount is completed by the payment of Estimate #1, a payment of 75% of the price bid for Mobilization will be made on Estimate #1. The remainder of the price bid for Mobilization will be paid on the following estimate.

Subsection 722.06.E, (pg. 803), 12-19-22; **Interior Utility Services; Revise Subsection E:**

E. Telephone and Internet

Provide telephone service with voicemail and two incoming phone lines. Provide internet service with wifi and two data ports for wired connections.

Subsection 722.09, (pg. 805), 12-19-22; **Concrete Cylinder Storage; Revise 1st Paragraph:**

Provide a storage facility (shed/building) for temporary storage of concrete acceptance cylinders. The storage facility shall be of sufficient size and construction to protect the concrete cylinders from the elements and damage. Obtain the Engineer's approval of the storage facility location. Department personnel shall have access to the storage facility. Equip the storage facility with a concrete curing environment consisting of a box or water curing tank with a heating/circulating system of sufficient size to properly cure all acceptance cylinders before transferring for final storage and testing. Provide a temperature measuring device capable of recording the conditions inside the curing environment. The curing environment shall comply with AASHTO M 201, and proper curing of the cylinders shall be in accordance with AASHTO R 100. Temperature data for the curing environment shall be kept for the duration of the projects and made available to the Department upon request. The Department will not accept any concrete without the Engineers approval of the storage facility.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021
(Rev. 12-19-22)
(Rev. 1-30-23)
(Rev. 12-27-23)
(Rev. 8-26-24)
(Rev. 12-26-24)

Supplemental Specifications – 900SS
of the
Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 901.01, (pg. 900), 12-19-22; **Hydraulic Cement;** Revise List, 2nd, and 3rd Paragraphs:

Portland Cement.....AASHTO M 85
Blended Hydraulic Cement..... AASHTO M 240

The maximum allowable equivalent alkalis for Portland Cement is 0.60 % when used in roadways with aggregates meeting the requirements of **903.24**.

Use Type I, Type IL, Type IP, or Type IS cement unless otherwise specified. Do not mix different types or sources of cement.

Subsections Listed, (pg. varied), 12-19-22; **Hydraulic Cement 901.01;** Revise Following Subsections:

204.06.B, (pg. 156), **Revise Materials List:**

304.02, (pg. 230), **Revise Materials List:**

306.02, (pg. 238), **Revise Materials List:**

309.02, (pg. 252), **Revise Materials List:**

312.05, (pg. 266), **Revise 1st Paragraph first sentence:**

313.02, (pg. 270), **Revise Materials List:**

616.03, (pg. 635), **Revise Materials List:**

619.02, (pg. 650), **Revise Materials List:**

619.03, (pg. 651), **Revise Table 619.03-1:**

619.13, (pg. 657), **Revise 1st Paragraph first sentence:**

622.02, (pg. 664), **Revise Materials List:**

Subsection 903.01, (pg. 903), 12-26-24**; Fine Aggregate for Concrete;** Revise Table 903.01-2:

Table 903.01-2: Gradation Requirements for Fine Aggregate

Sieve Size	Total Percent Passing by Weight
3/8 inch	100
No. 4	95-100
No. 16	50-90
No. 50	5-35
No. 100	0-20
No. 200 (1)	0-3

(1) If the fine aggregate is manufactured from crushed stone and if material finer than the No. 200 sieve consists of the dust of fracture, essentially free from clay or shale, this limit may be increased to ~~10~~7%.

Subsection 903.03, (pg. 904-905), 12-19-22; **Coarse Aggregate for Concrete;** Revise 2nd,4th,5th,6th and 7th Paragraphs:

Coarse aggregate for hydraulic cement concrete to be used in the finished riding surfaces of roadways shall meet requirements of 903.24 unless otherwise specified. Coarse aggregate for bridge decks (except decks that will be overlaid with HFST or Asphalt Pavements during the same construction season) and overlays on interstates and four or more lane highways shall meet **903.24** unless otherwise specified.

Coarse aggregate in Portland cement concrete pavements for finished riding surfaces of travel lanes including mainline pavements and ramps shall consist of Size No. 467. Ensure that either the Size No. 4 or Size No. 67 fractions meet **903.24**.

Coarse aggregate in two-lift composite pavements shall consist of Size No. 467 in the lower lift, graded as specified in **903.22,** the coarse aggregate for the lower lift does not have to meet the requirements of **903.24**. Coarse aggregate in the upper lift shall be Size No. 57 or 67 graded as specified in **903.22** and shall meet **903.24** riding surface requirements.

The coarse aggregates for travel lanes and bridge decks shall be crushed and consist of stone, slag, gravel, quartzite, gneiss, or combination thereof. The absorption of plus 4 material shall not exceed 5% on any individual aggregate. Do not use uncrushed gravel, pea gravel, or any other uncrushed particles. Crushed gravel, if used, shall consist of siliceous washed particles after processing, of which at least 70% by count of the material retained on the No. 4 sieve contains a minimum of two fractured faces. One face shall be fractured for the approximate average diameter or thickness of the particle.

Subsection 903.03, (pg. 904), 12-26-24**; Coarse Aggregate for Concrete;** Revise 2nd Paragraph:

~~Coarse aggregate for hydraulic cement concrete to be used in the finished riding surfaces of roadways shall meet requirements of **903.24** unless otherwise specified.~~ Coarse aggregates for bridge decks, portland cement concrete pavements (including ramps), ~~(except decks that will be overlaid with HFST or Asphalt Pavements during the same construction season)~~ and overlays used for the finished riding surfaces ~~on interstates and four or more lane highways~~ shall meet requirements of **903.24**. ~~unless otherwise specified.~~

Subsection 903.06.C, (pg. 914), 8-26-24; **Combined Aggregate Grading;** Revise Table 903.06-4:

Table 903.06-4: Hot Plant Mix Leveling CourseMixture Design Range of Gradations

Sieve Size	Total Percent Passing, by Weight					
	Grading BM	**Grading BM2 (1)**	**Grading C**	**Grading CM**	**Grading CW**	**Grading CS**
1-1/4 inch	--	100	--	--	--	--
1 inch	100	--	--	--	--	--
3/4 inch	85-100	81-93	100	100	100	--
3/8 inch	59-79	57-73	70-90	75-100	75-100	100
No. 4	42-61	40-56	39-66	--	--	89-94
No. 8	29-47	28-43	23-47	35-57	43-67	53-77
No. 30	13-27	13-25	10-27	18-35	23-47	23-42
No. 50	7-20	9-19	8-15	--	--	--
No. 100	4-10	6-10	4-8	4-10	4-10	9-18
No. 200	0-6.5	2.5-6.5	2.5-6.5	2.5-6.5	2.5-6.5	6-13.5

(1) When using natural sand as the fine aggregate, limit it to a maximum amount of 20% by weight of the mineral aggregate.

Subsection 903.11.C.3, (pg. 920), 12-19-22; **Grading OGFC;** Remove 2nd Paragraph:

~~Recycled asphalt pavement (RAP) milled from Department or other State Highway Agency projects shall be assumed to contain 75% polish-resistant material.~~

Subsection 903.12.B, (pg. 921-922), 12-19-22; **Aggregate for Micro-Surface;** Revise 1st, 2nd Paragraphs, and Table 913.12-2:

The aggregate shall be crushed slag, crushed granite, or crushed stone (crushed stone as specified in **903.24**) meeting the gradation limits specified in Table 903.12-2 and the physical properties of ASTM D692, except the percent of fractured pieces shall be 100. The aggregate shall meet the quality requirements in **903.25**. The aggregate shall have a minimum sand equivalent, as determined in accordance with AASHTO T 176, of 65. Polish-resistant aggregates will not be required for leveling courses, provided they will be covered with riding surface mixtures. Provide a Type A laboratory as defined by **106.06** capable of verifying gradation at the location of stockpiled material.

If blending aggregates from more than one source, use automated proportioning and blending equipment which has individual bins for each aggregate source used to produce a uniform stockpile meeting the job mix formula gradation. Proportion and blending equipment shall be calibrated at the beginning of production. All aggregate sources shall be polish-resistant as specified in **903.24**.

Table 903.12-2: Gradation Limits for Aggregate for Micro-Surface Based on Wash Gradation

Sieve	Design Master Range (Total Percent Passing)	Mixture Control Tolerances
3/8 inch	100	
No. 4	70-98	±5.0
No. 8	45-70	±5.0
No. 16	28-50	±5.0
No. 30	19-34	±5.0
No. 50	12-25	±4.0
No. 100	7-18	±3.0
No. 200	4-15	±2.0

Subsection 903.24, (pg. 927), 12-26-24**; Aggregates for Riding Surfaces (Polish-Resistant Aggregates);** Revise Table 903.24-1:

Table 903.24-1: Quality Requirements for Type I, II, III, and IV Aggregate

Aggregate Property	Test Method	Type I (all roads)	Type II (all roads)	Type III (15,000 ADT max, excluding Interstates)	Type IV (5,000 ADT max)
Silica Dioxide Content, % min	ASTM C25	40%	30%	20%	10%
Calcium Carbonate Content, % max		32%	--	--	--
Acid Insoluble Residue, % min	ASTM D3042	50%	35%	25%	--
British Pendulum Number,(1)(2) min	AASHTO T 278 AASHTO T 279	30	30	25	22

(1) After 9 hours of accelerated polishing using the British Wheel in accordance with AASHTO T 279

(2) British Pendulum Number only required for limestone aggregates.

Subsection 904.03 (pg. 931-934), 12-15-21; **Emulsified Asphalt;** Revise Table 904.03-1(c):

Table 904.03-1(c): Test Requirements for Emulsified Asphalt

Practices	AASHTO Test Method	CRS-2P	RS-2	RS-1	CRS-1
Saybolt-Furol Viscosity @ 77 °F, seconds	T59	n/a	n/a	20-100	n/a
Saybolt-Furol Viscosity @ 122 °F, seconds	T59	100-400	75-400	n/a	20-100
Storage Stability Test, 24- h, %	T59	1 Max	1 Max	1 Max	1 Max
5-day Settlement, %	T59	n/a	n/a	n/a	n/a
Particle Charge	T59	Positive	n/a	n/a	Positive
Sieve Test, %	T59	0.1 Max	0.1 Max	0.1 Max	0.1 Max

Practices	AASHTO Test Method	CRS-2P	RS-2	RS-1	CRS-1
Residue by	T59	Evaporation	Distillation	Distillation	Distillation
Residue, %	T59	65 Min	63 Min	55 Min	60 Min
Demulsibility, %	T59	40 Min	60 Min	60 Min	40 Min
Distillate, %	T59	n/a	n/a	n/a	n/a
Oil Test, %	T59	n/a	n/a	n/a	3.0 Max
Stone Coating	T59	n/a	n/a	n/a	n/a
Float Test, seconds	T50	n/a	n/a	n/a	n/a
Penetration	T49	75-175	100-200	100-200	100-250
Elastic Recovery, % (1)	T301	50 Min	n/a	n/a	n/a
Ductility @ 77 °F, cm	T51	40 Min	40 Min	40 Min	40 Min
Ductility @ 40 °F, cm	T51	n/a	n/a	n/a	n/a
R&B Softening Point, °F	T53	125 Min	n/a	n/a	n/a
Original G*/sind @ 82 °C	T315	n/a	n/a	n/a	n/a

(1) Straight-sided mold, 20-cm elongation, 5min hold, 25 °C

Subsection 908.04.A & C, (pg. 947-949), 12-26-24**; High Strength Bolts, Specifications;** Revise A No. 1 and C No. 1 a & b, and C No. 3.a:

A.1 Bolts. ASTM F3125, Grade A325 and Grade A490 – High Strength Bolts for Structural Joints.

C.1.a Perform proof load tests, in accordance with ASTM F606 Method 1, at the minimum frequency of testing specified in ASTM F3125 Grade A325 paragraph 9.2.4.

C.1.b Perform wedge tests on full size bolts, in accordance with ASTM F606 paragraph 3.5, at the minimum frequency of testing specified in ASTM F3125 Grade A325 paragraph 9.2.4.

C.3.a Except as modified herein, perform the rotational-capacity test in accordance with the requirements of ASTM F3125 Grade A325.

Subsection 908.09, (pg. 955), 12-27-23; **Bronze Bearing Plates, Plain;** Revise Subsection**:**

Provide plates conforming to ASTM B22, Alloy UNS No. C90500, C91100, or C86300, or ASTM B100, Alloy UNS No. C51000.

Subsection 914.01, (pg. 977), 12-19-22; **Non-Reinforced Concrete Pipe;** Revise 2nd Paragraph:

Manufacture all non-reinforced concrete pipe to meet the Department's procedure for the Manufacture and Acceptance of Precast Concrete Products.

Subsection 916.06, (pg. 988), 12-15-21; **Reflective Sheeting;** Revise Subsection:

Provide reflective sheeting from the Department's QPL conforming to AASHTO M 268 and the supplementary requirements for fungus resistance of AASHTO M 268. The sheeting material shall have a precoated adhesive backing or a heat and pressure activated adhesive backing protected by a removable liner.

For all signs with a SILVER-WHITE and ORANGE background when used on temporary barricades and channelizing drums, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

For all permanent panel signs with a SILVER-WHITE, YELLOW, RED, GREEN, BROWN, or BLUE background, provide reflective sheeting that meets or exceeds AASHTO M 268, Type D.

For overhead permanent signs attached to sign structures which overhang travel lanes and are not illuminated with sign lighting, provide reflective sheeting that meets AASHTO M 268, Type D.

For all other sign types, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

For FLOURESCENT ORANGE background, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

Subsection 916.06, (pg. 988), 12-27-23; **Retroreflective Sheeting;** Revise 2nd and Add 3rd Paragraph:

For all signs with a SILVER-WHITE and ORANGE background when used on temporary barricades, provide retroreflective sheeting that meets or exceeds AASHTO M 268, Type B.

For all sheeting with a SILVER-WHITE and FLUORESCENT ORANGE background when used on channelizing drums, provide retroreflective sheeting that meets or exceeds AASHTO M 268, Type B. The SILVER-WHITE material shall be of the same manufacturer as the FLUORESCENT ORANGE material.

Subsection 916.07, (pg. 988,989), 12-15-21; **Legends, Borders, and Accessories;** Revise Subsection:

Provide letters, numerals, symbols, borders, and route markers conforming to the MUTCD.

A. Type "A" Class I (Demountable)

Provide silver-white letters, numerals, symbols, borders, and route markers of a pre-coated pressure sensitive or a tack-free heat-activated adhesive reflective sheeting permanently adhered to the sign panel.

For all permanent panel signs, provide reflective sheeting that meets AASHTO M 268, Type D.

Mechanically apply the reflective sheeting to the properly prepared sign panel with the equipment and in a manner prescribed by the sheeting manufacturer. Letters, numerals, symbols, borders, and route markers shall be 0.032-inch-thick aluminum sheet of 3003 H14 Alloy or approved composite material. Properly degrease and etch aluminum, or treat with a light, tight, amorphous chromate type coating.

Supply each letter, numeral, symbol, and route marker with mounting holes, and secure to the sign surface with corrosion-resistant screws, bolts, or rivets.

B. Type "A" Class 2 Cut-Out (Direct Applied Reflective Sheeting Copy)

Provide silver-white cut-out letters, numerals, symbols, borders, and route markers of a pre-coated pressure sensitive or a tack-free heat-activated adhesive reflective sheeting.

For all permanent panel signs, provide reflective sheeting that meets AASHTO M 268, Type D.

For all other sign types, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

Subsections Listed, (pg. varies), 12-19-22; **Replace Reflective with Retroreflective 916.06;** Revise Following Subsections:

916.05.H, (pg. 986), **Revise 2nd Paragraph:**

916.05.H.3, (pg. 986), **Revise 1st Paragraph:**

916.05.I, .1, .2, (pg. 987), **Revise Heading, 1st, 2nd Paragraphs:**

916.06, (pg. 988), **Revise Heading, 1st, 2nd, 3rd, 4th, 5th, 6th Paragraphs:**

916.07.A, (pg. 989), **Revise 1st and 2nd Paragraphs:**

916.07.B, (pg. 989), **Revise 1st, 2nd, 3rd Paragraphs:**

916.08, (pg. 989-999), **Revise 1st, 2nd, 3rd, 4th Paragraphs:**

919.04, (pg. 1012), **Revise Heading, 1st Paragraph, List:**

919.05.A, .B, (pg. 1012-1013), **Revise Heading, 1st Paragraphs:**

712.02, (pg. 732), **Revise Materials List:**

712.02.B, .G, (pg. 732-733), **Revise 1st Paragraphs:**

712.04, (pg. 734), **Revise 2nd Paragraph:**

712.04.H.2.a.(2), .2.e, (pg. 740-741), **Revise 1st Paragraphs:**

712.06.1, .2, (pg. 743), **Revise 1st Paragraphs:**

713.04.A, (pg. 749), **Revise 1st Paragraph:**

713.04.F, (pg. 753), **Revise 3rd, 4th, 5th Paragraphs:**

713.06.3, (pg. 754), **Revise 1st Paragraph:**

716.01, (pg. 784), **Revise 1st Paragraph:**

716.02, (pg. 784), **Revise Materials List:**

716.03.B.2.b, (pg. 789), **Revise 8th Paragraph:**

716.03.B.3, .4, (pg. 790), **Revise 1st Paragraph:**

716.04, (pg. 790-791), **Revise Heading, 7th Paragraph:**

716.05, (pg. 791-792), **Revise Heading, 1st Paragraph:**

716.06, (pg. 792), **Revise 2nd Paragraph:**

716.07.A, (pg. 795), **Revise 11th Paragraph:**

716.08, (pg. 797), **Revise Last Paragraph:**

716.08.G, (pg. 797), **Revise Heading:**

910.02.C.2.e, (pg. 969), **Revise Heading:**

Revise Index (pg. 1053 & 1056), **Revise:** Reflective Pavement Markers, Reflective Sheeting, & Snowplowable Reflective Pavement Markers.

Subsection 918.01.B & D, (pg. 1003, 1004), 1-30-23; **Grass Seed, Seed Groups;**
Revise Tables 918.01-1, 2, 3, & 6:

Table 918.01-1: Group A (February 1-July 1)

Kind of Seed	Quantity, Percent by Weight
Kentucky 31 Fescue	80
White Clover	15
Annual Rye Grass	5

Table 918.01-2: Group B (June 1-August 15)

Kind of Seed	Quantity, Percent by Weight
Kentucky 31 Fescue	75
White Clover	15
German Millet	10

Table 918.01-3: Group B1 (April 15 - August 15)

Kind of Seed	Quantity, Percent by Weight
Bermudagrass (hulled)	70
White Clover	30

Table 918.01-6: Temporary Seeding

Seed Group (Season)	Kind of Seed	Percent by Weight
Group D (January 1 – May 1)	Annual Rye Grass	33-1/3%
	White Clover	33-1/3%
	Spring Oats	33-1/3%
Group E (May 1 – July 15)	Sorghum-Sudan Crosses (1)	100%
	or	
	German Millet (2)	100%
Group F July 15 – January 1	Cereal Rye	66-2/3%
	Annual Rye Grass	33-1/3%

(1) Dekalb Sudan SX11, Lindsey 77F, TN Farmer's Co-op GHS-1 or GHS-2A.

(2) German Millet, GaHi-1

Subsection 918.01.D, (pg. 1004), 12-26-24**; Temporary Seed;** Revise Table 918.01-6:

Table 918.01-6: Temporary Seeding

Seed Group (Season)	Kind of Seed	Percent by Weight
Group D (January 1 – May 1)	Annual Rye Grass	33-1/3%
	White Clover	33-1/3%
	Spring Oats	33-1/3%
Group E (May 1 – July 15)	Sorghum-Sudan Crosses [1]	100%
	or	
	German Millet [2]	100%
Group F July 15 – January 1	Cereal Rye	66-2/3%
	Annual Rye Grass	33-1/3%

[1] Dekalb Sudan SX11, Lindsey 77F~~, TN Farmer's Co-op GHS-1 or GHS-2A.~~

[2] German Millet, GaHi-1

Subsection 921.09, (pg. 1022), 12-19-22; **Grout; Revise Subsection:**

Submit grout mix designs to the Department's Materials and Tests. Grout designs shall use hydraulic cement meeting the requirements of **901.01** or an appropriate alternative from the Department's Qualified Products List. Use sand conforming to the requirements of **903.02**. Use water that has been approved by the Engineer.

When non-shrinking or non-shrinking fast-setting grout is specified, either formulate it by incorporating an admixture, or use a pre-mixed grout. Mix and use the grout in accordance with the manufacturer's recommendations. Grouts will be reviewed as follows:

A. Non-Structural Grout

Grout specified without a strength requirement will be non-structural and shall have its design submitted per Departmental procedures. Mix grout in small quantities as needed, and do not retemper or use grout after it has begun to set. Unless otherwise specified or directed, provide grout consisting of one part Portland cement and two parts sand by volume, mixed with sufficient water to form a grout of proper consistency.

B. Structural Grout

Grout specified with a strength requirement will be structural grout and shall have its design submitted per Departmental procedures.

APPENDIX B

SPECIAL PROVISIONS

Title	SP#
Employing and Contracting with Illegal Immigrants	102I
Specifications for Road and Bridge Construction	102LC
Buy America Requirements	106A
Prohibition of Certain Telecommunications and Video Surveillance Services or Equipment	106B
Air Quality for Mowing	107AQ
Water Quality and Storm Water Permits	107FP
Project Completion and Liquidated Damages	108B
Liquidated Damages for CEI Administered Contracts	108C
Payment Adjustment for Fuel	109A
Price Adjustment for Bituminous Material	109B
Measurement and Payment	109G
Mowing Payment Adjustment for Fuel	109MA
Scaling and Trimming	203E
Compaction Grouting	204CG
Embankment (Compacted in Place)	205A
Bituminous Plant Mix Roadway Density	407DEN
Intelligent Compaction (IC) for Hot Mix Asphalt (HMA)	407IC
Asphalt Pavement Safety Edge	407SE
Section 411 – Asphalt Concrete Surface (Hot Mix)	411C
Hot Applied Fiber Reinforced Polymer Patching Material	502FRP
Grinding Concrete Pavement	503

Title	SP#
Dowel Bar Retrofittings	503DB
Rubblizing Concrete Pavement	505
Repair Of Bridge Deck Cracks	604CR
Retaining Walls	624
Drilled Shaft Specs	625
Prefabricated Vertical Drains	627PVD
Highway Signs, Luminaries & Traffic Signals	700SIG
Traffic Control Supervisor	712B
Digital Speed Limit Sign Assembly	712DSL
Traffic Queue Protection	712PTQ
Speed Feedback Sign Assembly	712SFS
Contrast Pavement Markings	716CPM
Wet Reflective Pavement Marking Line	716WR
Roadway Sweeping	719
Removal and Disposal of Litter	719A
ITS Special Provision	725
Temporary Traffic Control (Signalization)	730A
Traffic Signals	730R
Right-of-Way Mowing	806
Equal Employment Opportunity	1230
Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246)	1232
Certification Regarding Debarment, Suspension, And Other Responsibility Matters Primary And Lower Tier Covered Transactions	1275

Title	SP#
Labor (State Projects Only)	1280
Non-Discrimination in Employment	1290
Tennessee Department of Transportation Minimum Wage Scales for Federal-Aid Construction and State Funded Construction	1320
State Wage Rates	AA-ST RATES

S T A T E **OF** **T E N N E S S E E**
Rev: October 10, 2016 January 1, 2021

SPECIAL PROVISION

REGARDING

EMPLOYING AND CONTRACTING WITH ILLEGAL IMMIGRANTS

The State shall endeavor to do business only with those contractors and subcontractors that are in compliance with the Federal Immigration and Nationality Act. This policy shall apply to all State Contractors including subcontractors. This policy statement is issued to establish implementation guidance to procuring state agencies and contractors reflecting the requirements of *Tennessee Code Annotated* §12-3-309 regarding the employment of illegal immigrants in the performance of state contracts.

1. The Contractor hereby attests, certifies, warrants, and assures that the Contractor shall not knowingly utilize the services of an illegal immigrant in the performance of this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant in the performance of this Contract. The Contractor shall reaffirm this attestation, in writing, by submitting to the State a completed and signed copy of the "Attestation form" provided by the Department, semi-annually during the period of this Contract.

2. Prior to the use of any subcontractor in the performance of this Contract, and semi-annually thereafter, during the period of this Contract, the Contractor shall obtain and retain a current, written attestation that the subcontractor shall not knowingly utilize the services of an illegal immigrant to perform work relative to this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant to perform work relative to this Contract.

3. The Contractor shall maintain records for its employees used in the performance of this Contract. Said records shall include a completed federal Department of Homeland Security Form I-9, *Employment Eligibility Verification*, for each employee and shall be subject to review and random inspection at any reasonable time upon reasonable notice by the State.

The Contractor understands and agrees that failure to comply with this section will be subject to the sanctions of *Tennessee Code Annotated* § 12-3-309 for acts or omissions occurring after January 1, 2007. This law requires the Chief Procurement Officer, Department of General Services, to prohibit a contractor from contracting with, or submitting an offer, proposal, or bid to contract with the State of Tennessee to supply goods or services for a period of one year after a

contractor is discovered to have knowingly used the services of illegal immigrants during the performance of this contract.

For the Purposes of this policy, “illegal immigrant” shall be defined as a non-citizen who has entered the United State of America without federal government permission or stayed in this country beyond the period allowed by a federal government-issued visa authorizing the non-citizen to enter the country for specific purposes and a particular time period.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-20) January 1, 2021

SPECIAL PROVISION

REGARDING

TENNESSEE DEPARTMENT OF TRANSPORTATION STANDARD

SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

Description

Any and all references concerning the January 1, 2015 Standard Specifications for Road and Bridge Construction shall be interpreted as the January 1, 2021 Standard Specifications for Road and Bridge Construction.

S T A T E **O F** **T E N N E S S E E**

September 10, 2020 January 1, 2021

SPECIAL PROVISION

REGARDING

PROHIBITION ON CERTAIN TELECOMMUNICATION AND VIDEO

SURVEILLANCE SERVICES OR EQUIPMENT

Installation of telecommunication and video surveillance equipment, services or systems shall contain no components from providers as listed in Title 2 Code of Federal Regulations (CFR) Part 200.216.

The prohibition on certain telecommunication and video surveillance services or equipment regulation in Title 2 CFR 200.216 shall apply to this contract. Take all necessary and reasonable steps in accordance with Title 2 CFR 200.216 to ensure that no prohibited telecommunication and video surveillance services or equipment are included in any of the work in this contract. As defined in Title 2 CFR 200.471, the regulation provides clarity that the telecommunications and video surveillance costs associated with Title 2 CFR 200.216 are unallowable for services and equipment from the providers.

It is prohibited from installing equipment, services, or systems that use covered telecommunications equipment or services from providers described in section 889 of the National Defense Authorization Act for Fiscal Year 2019 (NDAA 2019).

As described in section 889 of the NDAA 2019, “covered telecommunications equipment or services” means:

- Telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities);
- Video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities);
- Telecommunications or video surveillance services provided by such entities or using such equipment; or
- Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country. The term “covered foreign country” means the People’s Republic of China.

Any prohibited equipment installed must be removed and replaced at the contactor’s expense with acceptable equipment.

S T A T E **O F** **T E N N E S S E E**

(Rev 9-3-13) January 1, 2021

SPECIAL PROVISION

REGARDING

AIR QUALITY FOR MOWING

Description. The contractor will be required, absent an immediate safety issue determined by the Engineer, to cease mowing operations in the non-attainment counties listed below on Air Quality Action or Alert days within those counties. The appropriate TDOT representative will direct the contractor to suspend mowing operations upon the notification that an Action/Alert day forecast has been issued. Forecasts are issued by AIRNOW the day before the Action/Alert Day in the afternoons at the following web address:

http://airnow.gov/index.cfm?action=airnow.fcsummary&stateid=50

This will be the only authority for notifications used by TDOT. TDOT notification to the contractor will be made by the Close of Business (COB) the day prior to the Action/Alert Day.

The cessation of mowing operations will apply to any Action/Alert day forecast notification. The cessation of mowing operations shall remain in place until the Action/Alert day forecast is terminated. On these days, the contractor may mow outside of the non-attainment counties if the contract includes mowing in additional counties not listed below. Also, no trimming operations with weed trimmers will be allowed during these Action/Alert days. All working days that the contractor must cease mowing operations shall be added to the total number of days the contractor has to complete the disrupted mowing cycle.

Basis of Payment. All costs associated with the cessation of work caused by an Air Quality Action or Alert days will be compensated, on a per day basis, at the unit price bid for Item Number 717-10.01, INVOLUNTARY WORK SUSPENSION.

Payment will be made only when the contractor is actively mowing in one of the listed counties when an Air Quality Action/Alert day in that county has been declared and he is directed to cease mowing operations.

No payment will be made for any Air Quality Action/Alert day that occurs after mowing operations have been completed for a cycle. In addition, no payment will be made if after mobilizing for a mowing cycle an Air Quality Action/Alert day is declared before the contractor commences mowing operations.

Non-Attainment Area **Counties**
CHATTANOOGA REGION
Hamilton
CLARKSVILLE REGION
Montgomery
NASHVILLE REGION
Davidson
Rutherford
Sumner
Wilson
Williamson
KNOXVILLE REGION
Anderson
Jefferson
Knox
Loudon
Roane (only areas around TVA Plant)
MEMPHIS REGION
Shelby
GREAT SMOKY MTNS.
Blount
Cocke (only areas within Park)
Sevier

S T A T E **O F** **T E N N E S S E E**

(Rev. 2-8-21) January 1, 2021
(Rev. 12-9-24)

SPECIAL PROVISION

REGARDING

WATER QUALITY AND STORM WATER PERMITS

Description

This work consists of the conditions that apply to all construction activities on the project pursuant to the following:

1. Section 404 of the Federal Clean Water Act (33 U.S.C. §1344), and all implementing regulations, including without limitation regulations of the U.S. Army Corps of Engineers governing permits for discharges of dredged or fill material into waters of the United States in 33 CFR Part 323; and
2. Section 408 authorized under Section 14 of the Rivers and Harbors Act of 1899 (33 U.S.C.§408), and all implementing regulations, including without limitation regulations of the U.S. Army Corps of Engineers governing changes to USACE Civil Works projects; and
3. The Tennessee Water Quality Control Act (T.C.A. §69-3-101, et seq.) and all implementing regulations, including without limitation the Rules of the Tennessee Department of Environment and Conservation governing NPDES permits in Chapter 400-40-10, and Aquatic Resource Alteration permits in Chapter 400-40-7; and
4. Section 26a of the TVA Act of 1933 as amended (49 Stat. 1079, 16 U. S. C. sec. 831y1.) and all implementing regulations, including without limitation the regulations of the Tennessee Valley Authority governing construction in the Tennessee River System in 18 C.F.R., Part 1304; and
5. The Tennessee Wildlife Resources Agency Reelfoot Lake Watershed Management permit program (T.C.A. section 70-5-1,), and all implementing regulations, including without limitation regulations authorizing any activity, practice, or project which has or is likely to have the effect of diverting surface or subsurface water from the Lake or have the effect of draining or otherwise removing water from Reelfoot Lake; and
6. Coast Guard Bridge Permit (USCG) (Section 9 of the Rivers and Harbors Appropriation Act of 1899) and all implementing regulations, including but not without limitation for projects which impact streams deemed navigable by the U.S. Coast Guard.

Responsibility

Assume all responsibilities of the permittee as indicated in the permit that relates to protection of the "waters of the United States" and/or "waters of the State of Tennessee."

Obtain any additional permits required by the Contractor for off-site waste and/or borrow areas and associated off project work areas.

Sign the Notice of Intent (NOI) form, provided by the Department, indicating acceptance of the stipulations contained in the permit. Submit the signed NOI to the TDOT HQ Construction Division by email within 10 calendar days after submittal of the contract proposal or the Department may at its discretion cancel the award with the Contractor forfeiting the bid bond.

Implement the provisions of the Water Quality (including, but not limited to, TDEC ARAP, USACE 404, TVA Section 26a, Coast Guard, TWRA) and Storm Water [including, but not limited to, National Pollution Discharge Elimination System (NPDES), Statewide Stormwater Management Plan (SSWMP)] Permits and requirements that pertain to construction activities.

Review of the permit provisions, including NPDES Permit provisions the site specific SWPPP, the contract plans, Standard Specifications and contract Special Provisions and find the permit requirements and erosion prevention and sediment control (EPSC) procedures to be reasonable, workable, and binding.

The Contractor shall not be released from the project site responsibilities under the NPDES permit provisions until the Notice of Termination (NOT) is submitted to TDEC by the TDOT Regional Operations Engineer. The NOT is a certification that the construction project is permanently stabilized, and all construction related discharges have ceased. This means that the use of EPSC measures to alleviate concerns of surface erosion and transport of sediment to surface water conveyances or to waters of the state is no longer necessary. Furthermore, it means that permanent controls, hard surfaces and/or vegetation, used on the project are deemed adequate to prevent erosion and sediment transport and no other potential sources of construction-related pollution are on the project.

The Contractor shall not be released from any warranty provided for EPSC plantings, including sod and trees. If the entire project is complete as outlined in **105.15** of the Standard Specifications, the tree plantings shall still be required to meet the requirements of **802** Standard Specifications**.**

NPDES Permit Required Action

Accompany the TDOT EPSC inspector or TDOT consultant on all EPSC inspections of the entire construction project including permitted locations and potentially impacted streams and attend all QA/QC Project Assessments.

EPSC Inspections shall be conducted as required in the most current TN Construction General Permit. EPSC inspections shall be performed on the schedule established in the TN Construction General Permit until the site is permanently stabilized to determine if the permit requirements are being met. Where sites or portion(s) of the construction project have been temporarily stabilized,

the inspections only have to be conducted once per month until construction activity resumes. Written notification of the intent to change the inspection frequency and the justification for such request must be submitted to the TDOT Field Office and the TDEC Central Office before proceeding.

A representative who holds a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I"* certification shall accompany the TDOT EPSC inspector on all required EPSC inspections. The project supervisor(s) shall also hold a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I"* certification. Proof of required personnel training for the individual(s) shall be provided to the TDOT Field Office prior to beginning of construction.

The TDOT EPSC inspector shall document all deficiencies on the required current TDOT EPSC Inspection Report form. Sign the TDOT EPSC Inspection Report form and any supporting documentation indicating that there is agreement with the report, recommendations and repair schedule as stated in the documentation.

Make necessary maintenance and repairs relative to deficiencies in these permit conditions or requirements within 24 hours after an inspection identifies the maintenance or repair need, and/or as directed by the Department, unless conditions make a particular activity impracticable. Any such conditions that make immediate repairs impracticable shall be documented on the inspection report and provided to the TDOT Field Office and be accompanied by an expected repair schedule based on forecasted weather conditions.

Review the site specific SWPPP that will be made available prior to or at the pre-construction conference for any additional EPSC requirements. Sign and submit two copies of the SWPPP signature page provided by the Department in the site specific SWPPP. Submit for review and approval any changes/revisions to the SWPPP to prevent erosion and sediment transport at any time after contract execution. Rejection of any submittals by the Department does not relieve the liability for appropriate Best Management Practices (BMPs).

If at any time during this contract, the requirements for the Water Quality Permits and/or the Storm Water Permits for Construction Related Activities are changed/revised/updated, the Contractor shall be notified in writing by the Department of such requirements. Comply with the new requirements within 30 days of the Department notification.

If at any time that sedimentation is occurring or has occurred in streams impacted by the project, immediately notify the TDOT Field Office to evaluate the EPSC measures employed. A determination of the cause for sedimentation will be made by the Department. Immediately repair or replace defective EPSC measures and install, as applicable, additional or other EPSC measures with the goal of eliminating future sedimentation. Once a remediation plan is provided by the Department, within 24 hours after notification, begin the remediation as required. Based on the cause of sedimentation, the Department will determine if the cost of remediation will be performed at the Contractor's expense.

Failure to Comply

In the event a Notice of Noncompliance, Notice of Violation, Notice of Deficiency, or Order is issued by any State or Federal Agency on this project, any required corrective action and all fines will be the sole responsibility of the Contractor as outlined in **107.01** of the Standard Specifications.

Failure to comply or take immediate corrective actions required within 24 hours, unless documented conditions make a particular maintenance or repair activity impracticable immediately, shall be reason for the Department to suspend all other work on the Project, except EPSC and traffic control. The Department will apply non-refundable deductions of monies from the Contract per calendar day from monies due to the Contractor for any EPSC work on the Project. This deduction can be made for each location, as determined by the Department, for each calendar day that the deficiency is allowed to remain and charged as item description *"Failure to Comply with Permit Deduction"*. A deduction shall be made from monies due the Contractor, not as a penalty, but as liquidated damages, as indicated in **108.09** of the Standard Specifications.

If the necessary corrections/adjustments are not done in a timely manner as required, the Department will implement the provisions of **209.07** and **109.08** of the Standard Specifications that provides for the Department making repairs and recovering the costs thereof from the Contractor.

The Department will not participate in any payment or reimbursement for fines and will not authorize time extensions due to delays in project progress for work stoppage, to remedy the violations stated within the NOV, as stated in **105.01** of the Standard Specifications**.**

Spill Prevention, Control, and Countermeasure

To help prevent the discharge of oil into navigable waters, the U.S. Environmental Protection Agency (EPA) developed the Spill Prevention, Control, and Countermeasure (SPCC) Program. The SPCC Program is under the authority of Section 311 (j)(1)(C) of the Federal Water Pollution Control Act (Clean Water Act) in 1974. The rule may be found at Title 40, Code of Federal Regulations (CFR), Part 112. Additional information regarding the preparation and requirements of a SPCC Plan can be found at: Overview of the Spill Prevention, Control, and Countermeasure (SPCC) Regulation | US EPA

If applicable based upon the total aggregate capacity of aboveground oil storage, develop a site specific SPCC Plan per EPA requirements. This plan shall be provided to the TDOT Field Office as part of the required submittals during the project Pre-Construction Meeting or at which time the conditions on the project site meet the applicable criteria. If applicable, obtain any other necessary local, state, and federal permits as applicable. The SPCC Plan and/or permits shall be kept on-site.

Comply with all aspects of the site specific SPCC Plan including but not limited to performing any required inspections as directed by the SPCC Plan as well as implementing material and spill management practices per the project's SWPPP. In the event, where a release containing a hazardous substance in an amount equal to, or in excess of a reportable quantity established under either 40 CFR 117 or 40 CFR 302 occurs during a 24-hour period, immediately notify the TDOT Field Office.

S T A T E **O F** **T E N N E S S E E**

Rev. 8/20/18 January 1, 2021

SPECIAL PROVISION

REGARDING

POTENTIALLY ACID PRODUCING MATERIALS

DESCRIPTION: This work shall consist of locating, sampling, testing, and disposing of potentially acid producing materials as defined in the plans documents and in accordance with the Standard Specifications except as modified herein, or as directed by the Engineer.

Potentially acid producing materials are those rock, rock-like materials, and soil (including all rock types, minerals, ore deposits, coal, etc.) that contain sufficient amounts of certain minerals that could produce drainage at pH levels sufficiently less than background pH when exposed to atmospheric conditions and weathering processes. These minerals are typically pyrite, marcasite and chalcopyrite. Potentially acid producing materials are often referred to generally as "pyritic materials" or "pyrite" regardless of the actual mineral content of the material.

If acid producing materials exist in the excavation, proper monitoring, testing, and disposition of the material shall be required. If necessary, a water sampling plan will be prepared and water quality monitoring will be conducted throughout construction by a TDOT employed consultant at the direction of the Engineer and the TDOT Environmental Division. Detention / retention ponds, sampling, testing and treatment of any effluent for the disposal site shall be shown in the environmental documents and on the environmental plans sheets.

The following procedure describes the process of sampling and evaluating potentially acid producing materials in highway construction projects. The intent is to locate potentially acid producing material within a given cut interval before excavation of the material proceeds. When potentially acid producing material is encountered, it shall be disposed of under the direction of the Engineer and in accordance with contract plans and documents.

Acid Producing Material Sampling and Evaluating Procedure: The following sampling and evaluating procedures shall be followed for either rock or soil materials.

Rock: Prior to excavating any potentially acid producing rock materials as determined by the Engineer, samples of cuttings shall be obtained by the Engineer during the drilling operation and then tested using the acid/base accounting method. A minimum of three holes for each lot is to be sampled (additional holes may be sampled when deemed necessary by the Engineer). A lot shall consist of a volume equal to 5,000 square feet of surface area and the full depth of the drill hole. Holes to be sampled will be selected to obtain optimum coverage of the rock material.

A sample shall consist of approximately one cup of powdered rock material taken from the drill cuttings. Samples are to be taken at five foot intervals for the full depth of the drill hole.

Upon completion of the sampling procedure on three drill holes or more, the samples will be analyzed by the Engineer through the TDOT Geotechnical Section for potential acid production using the acid/base accounting method. Each sample will be analyzed for potential acid, potential alkalinity, per cent pyritic sulphur, net acid/base potential, and paste pH. Test results will be available in approximately 48 hours after laboratory receipt of the sample.

Soil: Prior to excavating any potentially acid producing soil material as determined by the Engineer, samples of soil shall be obtained and submitted for testing using the acid/base accounting method. The samples shall be obtained under the supervision of the Engineer by excavation of test pits conducted by the contractor to a depth of 5 feet or to the limit of excavation grade whichever is less. The Engineer will obtain the selected soil sample from the test pit, which shall consist of approximately 5 pounds. A test pit and sample shall be accomplished for every 5000 square feet of surface area of the proposed cut area. The sampling procedure shall be conducted for each 5 foot thickness of proposed cut.

Upon completion of the sampling procedure for each proposed cut section, the samples will be analyzed by the Engineer through the TDOT Geotechnical Section for potential acid production using the acid/base accounting method. Each sample will be analyzed for potential acid, potential alkalinity, per cent pyritic sulphur, net acid/base potential, and base pH. Test results will be available in approximately 48 hours after laboratory receipt of the sample.

Potentially acid producing material shall not be excavated prior to completion of the testing procedure. Any delays, idle equipment, etc. caused by the testing program will not form a basis for a claim for additional working time and/or compensation. Once the test results are known, the Engineer will make the final decision on the disposition of any material found to have acid drainage potential. Where the potentially acid producing material is geologically distinct from the surrounding materials and all of the excavated material shall be encapsulated, the Engineer, with the consultation and concurrence of the TDOT Geotechnical Engineering Section, may waive or adjust the requirements for testing of potentially acid producing rock being placed in an encapsulation site. If a portion of this geologically distinct layer has unknown pyritic content, is to be blended, or is to be placed as common fill, the testing requirements shall stand.

Treatment and Disposition of Acid Producing Materials: Potentially acid producing materials shall be treated and disposed of in accordance with the plans. These treatments may include full encapsulation, partial encapsulation, blending or hauling to an offsite landfill.

General: Disposal sites on sloping terrain shall be benched to provide stability for the embankment at no additional compensation.

When potentially acid producing material is encountered during construction, it must be separated to the extent feasible using normal excavation procedures and transported as soon as possible to the selected disposal site. At the disposal site the material shall be placed and treated as specified in the plans. Any questionable material identified during construction will be temporarily covered with ten (10) mil polyethylene sheeting until laboratory results determine its quality and manner of disposition. Excavated material which has not been excavated and/or

buried will be covered with polyethylene sheeting at the end of each daily excavation operation. Any exposed cut face on a slope that will be eventually covered with topsoil and matting (e.g. slopes that are not considered "rock slopes" that would be left as –is) shall be covered with the ten (10) mil polyethylene sheeting until such time that the stabilization measures such as topsoil, matting, bonded fiber matrix, sod, etc. as required by the Erosion Control Plans or elsewhere in the plans are implemented. The cost of polyethylene sheeting used for blending sites, off-site or on-site encapsulation areas shall be considered incidental and not for directly. Polyethylene sheeting used on the project slopes for temporary cover prior to stabilization will be paid for on the unit price basis for per square yard. Cost of polyethylene sheeting shall also include the cost of sandbags required to adequately hold the sheeting to the surface.

A temporary 6 inch compacted clay cap shall be required on top of any encapsulation or blending site not already brought to grade and completed where it will be left open more than 4 weeks without work except for the months of December, January, February, or March where the temporary 6 inch compacted clay cap shall be required if left open more than 2 weeks without work. This clay cap shall be scarified or removed prior to placement of further potentially acid producing rock in the encapsulation area. At the judgment of the Engineer and where practical, polyethylene sheeting may be substituted for the 6 inch clay cap. Any encapsulation area left open for more than 2 weeks without work shall be graded to drain to the closest detention pond and shall not have slumps, depressions or holes which would hold water on or directly above the encapsulated area. During construction of the encapsulation cell a temporary detention pond shall be used to collect runoff from the encapsulation area as directed by the TDOT Environmental Division and on the environmental plans sheets. This detention pond shall be sized to contain the runoff from the encapsulation area and shall only be required while encapsulation cell is under construction and not yet complete.

This provision will be placed on the plans in the Special Notes—Environmental sheet, on the Item Numbers sheet, and referred to on the encapsulation plans sheet.
Materials: Borrow Excavation (Graded Solid Rock) shall consist of sound, nondegradable limestone with a maximum size of three feet. At least 50 percent by weight of the rock shall be uniformly distributed between one foot and three feet in diameter, and no greater than 10 percent by weight shall be less than two inches in diameter. The material shall be roughly equi-dimensional. Thin, slabby material will not be accepted. When the crushed material is subjected to 5 alterations of the sodium sulfate soundness test (AASHTO T 104), the weighted percentage of loss shall not be more than 12. The contractor shall be required to process the material with an acceptable mechanical means (a screening process capable of producing the required gradation). The rock shall be approved by a representative of the Geotechnical Engineering Section, Division of Materials and Tests, before use.

Agricultural Limestone shall meet the requirements of Subsection 918.04. Limestone screenings may be substituted at the discretion of the Engineer with the consultation and concurrence of the TDOT Geotechnical Engineering Section. Representative limestone screening samples shall be provided to the TDOT Materials and Tests division for testing of gradation and suitability for use as a blending material or for use as blending with potentially acid producing rock in an encapsulation site. Limestone screenings shall have a Calcium Carbonate content of at least 95%. Limestone screenings with a Calcium Carbonate content of between 80% and 95% may be

used with the approval of the Geotechnical Engineering Section. However, this will increase the quantity and blending rate of the material. This blending rate will vary based on the Calcium Carbonate content of the screenings and will be supplied by the Geotechnical Engineering Section after submission of samples. This increase in quantity needed to compensate for lesser quality limestone screening samples shall be borne by the contractor as it is a substitution that will allow for use of less expensive materials.

Fine grained soil (AASHTO Classification A-4, A-5, A-6, A-7 with at least 50% passing the number 200 sieve) and Clay soil (AASHTO Classification A-6, A-7-5 or A-7-6 with at least 50% passing the number 200 sieve that also meets USCS Classification CH or CL) obtained from the roadway excavation may be used for encapsulation of potentially acid producing rock materials. If this material is not available from the roadway excavation, borrow material meeting the same criteria may be used.

COMPENSATION FOR ON-PROJECT DISPOSAL AREA

Method of Measurement: Road and Drainage Excavation (Acid Producing- On Site Disposal) shall be measured by the cubic yard in its original position by cross-sectioning the excavated area. Items associated with the encapsulation and /or blending shall be measured as follows: Borrow Excavation (Graded Solid Rock), Agricultural Limestone and Limestone screenings will each be measured by the ton. Road and Drainage Excavation (Unclassified) and Borrow Excavation (Select Material) will be measured by the cubic yard in its original position by cross-sectioning the area excavated. The geotextile and/or geomembrane will be measured by the square yard. Drainage rock shall be measured by the cubic yard. Sump pipe materials such as pipe boot, pipe and bentonite shall be considered incidental and the cost of these shall be included in the item cost for drainage rock. Fine grained soil and Clay soil as referenced above shall be paid for under Road and Drainage Excavation (Unclassified). If this material is not available from the roadway excavation, it will be paid for by the cubic yard under Borrow Excavation (Select Material).

Basis of Payment: The accepted quantities of materials will be paid for at the contract unit price and shall be full compensation for all excavation, hauling, site preparation, placement, encapsulation, treatment and incidentals associated with proper disposal of acid producing materials, with all work and material complete and in place.

In the event that a contract unit price is not available for any item needed for treatment and disposal of potentially acid producing materials, the work shall be performed in accordance with Subsection 104.02 D.

COMPENSATION FOR OFF-PROJECT DISPOSAL AREA

Method of Measurement: The potentially acid producing material to be disposed of and treated in accordance with the plans and documents at an offsite waste area, or hauled to a Landfill approved by the TDOT Environmental Division, will be measured by the cubic yard in its original position by cross sectioning the area excavated. Off project disposal area is any site not

designated as a disposal area on-project and for which there are no site specific design plans included in the contract plans.

Basis of Payment: The payment for excavation and disposal of potentially acid producing material will be paid for at the unit price per cubic yard of item Road and Drainage Excavation (Acid Producing-Off Site Disposal)**.** This payment includes all incidentals associated with disposal of the potentially acid producing materials including all items involved with disposal (such as Graded Solid Rock, Agricultural Lime, Limestone Screenings, geotextile fabric, geomembrane, polyethylene sheeting, fine grained soil, clay soil, drainage rock, sump pipe, drainage rock, pipe boot and all incidentals). Payment is also inclusive of all other items associated with constructing an offsite waste area such as site preparation, obtaining permits, erosion/sediment control. Payment is also inclusive of engineering design, geotechnical analysis, environmental analysis and drawing preparation costs associated with offsite disposal area in accordance with the *TDOT Standard Specifications for Road and Bridge Construction* and any associated supplemental specifications..

The contract unit prices paid shall be full compensation for all excavation, hauling, site preparation, placement, encapsulation, treatment and incidentals associated with proper disposal of acid producing materials.

Other: The cost of the 10 (ten) mil polyethylene sheeting used as temporary slope cover of the projects slopes prior to placement of stabilization shall be paid per square yard. Cost of sandbags to adequately hold down the sheeting is included in the cost of the sheeting and will not be paid directly.

S T A T E OF T E N N E S S E E

Date : October 31, 2025
County : Rutherford
Contract No : DB2505

SPECIAL PROVISION

REGARDING

PROJECT COMPLETION AND LIQUIDATED DAMAGES

All temporary lane closures and road closures on Interstates, State Routes and local streets must be approved by the Department in advance. Requests for temporary lane closure approvals and state trooper requests must be sent to the Department at least seven (7) calendar days in advance.

No lane or ramp closures will be allowed during Special Events, Holidays, or Holiday weekends in accordance with the plans and subsection 104.04 of the Standard Specifications, or as directed by the Engineer.

Temporary lane or ramp closures on I-24 may be allowed from 8:00 PM to 5:00 AM, or as directed by the Engineer. A minimum of one (1) lane in each direction shall be maintained on I-24 at all times. For each hour or portion thereof, which any traffic lane on I-24 remains closed outside the allowable closure hours, the sum of $2,500 per hour per lane shall be deducted from monies due the Contractor, not as a penalty, but as liquidated damages. No full closures on Interstate 24 will be allowed.

Rolling roadblocks shall be permitted on I-24 for intervals not to exceed 20 minutes from 10:00 PM to 4:00 AM. After each pacing interval, the traffic shall resume normal flow before beginning another rolling roadblock. For each 20 minutes, or portion thereof, that a pacing interval exceeds the initial 20 minutes, the sum of $2,500 shall be deducted from the monies due to the contractor, not as a penalty, but as liquidated damages.

If needed, blasting shall be permitted on weekdays between 10:00 AM and 2:00 PM. Rolling roadblocks shall not exceed 10 minutes in duration to accommodate blasting. Traffic shall be allowed to return to normal flow before beginning another rolling roadblock. For each 10 minutes, or portion thereof, that a pacing interval exceeds the initial 10 minutes, the sum of $2,500 shall be deducted from the monies due to the contractor, not as a penalty, but as liquidated damages.

Temporary lane closures may be allowed on Epps Mill Road and SR-2 (US-41 Manchester Pike) from 9:00 AM to 3:00 PM, or as directed by the Engineer. For each hour, or portion thereof, which any traffic lane on SR-2 (US – 41 Manchester Pike) remains closed outside the allowable closure hours, the sum of $1,500 per hour per lane shall be deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

For local street lane closures involving Epps Mill/Buchanan Road, Capital Way, and Miller Road, intersection and associated local streets, requests for approval must be sent to Rutherford County at least seven (7) calendar days in advance. Rutherford County has specific requirements for local street lane closures including the placement of message boards and detour signs a minimum of seven (7) calendar days in advance of closure. A detour plan for short-term and extended lane closures shall be submitted in advance with the request to Rutherford County.

Flaggers may also be required by the County to ensure safe movement of vehicular traffic during local street lane closures. Any traffic lane that remains closed outside the allowable closure hours, the sum of $1,500 per hour per lane shall be deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

All lane closures and operations must be coordinated with other construction contracts in the area, if any.

Maintenance

Failure to temporarily delineate damaged safety apparatuses, such as, but not limited to, guardrail, bridge rail, concrete barrier, cable barrier systems and attenuators that present a hazard to the traveling public within 24 hours of discovery or notification will result in the sum of $2,000 per occurrence per day, or portion thereof, until temporary delineation is complete being deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

Failure to complete permanent repairs of damaged safety apparatuses within 10 calendars days of discovery or notification will result in the sum of $2,000 per occurrence per day, or portion thereof, until permanent repair is complete being deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

Failure to begin and provide continuous mowing cycles on operational roadways per the Design-Builder's submitted and concurred maintenance plan within 2 weeks will result in the sum of $2,000 per occurrence per day, or portion thereof, until the cycle has begun being deducted from monies due the Contractor, not as a penalty, but as liquidated damages. See RFP Book 3 Section 10.3.2 for mowing requirements.

Failure to complete pothole mitigation as described in RFP Book 3 Section 10.3.2 within a 24-hour period will result in the sum of $2,000 per occurrence per day, or portion thereof, until pothole mitigation is complete being deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

Environmental

As outlined in the TN CGP, the Department will perform the monthly Environmental Quality Assurance Project Compliance Assessments (QA Inspections) on this Project, which will include any waste and borrow areas. Failure to comply with the regulations and have repeat non-conformance(s) on QA Inspections, Water Quality violations or a NOV, the Department shall increase the frequency

of QA inspections to twice per month. The extra QA inspection shall occur until the project has been brought back into compliance for two consecutive QA inspections. Until QA inspections return to once a month, each additional QA inspection in the sum of $1,500 shall be deducted from monies due the Contractor, not as a penalty, but as liquidated damages.

Project Completion

Project Substantial Completion: The project shall be completed in its entirety, except punch list (defined as a listing of instructions for correction of unsatisfactory work, in whole or in part, after an inspection by the Department prior to final acceptance and clean-up of laydown yards not requiring lane closures), on or before the completion date set forth in RFP Book 2 Section 4.3. Failure to complete all work specified in the contract on or before the completion date, a sum of money equal to $8,000 per Calendar Day after the Design-Builder's established completion date shall be deducted from monies due to the Design-Builder, not as a penalty, but as liquidated damages.

Project Acceptance: The Design-Builder shall achieve project acceptance from the Department no later than 180 Days after obtaining substantial completion. Failure to achieve project acceptance on or before the completion date set forth in RFP Book 2 Section 4.3, a sum of money equal to $500 per Calendar Day after the completion date shall be deducted from monies due to the Design-Builder, not as a penalty, but as liquidated damages. Project Acceptance deadline may be extended if the Design-Builder is diligently working to all outstanding contract items, at the Departments sole discretion, and agreed to by the Department in writing.

Where provisions of this Special Provision conflict with Subsection 108.09 of the Standard Specifications, as amended, and Contract Book 3, this Special Provision prevails.

No partial payments, including payment for stockpile materials, shall be made before work begins.

S T A T E **OF** **T E N N E S S E E**

(Rev. 1-3-13) January 1, 2021

SPECIAL PROVISION
REGARDING
PAYMENT ADJUSTMENT FOR FUEL

This special provision covers the method of payment adjustment for fuel price increases or decreases. Payment adjustments will be made in monthly increments based on the estimated fuel consumed on major items of work, the estimated price per gallon of fuel at the time of letting, and the percentage change of the Producer Price Index for Light fuel oils, Series ID Number WPU0573, published by the U.S. Department of Labor, Bureau of Labor Statistics.

The estimated price per gallon of fuel for this contract is $_____.

The _____ Price Index (Ib) for light fuel oils shall be used for this contract. Adjustments will be based on the price index in effect for the month in which the item was installed.

Fuel consumption for payment adjustment shall be based on the following:

Item Number	Description of Work	Gallons per unit	Unit of measure
203	Any Road and Drainage Excavation	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.36	Cubic Yard
203	Any Borrow Excavation (Other than Solid Rock)	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.16	Ton
203	Any Borrow Excavation (Other than Solid Rock)	0.11	Ton
203-05	Undercutting	0.25	Cubic Yard
203	Any Embankment (in-place)	0.25	Cubic Yard
303, 309, 312	Any Aggregate Base	0.79	Ton
313, 501	Treated Permeable Base or Lean Concrete Base	0.10	Square Yard
307	Any Bituminous Plant Mix Base (HM)	2.98	Ton
411	Any Bituminous Concrete Surface (HM)	2.98	Ton
501	Any Portland Cement Concrete Pavement		
	≤ 10 in. thickness	0.25	Square Yard
	> 10 in. thickness	0.30	Square Yard

No payment adjustment for fuel shall be made on any item of work which is not listed above.

No payment adjustment for fuel shall be made unless the price index varies 5% or more from the index indicated in this Special Provision.

Where the price index varies 5% or more, the payment adjustment will be made as follows:

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

Where:

PA =Payment Adjustment (may be plus or minus)
Ic =Index for Current Month
Ib =Index for Bidding
Fe =Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [∑ (Pay quantity x Gallons per unit)= Fe]
Fp = Fuel Price for Bidding

The Project Engineer will compute the payment adjustment for fuel on work sheets similar to the one attached and will furnish a copy of the calculations upon request to the prime contractor and approved subcontractors.

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for fuel will continue to be made only when the "Index for Current Month" is **less** than the "Index for Bidding" and varies 5% or more.

Payment adjustment, for fuel provided after the expiration of the allocated working time and where the “Index for Current Month” **exceeds** the “Index for Bidding”, will **not** be made until after the contract records have been approved by Final Records (FR)/Materials & Tests (MT) and a Final Estimate is ready to be processed. Upon contract record approval by FR/MT, fuel payment adjustments shall be calculated for each month where the allocated working time has expired, the “Index for Current Month” **exceeds** the “Index for Bidding”, and the indices vary 5% or more. The calculation of the fuel payment adjustment shall be made using the “Index for Current Month” or the “Index for Contract Completion Date” in accordance with the following formulas:

The “Index for Contract Completion Date” is the fuel index in effect on the allocated Contract Completion date or the completion date as extended by Change Order.

“Index for Current Month” is **less** than “Index for Contract Completion Date”

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

“Index for Current Month” is **greater** than “Index for Contract Completion Date”

$PA = [(Icd \div Ib) - 1] \times Fe \times Fp$

Where:

PA = Payment Adjustment (may be plus or minus)

Ic = Index for Current Month
Ib = Index for Bidding
Icd= Index for Contract Completion Date (or as extended by Change Order)
Fe = Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [∑ (Pay quantity x Gallons per unit)= Fe]
Fp = Fuel Price for Bidding

Payment Adjustment for fuel will be made under:

Item No.	Description	Pay Unit
109-01.01	Payment Adjustment for Fuel	Dollar

Monthly Payment Adjustment for Fuel Worksheet

Project No._____ Contract No._____

County_____

Fuel Price (Fp)_____Price Index Bidding (Ib)_____Current Price Index (Ic) _____

Index for Contract Completion Date (or as extended by Change Order) (Icd)_____

Estimate Period: Work Performed_____Adjustment Paid_____
(Month/Yr)

Item	Unit	Quantity		Fuel Factor		Total Fuel
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____

Total Fuel for Month (Fe)_____

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$
$PA = [(Icd \div Ib) - 1] \times Fe \times Fp$

S T A T E **O F** **T E N N E S S E E**

(Rev. 05-16-16) January 1, 2021
(Rev. 04-01-19)
(Rev. 11-08-19)
(Rev. 3-2-23)

SPECIAL PROVISION

REGARDING

PAYMENT ADJUSTMENT FOR BITUMINOUS MATERIAL

This Special Provision covers the method of payment adjustment for bituminous materials.

100% Virgin Bituminous Material

A payment adjustment will be made to compensate for increases and decreases of 5% or more in the contractor's bituminous material cost. The normal bid items in the contract covering the bituminous material shall not be changed. Payment adjustments (+/-) shall be paid under "Payment Adjustment for Bituminous Material" and calculated as described herein:

A "Basic Bituminous Material Index" will be established by the Tennessee Department of Transportation prior to the time the bids are opened. This "Basic Bituminous Material Index" is the average of the current quotations on P.G. 64-22 from suppliers furnishing asphalt cement to contractors in the State of Tennessee. These quotations are the cost per ton f.o.b. supplier's terminal.

The "Basic Bituminous Material Index" for this project is **$**_____ per ton.

The "Monthly Bituminous Material Index" is also established on the first day of each month by the same method. A payment adjustment shall be made provided the "Monthly Bituminous Material Index" varies 5% or more (+/-) from the "Basic Bituminous Material Index".

Where the price index varies 5% or more (+/-), the payment adjustment will be made as follows:

PA = [Ic - Ib] x T

Where:

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
T =	Tons bituminous material for Adjustment Month

Payment adjustment will be applied to all asphalt cement, asphalt emulsion, or bituminous material used for paving on this project.
Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for bituminous material will continue to be made when the "Monthly Bituminous Material Index" varies 5% or more (+/-) from the "Basic Bituminous Material Index".

The calculation of the bituminous payment adjustment shall be made using the "Monthly Bituminous Material Index" or the "Bituminous Material Index for Contract Completion Date" in accordance with the following formulas:

The "Bituminous Material Index for Contract Completion Date" is the Monthly Bituminous Material Index in effect on the allocated Contract Completion Date or on the completion date as extended by Change Order.

The "Monthly Bituminous Material Index" is **less** than the "Bituminous Material Index for Contract Completion Date".

PA = [Ic - Ib] x T

The "Monthly Bituminous Material Index" is **greater** than the "Bituminous Material Index for Contract Completion Date".

PA = [Icd - Ib] x T

Where:

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
Icd =	Bituminous Material Index for Contract Completion Date (or as extended by Change Order)
T =	Tons

FOR REFERENCE ONLY

SiteManager or spreadsheet calculates the price adjustment based on the actual amount of asphalt cement (residue) in the emulsion using the following percentages:

-tack coats and shoulder sealants (e.g., SS-1, SS-1h, CSS-1, Css-1h)	63% residue
-prime coats (e.g., AE-P)	54% residue
-scrub seals and microsurfacing (e.g., CQS-1HP)	65% residue
-chip seals (e.g., CRS-2, CRS-2P)	69% residue
-hot in-place recycle (ARA-3P)	63% residue

Mixes Containing Recycled Bituminous Material

The quantity of virgin asphalt cement in tons subject to payment adjustment in recycled mixes shall be the product of the total tons of each mix multiplied by the difference between (1) the percent of asphalt cement specified for bidding purposes and (2) the percent of asphalt cement obtained from the recycled asphaltic material (RAP) used in each mix. No payment adjustment under this special provision for increases and decreases in the contractor's cost for virgin asphalt cement in recycled mixes will be allowed for asphalt cement content in excess of the percent specified for bidding purposes, as all payment adjustments for asphalt cement in the mix design of recycled mixes in excess of the percent of asphalt cement specified for bidding purposes will be made in accordance with the Standard Specifications.

No payment adjustment for bituminous material containing RAP shall be made unless the "Monthly Bituminous Material Index" varies 5% or more (+/-) from the "Basic Bituminous Material Index" indicated in this Special Provision.

Where the price index varies 5% or more (+/-), the payment adjustment will be made as follows:

$$PA = [Ic - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

PA = Price Adjustment for Adjustment Month
Ib = Basic Bituminous Material Index
Ic = Monthly Bituminous Material Index
BA = Percent asphalt specified for bidding purposes
RA = Percent asphalt obtained from recycled asphaltic material used in each mix
Tm = Tons asphalt mix for adjustment month

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for bituminous material containing RAP will continue to be made when the "Monthly Bituminous Material Index" varies 5% or more (+/-) from the "Basic Bituminous Material Index".

The calculation of the bituminous payment adjustment shall be made using the "Monthly Bituminous Material Index" or the "Bituminous Material Index for Contract Completion Date" in accordance with the following formulas:

The "Bituminous Material Index for Contract Completion Date" is the Monthly Bituminous Material Index in effect on the allocated Contract Completion Date or on the completion date as extended by Change Order.

The "Monthly Bituminous Material Index" is **less** than the "Bituminous Material Index for Contract Completion Date".

$$PA = [Ic - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

The "Monthly Bituminous Material Index" is **greater** than the "Bituminous Material Index for Contract Completion Date".

$$PA = [Icd - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

Where:

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
Icd =	Bituminous Material Index for Contract Completion Date (or as extended by Change Order)
BA =	Percent asphalt specified for bidding purposes
RA =	Percent asphalt obtained from recycled asphaltic material used in each mix
Tm =	Tons asphalt mix for adjustment month

S T A T E **O F** **T E N N E S S E E**

January 1, 2021

September 8, 2016

SPECIAL PROVISION

REGARDING

MEASUREMENT AND PAYMENT

Insert the following before the penultimate paragraph in Subsection 109.01:

In lieu of platform scales, a computer controlled weighing system connected to the hydraulic lifting system on front end loaders, or similar machines, may be used for weighing rock materials obtained from the excavation as provided in Subsection 104.09or from temporary sources established to supply stone solely to the project where approved by the Engineer, subject to the following conditions:

1. The operator of the weighing system shall be a Certified Public Weigher as prescribed in Title 47, Chapter 26, Part 8, T.C.A.

2. The accuracy of the weighing system shall be within 1% ±.

3. The weighing system shall be checked for accuracy at least once each day, or as often as deemed necessary by the Engineer. Verified weights equal to the capacity of the loading equipment shall be available on the project at all times for checking the accuracy of the weighing system.

   With the bucket empty, the zero reading shall be checked each day before any material is loaded and again after one or two trucks are loaded and thereafter as determined by the operator or as directed by the Engineer.

   The operation and checking of the weighing equipment shall be in accordance with the recommendations of the manufacturer of the equipment. A copy of the manufacturer's Operators Manual shall be furnished the Engineer prior to beginning weighing operations.

4. If the weighing system exceeds the 1% ± tolerance during any scale check, use of the weighing equipment shall cease until the scales are brought back within required tolerance.

5. The weighing system shall have a digital display capable of displaying the following:

a. The weight of each bucket to the nearest 0.01 metric ton (ton) as the material is loaded.

b. The accumulated weight loaded into each hauling unit.

c. The total of the accumulated weights recorded on each sheet or roll of the printout (see Item No. 7 below).

6. The computer controlled weighing equipment shall be capable of printing weigh tickets on a continuous sheet or roll which provides the following data:

   a. Item number for rock material being weighed.

   b. Identification number for haul unit. (Each haul unit shall have an identification number prominently displayed.)

   c. Date and time each haul unit is loaded.

   d. Weight of rock material in each bucket weighed to nearest 0.01 metric ton (ton).

   e. Total weight of rock material in each haul unit.

   f. Total weight loaded during each shift or other unit of time as may be requested by the Engineer.

7. The weigh tickets will not accompany each haul unit to the placement site but will be retained on the printout in the loading unit; and the original printout shall be given to the Engineer's representative at the conclusion of the day's work, or upon request. Each continuous sheet or roll, or portion thereof, shall have the Certified Weigher's stamp affixed along with his/her signature.

8. The Department's Inspector at the delivery site will visually inspect each load and keep a record of the haul unit number and time of arrival. In the event a discrepancy between weigh tickets and the Inspector's record arises, the Inspector's record shall govern.

9. Under normal operations the computer controlled weighing system shall be capable of calibration by means of the programming buttons, switches or keys on the control panel or keyboard without resorting to internal adjustments.

10. If at any time the Engineer deems that the computer controlled weighing system is not performing satisfactorily, he will direct the Contractor to discontinue its use and weigh the rock material on platform scales as described above in this Subsection.

S T A T E **OF** **T E N N E S S E E**

(Rev. 11-3-08) January 1, 2021

SPECIAL PROVISION
REGARDING
MOWING
PAYMENT ADJUSTMENT FOR FUEL

This special provision covers the method of payment adjustment for fuel price increases or decreases. Payment adjustments will be made in monthly increments based on the estimated fuel consumed on major items of work, the estimated price per gallon of fuel at the time of letting, and the percentage change of the Producer Price Index for Light fuel oils, Table 6, published by the U.S. Department of Labor, Bureau of Labor Statistics.

The estimated price per gallon of fuel for this contract is $1.48.

The October 2020 Price Index (Ib) for light fuel oils shall be used for this contract. Adjustments will be based on the price index in effect for the month in which the item of work was done.

Fuel consumption for payment adjustment shall be based on the following:

Item No.	Description	Gallons/Pay Unit
806-01	Mowing	2.00/Acre

No payment adjustment for fuel shall be made on any item of work which is not listed above.

No payment adjustment for fuel shall be made unless the price index varies five percent or more from the index indicated in this Special Provision.

Where the price index varies five percent or more, the payment adjustment will be made as follows:

$$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$$

Where:

PA =Payment Adjustment (may be plus or minus)
Ic =Index for Current Month
Ib =Index for Bidding
Fe =Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [Pay quantity x Gallons]
Fp = Fuel Price for Bidding

Payment adjustment errors on items of work which have occurred because of quantity errors in previous months for which the time period in which the work was performed cannot be established will be rectified on a subsequent estimate according to the following formula:

$Fa = [(Fq \div Pq) \times Ea] - Ea$

Where,

Fa = Final Adjustment (Item of work)
Fq = Final Quantity of work
Pq = Total Quantity of work on previous estimates
Ea = Total amount paid on previous estimates for Fuel Adjustment for this Item of work

The Project Engineer will compute the payment adjustment for fuel on work sheets similar to the ones attached and will furnish a copy of the calculations upon request to the prime contractor and approved subcontractors.

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Supplemental Agreement, all payment adjustments for fuel will discontinue, except that when the current price indexes are less than the price index for bidding, payment adjustments will continue to be made.

Payment Adjustment for fuel will be made under:

Item No.	Description	Pay Unit
109-01.01	Payment Adjustment for Fuel	Dollar

Monthly Payment Adjustment for Fuel Worksheet

Project No._____ Contract No._____

County_____

Fuel Price_____Price Index Bidding_____Current Price Index_____

Estimate Period: Work Performed_____Adjustment Paid_____
(Month/Year)

Item	Unit	Quantity		Fuel Factor		Total Fuel
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____

Total Fuel for Month (Fe) = _____

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

Final Payment Adjustment for Fuel Worksheet

Project No._____ Contract No._____

County_____

Item	Final Quantity of Work (Fq) for Specified Item	Total Quantity on Monthly Estimates (Pq) for Specified Item	Total Previous Adjustments (Ea) for Specified Item	Final Adjustment (FA) for Specified Item
_____	[(_____ ÷	_____) x	_____] -_____ =	_____
_____	[(_____ ÷	_____) x	_____] -_____ =	_____

Total Final Adjustment (Fa) = _____

$Fa = \sum [(Fq \div Pq) \times Ea] - Ea$

STATE **OF** **TENNESSEE**

(Rev. 3-24-10) January 1, 2021

SPECIAL PROVISION

REGARDING

SCALING AND TRIMMING

The work covered by this special provision consists of scaling and trimming the existing slopes to a safe, stable condition by removing all loose spalls and rocks not firmly keyed into the slopes. Some rock in the slope may appear resistant to removal by some mechanical means. The Contractor will be required to scale and trim the existing slopes within the limits shown on the plans and as determined by the Engineer and dispose of all material removed resulting from the scaling and trimming operation.

Scaling is the removal of loose and unstable rock and debris from an existing cut slope by using manual devices such as pry-bars, removal by hand, as well as the use of hydraulic, pneumatic or other jacks, expansive grout or materials, hydraulic hammers and mechanical means using metal bars, "slushers" and "dozer tracks" which are drug across the face of a cut slope. For certain projects, some scaling techniques (i.e. dozer scaling track) may not be acceptable. Methods which are specifically disallowed for a project will be shown on the plans. If a particular scaling technique is ineffective, other scaling techniques must be employed at no additional cost to the state. Trimming is the process of removing overhangs of loose and unstable rock from a cut slope by mechanical percussion and/or blasting methods. This includes "blast scaling" and air cushion blasting. Where air cushion blasting is used, blast holes must be 2 inches or less in diameter.

The rock slopes shall be thoroughly scaled and trimmed by manual and/or mechanical means. If mechanical means prove insufficient and if directed by the engineer the slopes shall be traversed by laborers using hand tools to ensure that all potentially hazardous protrusions have been successfully removed to the satisfaction of the Engineer.

In the event the Contractor is directed to perform scaling and trimming on a slope previously approved as complete by the Engineer, the additional scaling and trimming will be measured and paid for at the contract unit price for "Scaling and Trimming". Scaling and trimming operations may require multiple scaling efforts across the slope during a project. For example, this may be required to safe up areas for other work, or where blasting will be conducted scaling may be required after blasting is complete. No additional payment shall be made for these multiple scaling efforts across the same surface

area unless the scaling operations were approved by the Engineer as complete for the project. No additional payment shall be made if the Engineer approves the scaling operations as complete for a particular step in the sequence of work if additional work may subsequently require scaling operations after future steps in the sequence of work.

The contractor is advised that since scaling and trimming operations will entail considerable hazards due to falling rock and debris, the traveling public shall be adequately protected from falling rocks and debris by installing, before scaling and trimming operations are started, temporary rockfall barriers or other devices as approved by the Engineer. The height of the temporary measures shall be a minimum of 8'-0". Traffic, personnel, equipment, and structures shall be protected from falling or blasted rock, falling debris, or other falling material caused by the work completed for this project. Temporary measures may not be required in the case of a roadway that is completely closed where there is no other equipment, personnel, traffic or structures that will be impacted by the falling rock and debris. The existing roadway outside the working area shall be protected from falling or blasted rock. These temporary measures are to be paid by the contractor and considered part of the item Scaling and Trimming. Contractor shall not be entitled to additional reimbursement for temporary measures used to protect the roadway, traffic or other structures during scaling and trimming operations. Any area (Roadway, shoulders and side slopes) that is disturbed outside of the construction area during the project shall be repaired by the contractor at his own expense in kind and quantity.

The quantity of scaling and trimming existing slopes to be paid for will be the actual area in square yards of existing slopes which have satisfactorily been scaled and trimmed, with the scaled and trimmed material being moved to the roadway level. Additional payment will also be made under Road and Drainage Excavation unclassified for the volume of material that is hauled off as a result of the scaling and trimming operations. Road and Drainage Excavation unclassified shall be paid for by the actual cubic yard of material hauled, measured by the cubic yard placed in the waste area.

The quantity of scaling and trimming existing slopes, measured as provided for above, will be paid for at the contract unit price per square yard for "Scaling and Trimming" and for Road and Drainage Excavation (Unclassified) by the cubic yard. Such price and payment will be full compensation of furnishing all labor, tools, equipment, and all incidentals necessary to complete the work, including any drilling and blasting required to scale and trim rock from the slopes and/or to break down large blocks of scaled rock to facilitate disposal of material. It shall also include the cost of protecting the traveling public, personnel, equipment and structures from falling rock and debris. This protection may include, but is not limited to temporary barriers, temporary rockfall fences, providing a cushioning layer of rock at the roadway level for energy reduction, blasting mats, draped mesh used to direct falling material, or other means to provide a barrier, energy reduction, redirection or direction of falling material so that it does not impact traffic.

Payment will be made under:

Item No.	Pay Item	Pay Unit
203-11	Scaling and Trimming	Square yard
203-01	Road and Drainage Excavation(Unclassified)	Cubic Yard

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-7-24) January 1, 2021

SPECIAL PROVISION

REGARDING

EMBANKMENT (COMPACTED IN PLACE)

Description

This work shall consist of constructing roadway embankments in accordance with the Standard Specifications except as modified herein. All work shall be performed in reasonably close conformity with the lines and grades shown on the plans or as directed by the Engineer and shall include roadway excavation, the furnishing of borrow material, the preparation of the area upon which embankments are to be placed, the placing and compacting of approved material within roadway areas, removal and replacement of unsuitable material, clearing and grubbing of borrow sites, transporting borrow material, and the transporting and waste, deposit, or disposal of excess excavation material as applicable.

Materials

Materials used in the construction of embankments shall meet the requirements of **205** unless otherwise specified on the plans.

Construction Requirements

Roadway excavation and embankment construction shall be performed in accordance with **203** and **205** respectively except as modified herein.

Perform all excavation indicated or described in the plans or directed by the Engineer. All suitable material obtained from the roadway excavation, bridge excavation, channel excavation or other excavation may be used in the formation of embankments. All additional material required for completion of the embankments shall be furnished by the Contractor from locations approved by the Engineer. All excess excavation materials not used in the formation of embankments shall be disposed of in accordance with **203.04**.

Unsuitable material encountered in the roadway excavation will be removed and disposed of in accordance with the Standard Specifications except that the unsuitable material will be measured and paid for under Embankment (Compacted in Place). No other material shall be removed from the project without the written consent of the Engineer except as provided for in the Plans and Specifications.

Topsoil shall be stripped and stockpiled in accordance with **203.06**. The Engineer may at his discretion measure and pay for topsoil prior to placing and spreading, however, such payment shall not exceed 50% of the estimated volume of the stockpile.

Method of Measurement

Embankment (Compacted in Place) will be measured by the cubic yard complete in place. Final volume of Embankment (Compacted in Place) will be computed using the average end area method and shall be based on original cross-sections taken after removal of topsoil and unsuitable material from the embankment areas and after placement of rock or other select material paid for under other items. Final cross sections will be taken on the completed embankment prior to placement of topsoil, mineral aggregate or other material which is paid separately. Boundaries of the embankment shall be the neat lines established by the slope stakes and the elevations shown on the plans or established by the Engineer. No measurement for payment will be made beyond these boundaries except as specified herein.

The centerlines, baselines or other lines shown on the Plans or established by the Engineer shall be used as reference lines for measurement of embankments. Cross-sections shall be taken from these reference lines at intervals not to exceed 50 feet.

The volume of embankment displaced by box culverts, box bridges, span bridges, and pipe(s) with cumulative diameter(s) of 60 inches or greater, the backfill required for the structures will be deducted from the embankment quantity.

The volume of embankment for retaining walls (Special Provision 624) shall be included in the backfill required and included in the embankment quantity. If the Contractor's design requires the use of select backfill, the volume shall be included in the embankment quantity.

Materials placed in the embankment area including but not limited to rock pads, sinkhole treatment and rock caps on subgrade which are paid for under other items will not be measured as part of the embankment.

Roadway excavation will not be measured on this project but shall be a responsibility to be assumed by the Contractor in connection with the pay item(s) specified herein.

Basis of Payment

The Department will pay for quantities of completed and accepted work, at the contract prices as follows:

Item No.	Description	Unit
203-10	Embankment (Compacted In Place)	Cubic Yard

Such payment shall be full compensation for furnishing all materials, placing and forming of embankments, all roadway excavation shown on the plans, clearing and grubbing of borrow pits, and all equipment, tools, labor, and incidentals necessary to complete the work.

Roadway excavation will not be paid for directly. The contract unit price for Embankment (Compacted in Place) shall be full compensation for all roadway excavation performed in accordance with the Plans and Specifications including the transportation and/or disposal of excess excavation materials not used on the project.

The select backfill material and unclassified backfill used behind the retaining walls shall be paid under the contract unit price for Embankment (Compacted in Place). If the Contractor's design requires the use of select backfill, there will not be any additional costs due to the use of select backfill material.

No additional payment will be made for undercutting at locations where the plans indicate undercutting is required. However, if the Engineer directs undercutting at locations not indicated on the plans, the unsuitable material removed will be measured by the cubic yard in its original location and paid for at 1.5 times the contract unit price bid for Embankment (Compacted in Place). Material used to replace unsuitable material will be measured and paid for under the appropriate contract item.

S T A T E O F T E N N E S S E E

January 1, 2021

Rev. 8/22/14
Rev. 1/15/16
Rev. 8/12/16
Rev. 12/11/17

SPECIAL PROVISION

REGARDING

HIGH FRICTION SURFACE TREATMENTS (HFST)

SCOPE OF WORK

This work shall consist of the application of High Friction Surface Treatments (HFST) for use on asphalt and concrete pavements in accordance with these specifications. The HFST is comprised of a single layer of a Binder Resin System and surface applied aggregate for asphalt and concrete pavements and a double layer of a Binder Resin System and surface applied aggregate for concrete above grade surfaces.

MATERIAL

High Friction Surface Treatments

- All HFST systems used shall be from the Departments Qualified Products List, 31: High Friction Surface Treatments.

Aggregate

High Friction Aggregate shall consist of Refractory Grade Calcined Bauxite Only

- Aggregate shall be angular, having less than 0.2% moisture and free of dirt, clay, asphalt and foreign or organic materials.
- Aggregate shall meet the requirements listed in Table 1.

Table 1— Physical and Chemical Requirements of the Aggregate

Property	Test Method	Requirement
Micro Deval Resistance to Degradation	ASTM D7428	5% Max
Aggregate Grading No. 4 Sieve No. 6 Sieve No. 16 Sieve	AASHTO T27	Percent Passing 100% min 95% min 5% max
Moisture Content	AASHTO T255	0.2% max
Aluminum Oxide	ASTM C25	87% min

PACKAGING

Binder Resin System Packaging:

- Binder Resin System components shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and the ratio of the components to be mixed by volume.
- Any special instructions regarding mixing shall be included.
- The label shall show Binder Resin System components, brand name, name of manufacturer, lot or batch number, temperature range for storage, expiration date and the quantity contained therein.
- The container shall be labeled with a Material Safety Data Sheet (MSDS) and caution warnings regarding contact of the binder with skin and eyes.

Aggregate Packaging:

- All aggregates shall be furnished in appropriate packaging that is clearly labeled and protects the aggregate from any contaminates on the jobsite and exposure to rain or other moisture.
- The label shall show the name of the manufacturer and location of processing.

MATERIALS CERTIFICATION

- At the request of the purchaser, the manufacturer of the binder resin system shall certify that the binder resin system meets the requirements of this specification.
- Such certification shall consist of either a copy of the manufacturer's test report or a statement by the manufacturer, accompanied by a copy of the current test results, that the binder resin system has been sampled and tested.
- Such certification shall indicate the date of testing and shall be signed by the manufacturer.
- At the request of the purchaser, the manufacturer of the aggregate shall certify that the aggregate meets the requirements of this specification. Such certification shall consist of either a copy of the manufacturers' test report or a statement by the manufacturer, accompanied by a copy of the current test results, that the aggregate has been sampled and tested.
- Such certification shall indicate the date of testing and shall be signed by the manufacturer.
- The manufacturer shall maintain and make available upon request complete records of sampling, testing, actions taken to correct problems and quality control inspection results.

QUALIFICATION OF INSTALLER

- The installer shall submit a minimum of 5 projects with the owner's contact information on which a cumulative minimum of 25,000 square yards of HFST have been placed within the past

three years demonstrating a friction reading of 70 FN40R when tested in accordance to AASHTO T 242 or 0.75 per ASTM E 1911.

- Quality Control (QC) Plan: The QC Plan shall be project specific detailing installer's key personnel, equipment, materials, proposed methods of installation for Binder and aggregate, materials blending procedures, and proposed curing table by temperature.
- Key Personnel
- Provide contact information for key personnel.
- Designate a Project Superintendent: who shall have full authority to institute any action necessary for the successful operation of the QC plan.
- Designate a Lead technician who shall be present at the job site and be responsible for the required field quality control sampling and testing in conformance with the approved QC plan and contract documents.

EQUIPMENT

- Equipment calibration records of metering devices and application monitoring devices to ensure specification compliance.
- Cleaning and maintenance schedule for application equipment.

MATERIALS

- Provide procedures for storage and protection of materials both stockpiled and onsite.

Installation of HFST:

- Provide procedures for mixing and placement of materials for HFST.
- Provide procedures for Monitoring, recording and submittal of ambient conditions (air temperature, surface temperature, relative humidity).
- Provide procedures for Recording of quantities of materials installed.

Corrective Action:

- The quality control plan shall include corrective actions to address unsatisfactory installation, such as failure to cure, failure to meet friction values, spills and job site hazards.
- Submit the QC Plan to the Engineer for approval at least 30 days prior to the placement.
- Any deviation from the approved QC Plan shall be cause for immediate suspension of operations until corrective action is complete and approved by the owner agency.

RECOMMENDED CONSTRUCTION PRACTICES

Storage of Materials

- Materials shall be stored in accordance to the manufacturer's recommendations.
- At no time shall the aggregate be exposed to rain, or moisture.
- Safety Data Sheet (SDS), Product Data Sheet, and other information pertaining to the safe practices for the storage, handling, and disposal of the materials, and to their health hazards shall be obtained from the manufacturer and posted at storage areas.
- A copy of such information shall be provided to the Engineer.

Application Conditions

- Do not apply HFST on a wet surface or when the surface temperature is outside the manufacturer's recommendation.
- Do not apply when anticipated weather conditions would prevent proper application and curing of the HFST.

Preparation of surfaces

- Utilities, drainage structures, curbs and any other structure within or adjacent to treatment location shall be protected from the surface preparation and installation of the HFST.
- Cover or protect all existing pavement markings that are to remain as directed by the plans prior to performing surface preparation and installation.
- Pavement markings that conflict with the HFST installation shall be removed by methods acceptable to the Engineer.
- Prepare all pavement surfaces immediately prior to the installation of HFST.
- Pavement surfaces contaminated with oils, greases, or other deleterious materials not removed by the surface preparation shall be prepared according to the manufacturer's recommendation.

Asphalt Surfaces

- Clean asphalt pavement surfaces exhibiting excessive dirt, loose aggregate, debris, and deleterious material using a mechanical sweeper.
- Air wash using a minimum of 180 cfm of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material.
- Maintain the tip of the air lance within 12 inches of the surface.
- For applications on new asphalt pavements a mandatory 45 day cure period shall take place prior to the installation of the HFST.

Concrete Surfaces

- Clean concrete pavement surfaces by shot blasting and air wash.
- Shot blast all surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material.
- The prepared surface shall comply with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5.
- After shot blasting, air wash, with a minimum of 180 cfm of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material.
- Maintain the tip of the air lance within 12 inches of the surface.

APPLICATION

- Apply the High Friction Surface Treatment, in accordance with project specifications.
- Apply the HFST material on a prepared surface, when the surface temperatures are above 50ºF and within manufacturer's recommendation.
- Do not apply the HFST material if the anticipated weather or pavement surface conditions would prevent the proper application of the surface treatment as determined by HFST installer.
- Pre-treat with the mixed Binder Resin System specified joints and cracks greater than 1/4 inch and less than 1/2 inches in width.
- Cracks greater than 1/2 inch in width shall be repaired by the owner prior to HFST installation with a material compatible with the Binder Resin System.
- Once the Binder Resin System in the pre-treated areas has gelled, the installation may proceed.
- Use the High Friction Surface Treatment systems in a single lift application (Binder Resin System and aggregate) for Asphalt and Concrete roadway surfaces.
- Pavement surfaces such as open-graded and porous pavement may require a second lift of HFST to be paid as an additional pay item.
- The HFST shall be applied to the full width of pavement per project plans.

Binder Application

- Proportion and mix the Binder Resin System to the correct ratio as determined by the Binder Resin System manufacturer (+/- 2% by volume).
- The Binder Resin System shall be applied at a uniform thickness of 65+/-5 mils (2.96 to 2.54 square yards per gallon) onto a prepared pavement surface.
- Coverage rate is based upon expected variances in the surface profile of the existing pavement.
- Ensure that any blushing (waxy surface coating on the epoxy) caused by a reaction of the moisture with the hardening agent does not occur during the application process.
- Evaluate and remedy as needed any areas that show signs of blushing that typically

cause adhesion issues to occur.
- Operations should proceed in a manner that will not allow the Binder Resin System to separate, cure, dry, be exposed, or otherwise harden in such a way as to impair retention and bonding of the aggregate.
- Walking, standing or any form of contact or contamination with the wet uncured Binder Resin System prior to application of the aggregate without the use of spiked shoes to minimize the disturbance to the binder layer will result in that section of Binder Resin System being removed and replaced at the installer's expense.
- Contractor equipment and traffic is not permitted on the HFST during curing period.

Aggregate Application

- The aggregate material must be properly embedded into the Binder Resin System.
- The placement of this material does not require any compaction.
- Aggregate shall completely cover the “wet” Binder Resin System to achieve a uniform surface.
- During the placement of the aggregate, by mechanical means, the aggregate will be dropped in a manner to not displace the wet Binder Resin System.
- When placing in multiple lifts, ensure that the aggregate used is the same calcined bauxite material as the final riding surface.
- It is the responsibility of the installers to ensure proper embedment of the bauxite aggregate.
- Immediately cover any wet spots of excess binder resin with aggregate prior to the gelling of the Binder Resin System to assure proper skid resistance and macro texture depth.
- Remove the excess aggregate by sweeping before opening to traffic.
- Excess aggregate can be reused if it is clean, dry, free from foreign matter, and meets gradation requirements.
- It must be blended prior to reuse at a ratio of a minimum of 3 parts virgin material to 1 part recycled material.
- All applications will require additional sweeping 3-7 days after installation is completed.

Application Methods

- Utilize one of the following methods to apply the binder resin and aggregate wearing course.

Fully-Automated Application

- Mechanically apply the HFST by a continuous self-contained application vehicle.
- The application vehicle shall provide continuous pumping and proportioning devices.
- The system shall mechanically mix, meter, monitor and apply the HFST (Binder Resin System and Aggregate) in one continuous pass without the use of squeegees or other

tools to spread the binder.

- Ensure the Binder Resin System manufacturer has approved the installers application equipment for spreading their material as stated in the installer's QC Plan.
- Heating system may be necessary if required by the Binder Resin System manufacturer to ensure proper installation.
- Limited touch-up of the resin with hand tools is permitted for areas less than 2 square feet.
- Within 5 seconds after placing the Binder Resin System; the aggregate is applied at a minimum rate of 14-16 pounds per square yard.
- Hand application of aggregate is allowed only to assist in completely covering the Binder Resin System to achieve a uniform surface.
- Apply the HFST so no seams are visible in the middle of the traffic lanes of the finished work after application of the surface aggregate.
- Operations will proceed in such a manner that will not allow the Binder Resin System material to separate in the mixing lines, cure, dry, or otherwise impair retention bonding of the high friction surfacing aggregate.
- The application machine shall be equipped with flushing systems such that blockages of lines will not occur, and installation operations are not delayed, stopped or otherwise compromised.
- Data shall be provided to the Engineer for each individual pass (start to stop) to compare manual depth checks for mil thickness to ensure equipment is properly calibrated.
- In case of equipment malfunction, calibration can also be done by measuring the total gallons used divided by the number of square yards applied.
- Coarse textured surfaces may cause the application rate to be adjusted in order to achieve overall desired mil thickness of finished product.
- Ensure that application equipment is capable of applying binder uniformly in one pass to obtain the desired mil thickness.
- Ensure that operations proceed in a manner that does not allow the Binder Resin System to separate, gel, or set up in a way that would impair the retention of the aggregate
- The Binder Resin System manufacturer shall approve the use of their material with said automated continuous application device.

Semi-Automated Application

- Use a Semi-Automated Application machine that mixes, meters, pumps, blends and applies the Binder Resin System.
- A heating system may be necessary if required by the Binder Resin System manufacturer to ensure proper installation.
- The Semi-Automated Application machine shall have positive displacement volumetric metering pumps.
- Use motionless, in-line mixing so as to not overly shear the material or entrap air in the mix. Maximize material working time by mixing it immediately before dispensing.
- After manually dispensing, spread the Binder Resin System with a serrated squeegee on

to the prepared pavement surface to meet the required uniform application thickness.

- Data shall be provided to the Engineer for each individual pass (start to stop) to compare manual depth checks for mil thickness to ensure equipment is properly calibrated.
- Maintain a "wet line" of resin without aggregate 2 feet wide ahead of the aggregate placement operation, then follow the resin manufacturer recommendations for dwell time for placement of aggregate on the wet line based on ambient and surface temperatures
- Mechanically apply the aggregate at a minimum rate of 14-16 pounds per square yard onto the Binder Resin System by means of Blower, Spreader Bucket or suitable device in such a manner as to not displace the resin binder.
- Hand application of aggregate is allowed only to assist in completely covering the Binder Resin System to achieve a uniform surface.

INSTALLATION OF HFST

Test Section

- The installer shall construct a test section of 250 square yards.
- This test section shall be used to demonstrate the Semi-Automated or Fully-Automated Application machine has been properly calibrated and to verify application rates and cure time.
- The test section shall be part of the HFST quantity of the project and approved by the project engineer.

Verification Testing

- The verification of the HFST quantities used shall be based on data collected for each day's production and for each individual pass (start to stop).
- Verification Testing shown in Table 1 may be performed by the installer or Owner Agency, as indicated in the project plans.

Table 1— Verification Testing

Property	Test Method	Requirement
Skid Resistance	AASHTO T242 ASTM E 1911	70 min (FN40R) 0.75 min (60 kph)
Macro Texture Depth (Sand Patch)	ASTM E965	1.0 mm min

- The Owner Agency will inspect the roadway and determine compliance of the work to this specification before finalization is completed.
- Any ordered repairs or removal and replacement of material will be at no additional expense to the Owner Agency.
- A repair procedure shall be submitted to the Owner Agency within 10 days of receiving notice that repairs are needed to a particular section.

The repair procedure shall be acceptable to the Owner Agency and shall be completed within 30 working days of receiving approval of repair procedure.

S T A T E **O F** **T E N N E S S E E**

(Rev. 5-15-17) January 1, 2021
(Rev. 4-15-19)
(Rev. 11-9-20)

SPECIAL PROVISION

REGARDING

BITUMINOUS PLANT MIX PAVEMENTS (HOT MIX)

ROADWAY DENSITY

Description

This work consists of the requirements for acceptance of asphalt roadway density by use of core samples, and for testing and acceptance of asphalt longitudinal joint density.

Meet all requirements of **407** of the Standard Specifications except as modified.

407.03.D.2.h - Contractor Quality Control System. Add the following between the second and third paragraphs:

Conduct quality control testing of surface and binder mixes for roadway density throughout placement to verify that the mixture being placed meets specified density requirements. A Quality Control Plan (QCP) for this density testing is required. Acceptable methods of quality control testing include coring, nuclear gauge testing, and non-nuclear gauge testing. Document all tests and records from the control strip (if any). Make quality control records available upon request to the Department.

407.07 - Rollers. Replace the entire subsection with the following:

Provide a sufficient number and type of self-propelled rollers to achieve proper compaction and obtain the specified densities.

407.15 - Compaction. Replace the entire subsection with the following:

A. General

After the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly compacted. Use a method that shall be capable of compacting the mixture to the specified density while it is in a workable condition. Rollers shall not park or be refueled on the bituminous pavements.

B. Density Requirements

Meet the applicable density requirements for travel lanes and joints as specified in Table 407DEN-1 and Table 407DEN-2.

1. Mix Types: All Travel Lanes for A, B, BM, BM-2, C, CW, D, E
2. All levels of ADT
3. %Gmm values specified are for lot averages.

Table 407DEN-1

Travel Lane Density		
% Gmm		% Pay
Min	Max	
99.0	100	90
98.0	<99	94
97.0	<98	98
96.0	<97	100
95.0	<96	101
94.0	<95	102
93.0	<94	101
92.0	<93	100
91.0	<92	98
90.0	<91	94
89.0	<90	90
88.0	<89	86
	<88	*

Table 407DEN-2

Joint Density Incentive/Disincentive		
%Gmm		$/L.F./Lot
Min	Max	
98.0	100	*
97.0	<98	-0.70
96.0	<97	-0.42
95.0	<96	0.00
94.0	<95	0.00
93.0	<94	0.07
92.0	<93	0.14
91.0	<92	0.07
90.0	<91	0.00
89.0	<90	-0.14
88.0	<89	-0.42
87.0	<88	-0.70
86.0	<87	-0.98
	<86	*

*Shall be removed and replaced at no cost to the Department or as directed by the engineer.

% Pay for travel lanes shall be applied to the theoretical quantity of the mix on the travel lanes only, even when the shoulder and travel lane are placed concurrently. No incentive shall be paid for the second travel lane unless the joint for that lot is a minimum of 90.0%.

Any lot of joint density tests averaging below 87% shall be sealed at no cost to the Department. Approved sealers are listed on the Department's Qualified Products List (QPL), Listing #40 for Pavement Sealers. Sealing of deficient longitudinal joint lots will only be required for surface mixes. No incentive/disincentive shall be applied to a longitudinal joint between a travel lane and a shoulder.

Meet the applicable density requirements for shoulders as specified in Table 407DEN-3.

1. Mix Types: All shoulder mixes
2. All levels of ADT
3. %Gmm values specified are for lot averages.

Table 407DEN-3

Shoulder Density		
% Gmm		% Pay
Min	Max	
98.0	100	*
97.0	<98	96
96.0	<97	98
95.0	<96	100
94.0	<95	100
93.0	<94	100
92.0	<93	100
91.0	<92	100
90.0	<91	100
89.0	<90	100
88.0	<89	100
87.0	<88	98
86.0	<87	94
85.0	<86	90
	<85	*

* Shall be removed and replaced at no cost to the Department or as directed by the engineer.

% Pay for shoulders shall be applied to the theoretical quantity of mix on the shoulder even when the travel lane and shoulder are placed concurrently.

407.20.B.5 - Acceptance of the Mixture. Replace the entire subsection with the following:

5. Acceptance for Mix Density on the Roadway

a. General. The Department will apply a deduction in payment, not as a penalty but as liquidated damages, for failure to meet the density requirements as specified in **407.15.B**. As soon as practical after the final rolling is completed on each lot, 5 density tests (1 per sublot) shall be performed by the Department at random locations determined by the Engineer, and an average of all such tests shall be computed. Any deduction for failure to meet density requirements or incentive for exceeding density requirements shall be

computed to the nearest 0.1% as a percentage of the total payment otherwise due for each lot.

Consecutive lots with density deductions is cause to stop production as directed by the Engineer. Adjust the rolling operation and Quality Control Plan to achieve the required density. Construct a test strip of not more than 250 tons to demonstrate to the Engineer that the changes made produce densities meeting the requirement without deductions. Only resume full production after the Engineer has accepted the test strip.

b. Travel Lane, Turning Lane, Ramp or Shoulder Density. For density acceptance purposes, the pavement shall be divided into lots of 1,000 tons for surface mixes (D, E, C, and CW), 2,000 tons for intermediate mixes (B, BM, and BM2), and 3,000 tons for base mixes (A). Lots shall be divided into 5 even sublots. One core will be tested in each sublot and the average for the entire lot shall be compared with the requirements in Table 407DEN-1 for travel lanes or Table 407DEN-3 for shoulders. When possible, attention should be provided to avoid cutting cores in areas where signal/loop wire may be affected. If test location selections indicate testing locations in these areas, a new random number should be selected. At the beginning of a project or at any time advisable, the Department may consider smaller lots to evaluate compaction methods or for other reasons as approved or directed by the Engineer.

c. Joint Density. For density acceptance purposes, joints shall use the same length lot and longitudinal coring location as the last adjoining lane to be paved. The average of the 5 cores for the entire lot shall be compared with the requirements in Table 407DEN-2. At the beginning of a project or at any time advisable, the Department may consider smaller lots to evaluate compaction methods or for other reasons as approved or directed by the Engineer.

d. Test Method. Five randomly selected cores (4" min./ 6" max. diameter), from each lot, will be tested to determine density compliance and acceptance. The density (bulk specific gravity) determination for a compacted asphalt mixture shall be performed in accordance with AASHTO T-166, Method A only.

All core samples shall be COMPLETELY DRY before testing. Air drying is permitted provided core samples are weighed at 2-hour intervals until dry in accordance with AASHTO T166, Section 6.1. Cores may also be dried in accordance with ASTM D 7227.

The Bulk Specific Gravity (G_{mb}) of the cores shall be averaged for each lot.

For **lanes and shoulders** the maximum theoretical gravity (G_{mm}) from acceptance testing for that shift's production will be averaged and the percent density will be determined for compliance by dividing the G_{mb} average for each lot by the G_{mm} daily average.

For **joints** the maximum theoretical gravity (G_{mm}) from acceptance testing for both adjoining lanes shall be averaged, and the percent density will be determined for compliance by dividing the G_{mb} average for each lot by the G_{mm} daily average.

Obtain the cores at the locations randomly selected by the Engineer. The Department will test the cores by a certified plant technician.

If a lot is split between two days, determine the percent density of each individual core using the daily G_{mm} average from the day the sublot (represented by the core being tested) was paved.

After obtaining the cores, all core holes shall be properly filled and compacted in kind with hot mix asphalt at no additional cost to the Department.

Cores shall be clearly labeled in a discrete, sequential manner (i.e. – M1, M2,...,M30; J1, J2,...,J15) throughout the course of the project. After testing, cores shall be retained along with copies of test results and will be periodically obtained by regional materials and tests for spot-check verification testing. The cores may be discarded, if regional materials and tests determines that they are no longer needed for payment or dispute resolution.

e. Incentive/Disincentive Payment. The Department shall apply the incentive disincentive payment in accordance with the tables in **407.15.B**.

Any deduction in monies due the Contractor for failure to meet the density requirements shall be made under the item for Density Deduction.

Any incentive payment due the Contractor shall be under the item for Density Incentive.

STATE OF TENNESSEE

August 14, 2017
(Rev. 10-17-19)
(Rev. 11-5-21)

January 1, 2021

SPECIAL PROVISION

REGARDING

INTELLIGENT COMPACTION (IC) FOR HOT MIX ASPHALT (HMA)

Description

This work consists of the requirements for modification of standard HMA compaction equipment for the purpose of tracking and documenting location, and temperature. Compaction equipment and procedures shall meet all requirements listed in **407.07** and **407.15** except as modified herein.

Equipment

A. Rollers

Install Intelligent Compaction equipment meeting the requirements listed herein on the first (breakdown) and second (intermediate) roller in the roller train. Roller type(s) are to be as required in **Table 407.15 – Roller Requirements by Mix Type**. The IC systems may be either an integrated system or an added-on/retrofit systems.

B. Global Navigational Satellite System (GNSS)

Rollers shall be equipped with a GNSS units to monitor the equipment locations and track the number of roller passes utilizing the same reference system. GNSS system shall have a survey tolerance of not greater than 2.0 in in both the horizontal (x and y) directions.

GNSS receivers shall utilize the Universal Transverse Mercator (UTM) or Tennessee State Plane coordinate system. Once declared, the coordinate system utilized shall be the same for both rollers for the entire project.

GNSS data shall be in the following format:

1. Time: Military, local time zone, hhmmss.ss
2. GNSS: Latitude/Longitude, degrees/minutes; ddmm.mmmmmmmm or decimal degrees; dd.dddddddd
3. Grid: Meters, 0.001 m

C. Temperature Measurement

Rollers shall be equipped with non-contact temperature sensors for both the forward and reverse directions for measuring pavement surface temperatures. Temperature sensor shall be accurate to ±3°F.

D. Integrated On-Board Documentation System

An on-board documentation system that is capable of displaying real-time color-coded maps of IC data as defined under Project IC Data.

The Intelligent Compaction System shall be capable of transferring the Project IC Data by means of cellular data upload to cloud storage during the day's production.

E. Cloud Storage and Cloud Computing

Provide a system of cloud storage and cloud computing. The cloud storage shall be sufficient to contain all Project IC Data associated with the contract and accessible to the Department. The cloud computing system shall support real-time visualization/mapping of the Project IC Data. Paving operations shall not begin until real-time access is granted to the Department.

Project IC Data is to be uploaded throughout the project in real-time if data cellular coverage allows, but not less than once per day otherwise. If cellular data coverage for uploading the data at the project site is unavailable, upload the data prior to the next day's production by other means.

Provide the Department with unlimited review access to the intelligent compaction records through cloud storage and cloud computing starting from the beginning of the project paving until project finalization.

Construction Requirements

A. Project IC Data

Track and record the Project IC Data for the contract. Project IC data shall consist of:

1. Location of the roller in real time,
2. Number of roller passes at a given gridded location,
3. Pavement surface temperatures associated with each roller pass, and
4. The roller speed associated with each roller pass.

All data is to be gridded in one foot by one foot grid.

At the end of the project, provide a copy of the final Project IC Data for each pavement layer in a separate digital file to the Department formatted in the most current version of Veta. Veta is available at www.intelligentcompaction.com.

Export the raw or gridded data:

1. Directly into Veta if a file format compatible with Veta is available, or
2. Through a direct transfer of data from cloud storage to Veta.

Ensure that the date/time stamp is reflective of the local time zone for both mapped and exported data.

B. System Failure

In the event that the intelligent compaction system does not work due to failure of the system, work may continue for the day's production. The Intelligent Compaction system must be operational prior to starting the next day's production.

Notify the Engineer if real time data cannot be uploaded to cloud storage due to lack of cellular data or satellite coverage. Notification must be made each day if real time uploading of data is unavailable. In instances where the file is not uploaded in real time to the cloud storage, it must be uploaded by other means prior to the next day's paving.

File Name

Name Veta project files (*.VETAPROJ) using filenames CNXXXX_ROUTE_HMA_YYY standardized format where XXXX is replaced by the contract number (e.g. Z999), YYY is replaced with the mix type (e.g. D, BM2, TLD, etc) and ROUTE is replaced with the five character State Route or Interstate designation (e.g. SR001 or I0040).

Method of Measurement & Basis of Payment

The Department will not measure and pay for Intelligent Compaction directly, and will consider such work incidental to other items of work relating to the placement of Asphalt.

S T A T E **O F** **T E N N E S S E E**

April 4, 2011 January 1, 2021

SPECIAL PROVISION

REGARDING

ASPHALT PAVEMENT SAFETY EDGE

Description

The contractor shall attach a device to the screed of the paver such that material is confined at the end gate and extrudes the asphalt material in such a way that results in a consolidated wedge-shape pavement edge of approximately 25 to 30 degrees as it leaves the paver (measured from a line parallel to the pavement surface). The device shall maintain contact to the graded material adjacent to the pavement and must be adjustable to allow for transition to cross roads, driveways and obstructions without requiring the paver to be stopped routinely. The device shall constrain the asphalt head and increase the density of the extruded profile. To achieve desired results, rolling is not required on the wedge. The desired pavement edge angle is 30 degrees but angles as steep as 38 degrees are acceptable after the mat has been rolled for compaction.

The contractor shall use the TransTech Shoulder Wedge Maker, the Advant-Edge Edger or Ramp Champ, Carlson's Safety Edge Endgate or an equivalent device that produces the same wedge consolidation results. If the contractor uses a similar device, he must provide proof that his device has been used on previous projects with acceptable results (proof shall consist of, at a minimum, approval and endorsement of another State D.O.T. or FHWA Division). Short sections of handwork will be allowed when necessary for transitions and turnouts or otherwise authorized by the engineer. Conventional single plate strike off devices will not be allowed.

No direct payment will be made for the Safety Edge and all cost of furnishing and/or operation of this device will be included in other items.

Contact information for these wedge shape compaction devices is as follows:

1. **TransTech Systems, Inc.**
   1594 State Street
   Schenectady, NY 12304
   1-800-724-6306
   http:/www.transtechsys.com

2. **Advant-Edge Paving Equipment LLC**
   33 Old Niskayuna Road
   Loudonville, NY 12211
   Ph. 814-422-3343
   http://www.advantedgepaving.com

3. **Carlson Paving Products, Inc.**
   18425 50th Ave E, Tacoma WA 98446
   Phone (253) 875-8000 | Toll Free 1-800-216-2108 | General Fax# (253) 846-2703
   http://www.carlsonpavingproducts.com

S T A T E **O F** **T E N N E S S EE**

(Rev. 10-10-16) January 1, 2021
(Rev. 2-13-17)
(Rev. 10-8-18)
(Rev. 2-11-19)
(Rev. 10-12-20)
(Rev. 12-21-21)

SPECIAL PROVISION

REGARDING

ASPHALTIC CONCRETE SURFACE (HOT MIX)

This provision sets up pavement smoothness requirements and how testing procedures, acceptance, and payment practices will be handled by the Department.

Completed pavement surfaces of traffic lanes, including those on bridge deck surfaces on both the mainline and ramps with stop or yield conditions shall be tested for smoothness with the Road Profiler in accordance with Department procedures.

The Contractor shall be paid monies due for items in the surface mix based on the applicable payment table. Any lot (1 mile or fraction thereof) of pavement where the Road Profiler's International Roughness Index (IRI) value exceeds the maximum limit or does not provide at least the minimum percent improvement, as shown in the applicable payment tables, will require corrective action. Any unacceptable lot(s) will be divided into 0.1-mile sub-lots for closer evaluation. Choose those sub-lots, within the unacceptable lot, to correct in order to bring the overall lot into the acceptable smoothness range. However, do not choose more than 3 sub-lots for repair, unless they are adjacent to each other and there are no more than 6 transverse joints. Otherwise, the entire lot will require corrective action. The minimum corrective action shall be the length of the entire sub-lot of 0.1 mile. The only acceptable corrective action is mill and inlay. Payment for the corrected 1 mile lot(s) will be based on the Road Profiler's International Roughness Index after corrective action has been taken.

Each lot of pavement will be tested by one pass of the Road Profiler. If corrective action is required, a second pass will then be made to determine the pay adjustments for the corrected lot(s).

Roadway sections excluded from this provision will be identified in the project documents. Any excluded sections of roadway must comply with the straightedge requirements specified in **411.08** of the Standard Specifications.

Any deduction in monies due the Contractor for ride quality shall be made in accordance with this provision under the item for Rideability Deduction.

Payment tables for smoothness based on Road Profiler IRI values are as follows:

Table 411C-1 will apply to lots of surface mixtures that are greater than or equal to 1 inch in thickness that either receive more than one lift of surface mixture and/or lots of single lifts with an initial IRI less than 90 in/mi. Table 411C-1 will also apply to all lots of any thickness that are milled prior to overlay with an initial IRI less than 110 in/mi.

Table 411C-2 will apply to lots of surface mixtures that are greater than or equal to 1 inch in thickness that are single lift with an initial IRI greater than or equal to 90 in/mi. Table 2 will also apply to all lots of any thickness that are milled prior to overlay with an initial IRI greater than or equal to 110 in/mi.

Table 411C-3 will apply to lots of surface mixtures that are less than 1 inch in thickness that are a single lift with an initial IRI less than 90 in/mi and have not been milled prior to placement.

Table 411C-4 will apply to lots of surface mixtures that are less than 1 inch in thickness that are a single lift with an initial IRI greater than or equal to 90 in/mi and have not been milled prior to placement.

Cape Seal projects (i.e. chip seal/scrub seals, microsurface, that are covered by less than 1 inch of surface mixture) will follow Table 411C-3 or Table 411C-4 based on the initial IRI.

Thin lift surface mixtures placed on top of new construction, full depth recycled pavement, hot in-place or cold recycled pavement shall meet the requirements of Table 411C-1 and Table 411C-2.

For the purpose of this provision, placement of any mixture for spot leveling, cape seals, or microsurface will not be considered a lift of mixture to improve smoothness.

Table 411C-1

Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items
65 or less	100%
66	99%
67	98%
68	97%
69	96%
70	95%
71	94%
72	93%
73	92%
74	91%
75	90%
76	88%
77	86%
78	84%
79	82%
80	80%
81	77%
82	74%
83	71%
84	68%
85	65%
86	61%
87	57%
88	53%
89	49%
90	45%
Greater than 90	Mill & Inlay*

Table 411C-2

Percent Improvement % **	Percentage paid on bid price of surface items
30 or more	100%
29	99%
28	98%
27	97%
26	96%
25	95%
24	94%
23	93%
22	92%
21	91%
20	90%
19	88%
18	86%
17	84%
16	82%
15	80%
Less than 15	Mill and Inlay*

Table 411C-3

Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items
75 or less	100%
76	99%
77	98%
78	97%
79	96%
80	95%
81	94%
82	93%
83	92%
84	91%
85	90%
86	88%
87	86%
88	84%
89	82%
90	80%
Greater than 90	Mill & Inlay*

Table 411C-4

Percent Improvement % **	Percentage paid on bid price of surface items
15 or more	100%
14	99%
13	98%
12	97%
11	96%
10	95%
9	94%
8	93%
7	92%
6	91%
5	90%
4	88%
3	86%
2	84%
1	82%
0	80%
Less than 0	Mill & Inlay*

*The mill and inlay shall be the thickness as specified on the plans for the surface layer

**% Improvement $= \frac{(\text{Initial IRI - Final IRI})}{\text{Initial IRI}} \times 100$

STATE **OF** **TENNESSEE**

(Rev. 12-13-16)
(Rev. 12-16-19)
(Rev. 3-4-22)

January 1, 2021

SPECIAL PROVISION

REGARDING

HOT APPLIED FIBER REINFORCED POLYMER PATCHING MATERIAL

Description

This work consists of furnishing, installing, all labor, material, and equipment necessary to repair spalled areas, potholes, joints, and large cracks (> 1 inch wide) on concrete pavements using a Hot Applied Fiber Reinforced Polymer Patching Material, bulking aggregates, and surface coarse aggregates as specified below.

Definitions

For the purposes of this specification, the following definitions apply:

- Binder - the thermal setting material that is the basis of the patching material, and to which any fillers, fibers, or other components are added.
- Patching material - the binder and other additives, mixed together, and in the form that will be applied to the patch, and shall not include bulking aggregate or final surface aggregate.
- Bulking aggregate - additional aggregate applied to the patch after the patching material has been applied for patches greater than 1 inch deep, and shall not include final surface aggregate.
- Final Surface Aggregate - aggregate applied to the surface of the patch to provide friction and protection

Material

Provide a hot applied patching material consisting of a combination of resin binder, polymers, graded fillers, aggregates, fibers, and rubber that once heated provides an impermeable, void less solid mass at ambient temperatures. Formulate the patching material according to climatic conditions to provide a durable pavement repair with good fluidity at process temperature, low temperature flexibility, and ambient temperature flow resistance.

The patching material shall be a product on the Department's Qualified Products List 13, Section B: QPL.13.010 - Elastomeric Patching Material Hot Applied. The material used shall be gray in color.

Bulking Aggregate

Provide **single sized** bulking aggregate consisting of a crushed, double washed, and dried granite. The size shall be from 5/8 to 7/8 inches determined through sieve analysis and shall not include any final surface aggregate.

Final Surface Aggregate

Final surface aggregate shall be crushed; double washed, and dried granite or Bauxite. The size shall meet the following gradation:

No. 4 Sieve Size	100% Passing
No. 16 Sieve Size	5% max Passing

Equipment

Provide all necessary equipment for satisfactory completion of the work including restoration of the site. Application equipment shall be certified by the material manufacturer.

Construction Requirements

1. Place the patching material installation to encompass the damaged or spalled areas as shown on the plans, or as directed by the engineer, with adjustments to the depth and width of the repairs as directed.
2. Saw cut around or mill the repair area and remove all loose and damaged pavements.
3. Remove material from the repair area to a depth and width which will allow proper seating of the patching material. (Minimum ¾ inch depth)
4. Remove all loose and damaged material from the repair area, either by saw cutting around the area and using a jackhammer to remove material, or by using a milling machine, as directed.
5. Remove material from the repair area to a depth and width necessary to provide sound pavement that will allow proper seating of the patching material.
6. If using a jackhammer, use an approved jackhammer capable of performing the required removal of the existing material without further damaging the surrounding pavement. Use a jackhammer no larger than 30 pounds unless approved by the Engineer.
7. Thoroughly clean and dry substrate faces using a hot-compressed air lance.
8. Prime the area using a primer determined by the manufacturer.
9. Allow the primer to completely dry before applying patching materials.
10. Mix and heat the patching material to 300°F – 360°F on site in a mixing unit equipped with electronically controlled thermostats in accordance with the manufacture's requirements.
11. Heat the bulking and final surface aggregates to ensure no moisture is present using a wheelbarrow or other approved container that will withstand the heat applied.
12. Apply the patching material to the repair area. If the repair area is deeper than 1 in., add bulking aggregate at a rate of 20%–40% by volume after placing the patching material.
13. Install additional patching material and bulking aggregate in 1 – 2 1/2 inch lifts until the repair is 1/2 inch or less below the existing pavement
14. The final lift shall be ¾ to 1 inch depending on the manufacture's requirements. Apply a final coat of the heated patching material to level the repair area.

15. Dress the surface of the patch with heated final surface aggregate. Perform this operation while the patch is still hot.
16. Sweep the area and remove all debris from the site.
17. Do not allow traffic over the material until after it has cooled to the point that it does not permanently deform under pressure, as recommended by the manufacturer, or as directed.

Traffic Control

Traffic control shall be completed in accordance with the plans and/or contract documents. All traffic control operations shall apply with the MUTCD at a minimum. Any changes must be approved by the engineer.

Method of Measurement

The Department will measure hot applied fiber reinforced polymer patching material by the pound of resin binder used, including primer, resin binder, bulking aggregate, and final surface aggregate.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Item No.	Description	Unit
502-03.05	HOT APPLIED FIBER-POLYMER PATCHING MATERIAL	POUND

Such payment for the pound measurement of resin binder used shall be full compensation for primer, resin binder, bulking aggregate, final surface aggregate, labor, equipment, saw cutting, milling, removal and disposal of existing pavement material, and all incidental work and material.

S T A T E **O F** **T E N N E S S E E**

(Rev 10-11-21) January 1, 2021

SPECIAL PROVISION

REGARDING

GRINDING CONCRETE PAVEMENT

Description

The work consists of grinding Portland Cement Concrete Pavement to eliminate joint faulting and/or to restore proper drainage, riding characteristics and skid resistance to the pavement surface. The work shall be accomplished in accordance with these Specifications and in reasonably close conformity to the details on the Plans.

Equipment

The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture Portland Cement Concrete Pavement with diamond blades. The effective wheelbase of the machine shall not be less than 12.0 feet. The equipment shall be of a size that will cut or plane at least 3.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the Work area. The equipment shall be capable of grinding the surface without causing spalls at cracks, joints, or other locations.

Alternate equipment use may be requested in writing in accordance with **105.17**.

Construction Requirements

The Plans will designate the areas of concrete pavement surfaces to be ground. Grinding of bridge decks and roadway shoulders will not be required unless indicated on the Plans or required to improve drainage.

The work shall be scheduled and proceed in a manner that produces a uniform finished surface. Grinding will be accomplished in a manner that eliminates joint or crack faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and acceptable riding surface. The entire area designated on the Plans shall be ground until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. The work shall result in pavement that conforms to the typical cross-section requirements, the faulting at joints and cracks should be eliminated, the rideability shall be within the limits specified, and the pavement surface shall be textured except that extra depth grinding to eliminate minor depressions in order to provide texturing for 100 percent of the pavement surface will not be required.

Establish a positive means for removing grinding and grooving residue. Remove solid residue from pavement surface during the grinding or grooving operations. Do not allow residue to flow across lanes used by public traffic, into gutters or drainage facilities. Dispose of residue in a manner that will prevent residue, whether in solid or slurry form, from reaching any waterway in a concentrated state.

Final Surface Finish

The grinding process shall produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall be approximately 1/16 inch higher than the bottoms of the grooves with approximately 50 to 52 evenly spaced grooves per foot for pavements constructed with limestone coarse aggregate and 53 to 57 evenly spaced grooves for pavements constructed with aggregate other than limestone. Grinding chip thickness shall be a minimum of 0.100 inches thick for pavements constructed with limestone coarse aggregate and a minimum of 0.080 inches thick for pavements constructed with coarse aggregate other than limestone.

The Department will conduct rideability testing using a roadway profiler to provide an International Roughness Index (IRI). Testing will be performed on each lane for mainline, auxiliary lanes, and all ramps.

To determine pavement rideability, the Department will evaluate the pavement using 0.1-mile Mean IRI (MRI) sections for overall roughness and IRI for individual continuous 25-foot sections for localized roughness in each wheel path. Mean IRI (MRI) shall be the average of each wheel path. Each 0.1-mile section will be considered a lot. IRI data will be calculated per ASTM E 1926. Each lot shall have a maximum Mean IRI value of 100 inches per mile. No individual continuous 25-foot section shall exceed an IRI of 220 inches per mile in either wheel path.

Perform corrective action to reduce the Mean IRI for each lot or IRI for any individual continuous 25-foot section that fails to meet the requirements specified. No more than 0.25 inches (two grinding passes) of material shall be removed by corrective diamond grinding without approval of the Engineer.

A grinding strategy plan is required before any corrective action begins. Submit a copy of the grinding plan to the Engineer at least 5 days prior to starting any work. After Corrective action is complete, the Department will retest and evaluate the pavement.

Grinding along the inside edge of the existing pavement shall conform to the straightedge requirements.

Transverse joints and random cracks shall be visually inspected to ensure that adjacent surfaces are in the same plane. Misalignment of the planes of the surfaces on adjacent sides of the joints or cracks which is in excess of 1/16 shall be ground until the surfaces are flush.

The transverse slope of the pavement shall be uniform to a degree that no depressions or misalignment of slope greater than 1/4 inch in 12 feet are present when tested with a straightedge placed perpendicular to the centerline. Straightedge requirements do not apply across longitudinal joints or outside of areas ground.

Measurement

The Department will measure Grinding Concrete Pavement by the square yard. Only the ground portion will be measured for payment.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
503-01	Grinding Concrete Pavement	Square Yard

Such payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals to complete the work

S T A T E **O F** **T E N N E S S E E**

January 1, 2021

SPECIAL PROVISION

REGARDING

DOWEL BAR RETROFITTING

DESCRIPTION

The work consists of installing epoxy coated 1-1/2 inch diameter by 18 inch long plain round dowel bars into existing concrete pavement. The existing Portland Cement Concrete pavement shall be slotted and the dowel bars shall be retrofit across pavement cracks and/or joints.

MATERIALS (See Standard Specifications for other details)

Dowel bars, including the ends, shall be epoxy coated. The dowel bars shall also be further coated prior to installation with a bond breaking compound. The bond breaking coating shall be one of the approved products appearing on the Department's Qualified Products List.

The dowel bars shall have tight fitting end caps made of nonmetallic material that allows for 1/4 inch bar movement at each end of the bar. The Contractor shall submit an end cap sample to the Engineer for approval prior to installation.

Chair devices for supporting and holding the dowel bar in place during placement of the patching material shall be completely epoxy coated and made of nonmetallic material. The Contractor shall submit a chair sample to the Engineer for approval prior to installation.

The foam core board filler material shall be 1/4 inch thick, constructed of closed cell foam and faced with poster board material on each side. The foam core board is to be used when existing transverse joints are being retrofitted.

The caulk for sealing the existing crack/joint at the bottom and sides of the slot shall be a commercial grade of silicone caulk containing a minimum of 50 percent silicone.

The Portland cement concrete pavement that is removed to install the dowel bars shall be replaced with one of the following approved patching products: Patchroc 1060, Five Star Highway Patch, Burke 928 Fast Patch, or an approved equal. The use of Set 45 will not be allowed.

The patching material may be extended with aggregate meeting the manufacturer's recommendations. The Contractor shall provide a concrete mix design, including all additives, to meet a minimum compressive strength of 4,000 psi in 6 hours.

The Contractor shall verify the results of the mix design prior to beginning work. If the mix design is not satisfactory, the Contractor shall provide the Department with a mix design that meets the requirement

prior to the beginning of work.

CONSTRUCTION REQUIREMENTS

The Contractor shall install the dowel bars in the existing Portland cement concrete pavement as shown in the plans and according to the following requirements:

1. Diamond saw cut the pavement to place the center of the dowel bar at mid-depth in the pavement. Multiple saw cuts parallel to the center line may be required to properly remove the waste material from the slot. The saw cuts for the six slots at each transverse crack/joint shall be made such that the dowel bars are placed within the following tolerances:

   Centerline of individual dowel bars shall be parallel to the top of pavement, parallel to the ether dowel bars, and parallel to the roadway centerline within + or - 1/4 inch in 18 inches.

2. Any jackhammers used to break loose the concrete shall net be larger than the 30 pound class. If the pavement is damaged by the 30 pound jackhammer, the engineer will require the Contractor to use a 15 pound hammer.

3. All surfaces exposed and cracks in the slot shall be sand blasted and cleaned prior to bar installation.

4. The crack/joint on the bottom and the sides of the slot shall be filled with silicone caulk.

5. The dowel bars shall be lightly coated with the bond breaking compound prior to placement. The bar chairs shall provide a minimum of 1/2 inch clearance between the bottom of the dowel bar and the bottom of the slot. The dowel bar shall be placed to the depth shown on the plans, parallel to centerline and the top of the roadway surface, and at the middle of the slot, all within the specified tolerances. The chairs shall hold the dowel bar securely in place during placement of the patching mix.

   Longitudinal dowel bar placement for skewed joints or cracks shall be within + or - 2 inches. Longitudinal dowel bar placement for perpendicular joints shall be within + or - 1 inch.

6. The 1/4 inch thick foam core board shall be placed at the middle of the dowel bar to maintain a transverse contraction joint. The existing joint sealant may need to be cut or removed to accommodate the 1/4 inch thick foam core board with 1/2 inch by 1 inch tabs. The tabs are required to stabilize the foam core board during patching material placement. The foam core board shall fit tightly around the dowel bar and to the bottom and edges of the slot. The top of the foam core board shall be flush with the top surface of the concrete pavement.

   The Contractor may need to increase the width of the foam core board for pavements with skewed joints. The skew angle may vary for different pavement sections.

   The Contractor shall caulk the transverse joint crack at the bottom and the sides of the slot on both sides of the 1/4 inch thick foam core board. The foam core board shall be capable of remaining in a vertical position and tight to all edges during the placement of the patching material.

If for any reason the foam core board shifts during the placement of the patching material, the work shall be rejected and replaced at the Contractor's expense.

7. The Contractor shall thoroughly moisten all surfaces on the sawed slot immediately prier to filling with patching compound. Care shall be taken to prevent standing water in the slot. All excess water shall be removed with compressed air.

   The Contractor shall fill the slot (with the installed dowel bar, chairs, foam core board where used, and silicone in place) with an approved patching material. The patching material shall be vibrated with a small hand held vibrator capable of thoroughly consolidating the patching material into the slot and around the dowel bar. The top surface of the filled slot shall be trowel finished and cured immediately after each group of three dowels are installed. The curing compound shall meet the requirements of the Standard Specifications.

   The patching material shall be mixed with a hand mixer. The Engineer will test the patching material once every four hours of production. The patching material shall have a minimum compressive strength of 4,000 psi in 6 hours. Department compression testing may be performed up to 24 hours after the cylinders are made. If the compressive strengths are not being met, production shall cease and the Contractor shall resubmit a concrete mix design correcting the strength problems.

8. The transverse contraction joints shall be sawed and sealed as required in the Standard Drawings within 24 hours after placement of the patching material.

9. Any damage to the pavement due to the Contractor's operation shall be repaired or replaced at the expense of the Contractor.

MEASUREMENT

Dowel bar retrofit will be measured by each dowel bar installed and accepted.

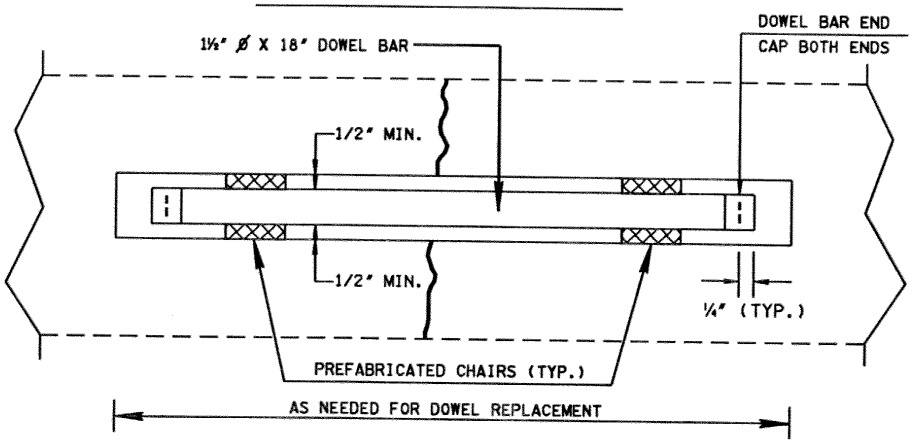
PAYMENT

Dowel bar retrofit will be paid at the contract unit price bid per each dowel bar. Payment shall be full compensation for equipment, materials, labor, and all incidentals required.

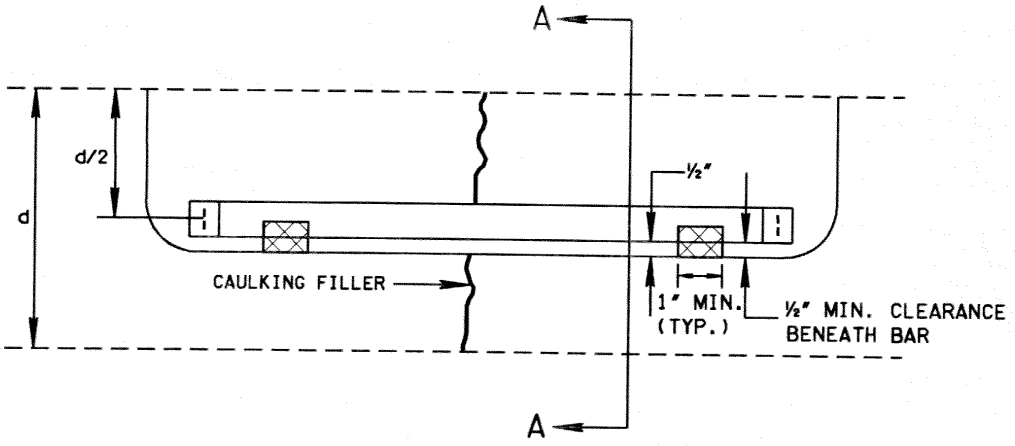
SP503DB

DOWEL BAR RETROFIT DETAILS

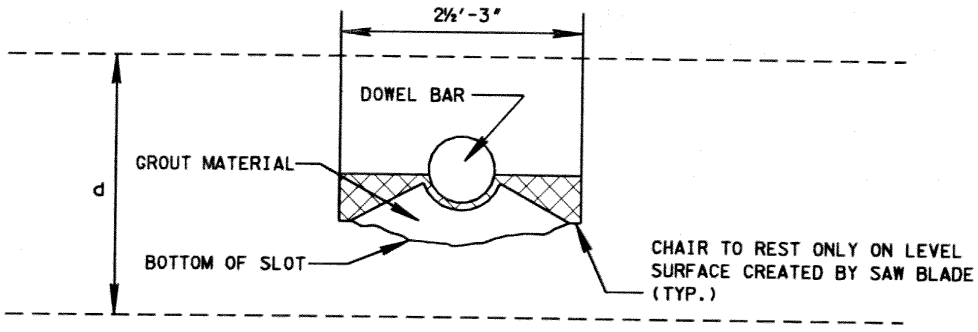
SP503DB



PLAN

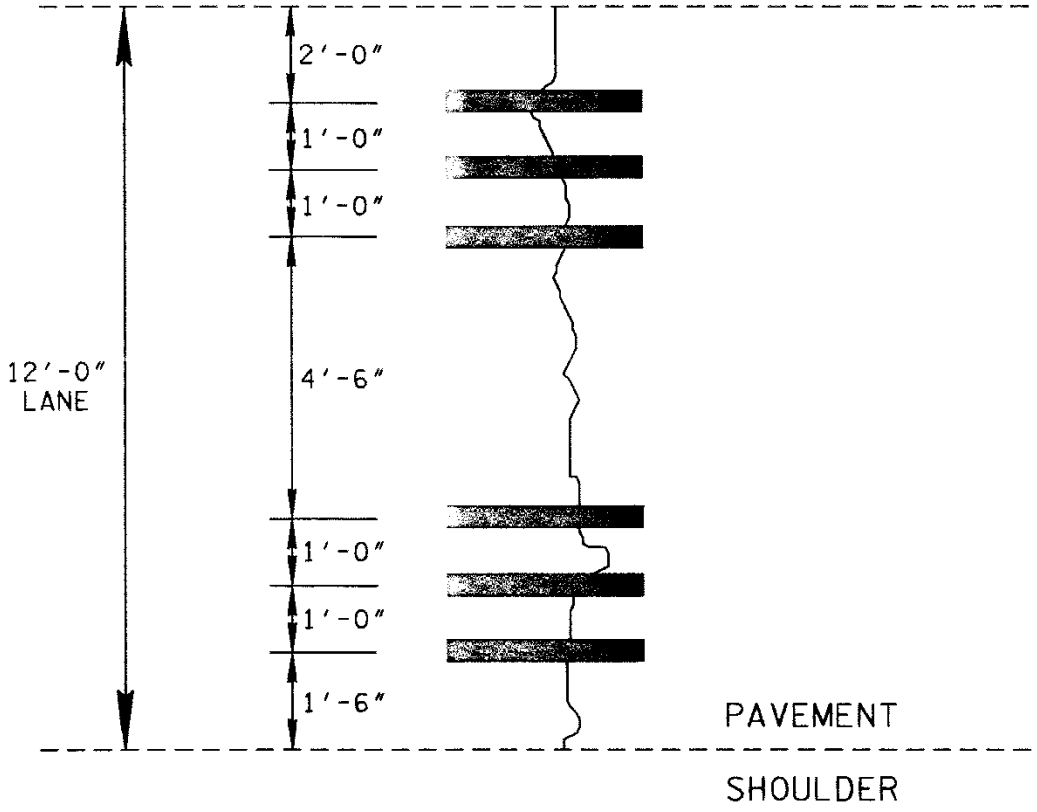


ELEVATION



SECTION A-A

SP503DB SP503DB



DOWEL BAR PLACEMENT

S T A T E **O F** **T E N N E S S E E**

(Rev. 1-1-15) January 1, 2021
(Rev. 7-21-21)

SPECIAL PROVISION

REGARDING

RUBBLIZING CONCRETE PAVEMENT

Description

This work consists of rubblizing and compacting portland cement concrete pavement in accordance with these specifications, the lines and grades shown on the plans or as directed by the Engineer.

Materials

Filler aggregate shall meet the requirements of **903.03** for Size No. 57 or Size No. 67.

Equipment

The rubblizing operation shall be performed with a self-contained, self-propelled resonant frequency breaking unit or multi-head breaker capable of rubblizing the pavement to the sizes specified. The unit shall be equipped with a water system to suppress dust generated by the rubblizing process. A screen shall be provided to protect vehicles in the adjacent lane from flying chips during the fracturing process if the deemed necessary.

The compaction shall be performed with a vibratory steel wheel roller having a nominal gross weight of not less than 10 tons when operated in the vibration mode and a pneumatic tire roller having a nominal gross weight of not less than 25 tons.

Construction Requirements

Prior to rubblization remove all existing asphalt pavement surfaces. Patch materials do not need to be removed. Remove any snowplowable or raised pavement markers.

At least 2 weeks prior to rubbilization, the underdrain systems must be installed to allow the existing base to drain and dry out.

Full depth saw cut existing joints between the mainline pavement and ramp tapers, bridge approaches or other designated locations that are not to be disturbed to isolate the rubblized area.

The majority of the rubblized particles at the surface shall be 3 inches or less in greatest dimension. Any particles at the surface greater than 6 inches in greatest dimension shall be broken down further or removed and replaced with filler aggregate. The majority of rubblized particles shall be 9 inches or less in greatest dimension and all rubblized particles shall be 12 inches or less in greatest dimension. The Engineer may direct or allow larger maximum particle dimensions.

Before full production of rubblization, set up a test section to determine the proper speed and coverage required to rubblize the concrete pavement as specified and to demonstrate the equipment is capable of providing the specified particle size. The test section shall not exceed 500 feet in one travel lane. Excavate at least 2 full widths by 3 feet long, full depth sections at locations directed by the Engineer. At any time during rubblization, the Engineer may request verification sections be excavated to verify particle sizes are being met at no additional cost.

The test section shall also be used to determine the appropriate coverage of each roller in order to provide satisfactory seating and compaction of the rubblized materials. As a minimum, at least 2 passes with both the steel wheel and pneumatic tire roller shall be made. The roller speed shall not exceed 6 feet/sec (4 mph).

Once a sequence of operations has been established, this procedure shall be used for the remainder of the project unless field conditions reflect the need for modification.

The rubblizing pattern shall proceed in a longitudinal direction, beginning at a free edge (shoulder or previously rubblized edge) and progressing toward the opposite shoulder.

Any areas where the subgrade is found to be weak, or unsuitable, shall be repaired satisfactorily and all unsuitable materials shall be removed and replaced at no additional cost. Replace the rubblized concrete or place base materials meeting the requirements of **303**.

Any depressions, one inch or greater in depth from that of the immediate surrounding area, resulting from the rubblizing or compaction effort shall be filled with Size No. 57 or 67 aggregate and compacted as previously described.

Any reinforcement or dowels that are exposed as a result of the rubblization shall be cut off below the surface and removed.

Any damage to drainage structures, utilities, private property, or any existing structure due to rubbilization methods and practices shall be repaired or replaced at no additional costs.

Except at restricted cross-over and ramp intersections, traffic will not be allowed on the rubblized pavement before the initial asphalt overlay course is in place. Crossover and ramp intersections shall be maintained in the same compacted state as other areas until the initial asphalt concrete is placed.

Placing of the first course of the bituminous pavement shall follow the rubblization operations as closely as is practicable and, in no case shall the broken pavement remain exposed more than 24 hours. In the event that this 24 hour requirement is exceeded, rubblization operations shall be suspended until all existing broken pavement is covered by at least one bituminous paving course. No more than 5,000 linear feet of pavement shall be broken ahead of this paving operation.

In the event of rain, the placement of the asphalt overlay will be prohibited until the rubblized surface has sufficiently dried as determined by the Engineer.

Remove all loose materials, assure the surface is smooth and uniform, and apply a heavy application of tack coat (0.15 gal/sy) prior to paving.

Method of Measurement

The Department will measure Rubblization of Concrete Pavement, as accepted complete in place by the square yard in accordance with **109**.

Basis of Payment

Item No.	Description	Unit
505-01	RUBBILIZATION OF CONCRETE PAVEMENT	SQUARE YARD

Such payment shall be full compensation for furnishing all labor, equipment, materials, and all incidentals necessary, including leveling materials, base materials, saw cutting, preparing and testing of test sections and verification sections, etc.., to rubblize portland cement concrete pavement as specified.

S T A T E **O F** **T E N N E S S E E**

(Rev. 2-8-21) January 1, 2021

SPECIAL PROVISION

REGARDING

REPAIR OF BRIDGE DECK CRACKS

Description

This work consists of the cleaning and repairing of visible bridge deck cracks in accordance with the contract plans or as directed by the Engineer. Cracks shall be repaired using a High Molecular Weight Methacrylate (HMWM).

Materials

The material used for treating cracks shall be a low viscosity, non-fuming, high molecular weight methacrylate resin conforming to the following:

Physical Property	Requirement
Viscosity	25 cps, maximum (Brookfield RVT with UL adaptor, 50 RPM at 25°C (77°F))
Density	0.9 kg/L (7.5 lbs/gal), minimum, at 25°C (77°F)
Flash Point	82°C (180°F), minimum
Vapor Pressure	1.0 mm Hg, maximum at 25°C (77°F)
Gel Time	20 minutes minimum at application temperature
Tack Free Time	6 hours maximum
Bond Strength	10.3 MPa (1500 psi) minimum (ASTM C 882)

A qualified representative shall be on site to provide expert assistance on storage, mixing, application, clean-up and disposal of materials.

The promoter and initiator, if supplied separately, shall not contact each other directly. Containers of promoters and initiators shall not be stored together in a manner that will allow leakage or spillage from one to contact the containers or material of the other.

The quantity of resin mixed with promoter and initiator shall be limited to 5 gallons at a time for manual application. A significant increase in viscosity shall be cause for rejection. The mixed resin shall be applied within 10 minutes after complete mixing.

A Material Safety Data Sheet (MSDS) shall be furnished for the HMWM resin promoter and initiator to be used. A certification showing conformance to these specifications shall be provided with each batch of resin.

Aggregate materials shall consist of clean, dry, fine grained sand as per resin manufacturer specifications.

Surface Preparation

Preparation of the concrete bridge deck surface shall consist of air blasting all visible cracks with oil free compressed air using sufficient air pressure to remove all loose or objectionable material from the cracks and bridge deck surface as approved by the Engineer The surface cracks shall be visually dry before treatment with HMWM is allowed to begin.

Application of HMWM

Plan and prosecute the operations in such a manner as to protect persons and vehicles from injury or damage. If required, perform the Work prior to any mechanical grooving.

The concrete surface temperature shall not be less than 50° F and not more than 100° F at the time of resin application.

In applying to individual cracks on a linear foot basis the resin shall be applied at an average rate of 1 gallon per 200 linear feet or as directed by the Engineer. Large cracks (wider than 0.03 inches) should be pre-filled with sand before applying resin. Each crack shall be treated with resin by ponding the resin over the crack and allowing gravity to feed the material into the crack. The resin shall be ponded over each crack for 5-10 minutes. The ponding procedure shall be repeated until each crack is sealed. Excess resin shall be cleaned up.

Traffic shall not be permitted on the treated bridge deck until the treated cracks are tack free (non-oily).

Method of Measurement

The Department will measure, complete in place, Bridge Deck Crack Sealing by the linear foot

The Department will measure Sealant by the gallon of sealant material used for bridge deck crack sealing.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
617-02	BRIDGE DECK CRACK SEALING	LINEAR FEET
617-05	SEALANT (DESCRIPTION)	GALLON

Such payment will be full compensation for all work specified including labor, materials, equipment, tools, surface preparation and incidentals to complete the work.

S T A T E **O F** **T E N N E S S E E**

(Rev. 5-15-23) January 1, 2021
(Rev. 10-7-24)

SPECIAL PROVISION

REGARDING

RETAINING WALLS

General Description

This Special Provision covers the design requirements, submittal of wall design drawings and supporting calculations, materials, construction, measurement, and payment for earth retaining walls. The scope of work for retaining wall construction includes, but is not limited to, the following as required:

1. All grading necessary for wall construction,
2. Undercutting and back filling of weak surficial zones, and or ground improvement as required by plans,
3. Temporary Shoring/Wall,
4. Compaction of wall foundations,
5. General and local dewatering as required for proper execution of the work,
6. Construction of leveling pads,
7. Formwork, placement of reinforcing steel, placement and curing of concrete,
8. Texture coating or architectural treatment,
9. Placement of drainage materials,
10. Installation of piling,
11. Placement of soil reinforcing devices,
12. Placement and compaction of backfill,
13. Preparation and erection of wall units,
14. Construction of any required caps, copings, or end sections.

All items included in the construction of the retaining wall shall conform to this Special Provision, the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction,* henceforth referred to as the Standard Specifications, American Society for Testing Materials Standards (ASTM), Federal Highway Administration (FHWA) Technical Publications, the current edition of the *AASHTO LRFD Bridge Construction Specifications*, and the current *AASHTO LRFD Bridge Design Specifications* with interims, henceforth referred to as the AASHTO LRFD. The architectural treatment and/or texture finish of the walls shall be in accordance with the contract plans.

Design Criteria

The design of all types of earth retaining walls shall be in accordance with this Special Provision and the following Specifications as required:

1. AASHTO *LRFD Bridge Design Specifications* with interims
2. Publication No. FHWA-NHI-10-024, *Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes*
3. FHWA Report No. FHWA-IF-99-015,1999 *Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems*

The soil and/or rock properties and specific design values required for wall design are provided in the contract plans.

Submittal Requirements for Contractor/Supplier Prepared Design Plans

The Contractor shall utilize the information contained on the Retaining Wall Conceptual drawing as well as information shown elsewhere in the plans (i.e., utility sheets or traffic control/phasing sheets) to prepare his bid for the wall during the project bidding process and to prepare wall design plans during the construction of the project. The final design shall be submitted subsequent to contract award and a minimum of 60 days prior to start of wall construction and shall include detailed design computations and all details, dimensions, quantities, and cross sections necessary to construct the wall. Acceptable wall types will be identified on the concept drawing. Specific wall systems for the Acceptable Wall Types shall be selected from the Department's Qualified Products List (QPL) in effect at time of bid letting. In certain circumstances for a particular project, the Department may elect to provide a complete, detailed wall design in the contract plans. The Contractor shall not bid for, nor shall the Contractor submit plans for wall types and/or specific wall systems not listed as an Acceptable Wall Type on the Retaining Wall Conceptual Drawing and related drawings. If a specific wall design is provided for in the contract plans, the Contractor shall not bid for or submit plans for other wall types or design. (See Section 8 for the limited conditions under which other wall types or designs may be considered). The Contractor shall not start work on any wall until the working drawings have been approved by the Engineer.

The plans shall be prepared to include but not be limited to the following items:

1. A plan and elevation sheet or sheets for each wall containing the following:
    a. An elevation view of the wall showing grades at the top of the wall, every 50 feet along the wall and at all horizontal and vertical break points. Elevations at the top of leveling pads and footings, the distance along the face of the wall to all steps in the footings, and leveling pads, the designation as to the type of panel or module, the length, size and number of tiebacks, nails, mesh or strips and all the distances along the face of the wall to where changes in length of the reinforcing elements occur and the location of the original and final ground line should be shown. The Contractor shall be responsible for field verifying original ground elevations.
    b. A plan view of the wall shall indicate the offset from the construction centerline to the face of the wall at all changes in horizontal alignment, the limit of the widest module, tiebacks, nails, mesh or strip and the centerline of any drainage pipe which is behind, under, in front of or passes through the wall.
    c. Any general or special notes, standard or special drawings, or other unique provisions required for construction of the wall.
    d. All horizontal and vertical curve data affecting wall construction.
    e. Cross sections showing limits of construction and in fill sections, limits, and extent of select backfill material placed above original ground.
    f. Limits and extent of reinforced soil volume.
    g. Limits and extent of any ground improvements as required by the contract plans.
    h. Limits and extent of temporary shoring/retaining walls.
    i. A plan and elevation view indicating the location of utilities near retaining wall.

2. Details

   a. All structural details including reinforcing bar bending details. Bar bending details shall be in accordance with Concrete Reinforcing Steel Institute (CRSI) standards.
   b. All details for foundations and leveling pads, including details for steps in the footings or leveling pads.
   c. Wall Elevation drawings shall delineate the changes in wall design height with corresponding changes in reinforcement type and/or lengths for the design section.
   d. For each delineated wall design segment, the Applied Factored Bearing Load at both the Service and Strength Limit States shall be shown.
   e. All modules and facing elements shall be detailed. The details shall show all dimensions necessary to construct the elements, all reinforcing steel in the element, and the location of reinforcement element attachment devices embedded in the facing.
   f. All details for construction of the wall around drainage facilities, overhead sign footings, abutment piles or other obstructions shall be clearly shown.
   g. All details for connections to traffic barriers, coping, parapets, noise walls and attached lighting shall be shown.
   h. All details for drainage behind wall or reinforced soil volume.
   i. If vehicular impact protection is required due to the wall system not satisfying the minimal design requirements of Section 5.0, details of the barrier wall and end terminals shall be shown on the Contractor/Supplier Design plans for the proposed wall.

3. Detailed design computations which clearly demonstrate compliance with design requirements provided in this specification.

4. Limits of design responsibility, if any.

5. Each design submittal shall include a detailed list of quantities for each wall unit. The quantities shall include but not be limited to concrete cast in-place, pre-cast concrete, select backfill material, backfill material, reinforcing steel, geomembrane/geogrid reinforcement, modular blocks, structural steel, pre- stressing steel, etc. If known, all materials sources shall be identified so acceptance and verification sampling and testing can be conducted. All quantities listed are for informational purposes only and do not necessarily constitute a pay item or quantity. All retaining walls shall only be paid for under the respective retaining wall bid item measured and described herein.

6. The Contractor's wall plans shall be signed, stamped, and dated by a qualified registered Professional Engineer licensed in the State of Tennessee.

7. Submittals and Approval

   Submit design drawings and detail design computations as specified meeting **105.02**. The computations shall include a detailed explanation of any symbols and computer programs used in the design of walls. Structures Division will submit to the Division of Materials and Tests.

   All designs and construction details will be checked by the Structures Division and the Materials and Tests Division against the pre- approved design drawings and procedures for that particular system. Review of the wall submittal will occur within 30 days of receipt. If there are design or plans issues requiring revisions, then the Structures Division will inform the appropriated Department Construction Office and provide a listing of the required revisions. Depending on the required revisions the 30 day review

timeframe may be extended. Approval of the detailed design and plans shall be made by the Structures Division and Materials and Tests Division. Notification to proceed shall be made by the Structures Division.

Submit an electronic copy of the design drawings and detail design computations to the Structures Division and the Materials and Tests Division upon completion of the project.

8. Other Submission Requirements

As discussed in the previous sections, the Contractor shall bid for and, subsequently, (for the Contractor for which the project was awarded) prepare plans for and be prepared to construct the wall type(s) given on the Retaining Wall Conceptual Drawing or, under special circumstances, the specific wall type and design as provided by in the Contract Plans. The Contractor awarded the project may only under the circumstances discussed below request that a wall type, wall system, or associated construction for a wall (i.e., foundation improvement requirements, construction sequence requirements, etc.) be changed, altered, or eliminated from those requirements set forth in the plans.

The Contractor may request the Department consider a change in the wall type, specific system, and associated construction through the submission of a Value Engineering Change Proposal (VECP) unless the contract prohibits submission of a VECP. Furthermore, any conditions of a VECP, such as a minimum cost savings required by the contract must be followed. The Department's agreement to review a VECP for a retaining wall shall in no way imply subsequent acceptance of the VECP or any part thereof. Any costs associated with preparation and submittal of a VECP shall be borne by the Contractor and no construction scheduling changes or time delays shall be caused by the Contractor's submission of the VECP and the Department's review of the VECP. If the proposed change involves a wall system not on the Approved Wall System list, then the Contractor must coordinate with the system supplier to gain approval of the system and shall be aware of the approval requirements and time considerations for this approval process.

The Contractor may request the Department consider a change in the wall type, specific system, and/or associated construction if the Contractor determines that project conditions exist that substantially differ from those conditions upon which the decision to specify in the plans a particular wall type(s), wall system, or associated construction was made. An example of this would be where a soldier pile-lagging wall is specified as the only wall type due to right-of-way constraints not allowing for a typical wall type to be built, then subsequently it is determined the Department can acquire or has sufficient right- of-way available to make another wall type feasible.

The request for consideration of changing of a wall type, system, or associated construction shall be made in writing and be submitted to the Construction Engineer. The Construction Engineer will distribute the request to the Regional Construction Engineer, Structures Division, Geotechnical Engineering Section, Design Division, and Right-of-Way Division, if applicable. The parties will review the request and provide recommended action (approval, rejection, alterations) to the Construction Engineer. If necessary, a plans revision will be made. Note that the Contractor's submission of a request does not imply acceptance by the Department and that the request process shall not be justification for a project schedule change or time extension. The Department reserves the right to require the Contractor to construct the wall as shown in the plans if there are no conditions that exist which render the contract plan wall requirement not

constructible.

The Contractor must provide documentation in the request to demonstrate that the proposed change does not in any way cause additional cost to the wall and associated construction or to other aspects of the project. If the Contractor judges that a change involving wall construction must be made due to differing site conditions, the Contractor must follow procedures given in **104.02** and **104.03** of the Standard Specifications.

Existing Conditions – Prior to beginning work, the Department shall provide utility location plans to the Contractor. The Contractor is responsible for contacting a utility location service to verify the location of underground utilities before starting work. The Contractor shall survey the condition of adjoining properties and make records and photographs of any evidence of settlement or cracking of any adjacent structures. The Contractor's report of this survey shall be delivered to the Department before work begins.

Requirements for Retaining Wall Protection Provided by the Retaining Wall System

When noted on the plans that a retaining wall is located in a hazard zone subject to vehicular impact, the Contractor shall be aware that retaining wall protection against vehicular collision for the wall may be required. If the retaining wall facing meets any one of the following criteria, an independent barrier wall shall be provided in front of the wall and included in the square foot cost of the wall:

1. Any retaining wall facing that is constructed of non-reinforced concrete (cast- in-place concrete gravity walls are exempt from this requirement and do not require protection.
2. Any dimension of a retaining wall facial panel that is less than 5.0 feet x 5.0 feet x 6 inches thick reinforced panel.
3. A cast in place reinforced facing that has a thickness less than 6 inches.

Materials Approval

The materials used in the construction of the earth retaining walls shall conform to this Special Provision, the Standard Specifications, and/or Departmental procedures. Prior to delivery of any material used in the retaining wall construction, the materials must be accepted in conformance with the specifications associated with the wall type being constructed.

Materials

Unless other otherwise stated in specific retaining wall specifications, the materials used in the construction of earth retaining walls shall conform to the following specifications:

1. All materials shall come from an approved facility listed on the Departments Producer List.
2. Class X - 3,000 pounds per square inch (psi) concrete shall be in accordance with Section **604** of the Standard Specifications.
3. Class X - 4,000 psi concrete shall be in accordance with Section **604** of the Standard Specifications.
4. Reinforcing steel shall conform to ASTM A615, Grade 60.
5. The sources for all backfill material shall be approved in conformance with the Standard Specifications before the material is delivered to the job site. Any select backfill material must be approved or tested for compliance prior to construction.
6. Lifting hooks and threaded inserts shall be of the size indicated on the working drawings.

7. When required, imbedded items must be galvanized in accordance with AASHTO M 232 or ASTM A153.
8. Acceptance of materials furnished for work will be in accordance with " SOP 1-1: Quality Assurance for the Sampling, Testing of Materials and Products" and certified test reports as specified in **106** supplemented by routine tests run by the Department as defined in the various applicable sections of the Standard Specifications.
9. Clearing and grubbing, removal of structures and obstructions, and excavation and undercutting shall be performed in accordance with the provisions of **201**, **202**, and **203** of the Standard Specifications. Cost of these items, however, shall be included in the square foot price bid for retaining walls as shown in contract plans.
10. Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with the Department's contract plans or drawings.
11. Stone masonry shall be in accordance with **612** of the Standard Specifications.
12. All fabricated or precast retaining wall assemblies shall be selected from the Department's Qualified Products List

Select Backfill Material - All backfill material used in the Mechanically Stabilized Earth structure volume, as shown on the plans, shall be reasonably free (maximum of 0.1 percent) from organic and otherwise deleterious materials, and it shall be approved by the Engineer prior to use. The material shall conform to the following gradation limits and be tested at the established frequencies in SOP 1-1: "Quality Assurance for the Sampling, Testing of Materials and Products." The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

i. Gradation as determined by AASHTO T 27.

Sieve Size	Percent Passing
4 inches	100
3/8 inch	0-75
No. 4	0-25
No. 8	0-10
No. 16	0-5

Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in **903.22** of Standard Specifications meeting the above gradation requirements.

ii. In addition, the backfill must conform to all of the following requirements:

- Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after 5 cycles determined in accordance with AASHTO T 104.
- The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.
- Electrochemical requirements - The backfill shall meet the following criteria:

REQUIREMENTS	TEST METHOD
pH = 5-10	AASHTO T 289
Resistivity > 3,000-ohm centimeters[1]	AASHTO T 288
Chlorides < 100 parts per million	AASHTO T 291
Sulfates < 200 parts per million	AASHTO T 290
Organic Content < 1 percent	AASHTO T 267

1. If the resistivity is greater or equal to 5,000-ohm centimeters the chloride and sulfates requirements may be waived.

- Unit weight- The unit weight of the backfill material (at optimum condition) shall meet the requirements of the approved shop drawings or plans.

All concrete, reinforcing steel, and backfill materials shall be tested at the specified frequencies in accordance with SOP 1-1: "Quality Assurance for the Sampling, Testing of Materials and Products."

Method of Measurement

The Department will measure by the square foot area of the wall face, measured from the top of footing (or bottom of wall for walls without footings) to the top of the wall excluding any appurtenances in accordance with drawing number W-MSE-1 Appurtenances are defined herein as barriers, fences, sign supports, noise wall support posts, and other fixtures. Coping, caps, end sections and moment slabs will not be considered appurtenances and are to be considered as part of the wall face.

Basis of Payment

The earth retaining wall, complete in place and accepted, shall be paid for at the contract square foot bid price. The bid price for walls shall include as required: grading and compaction of the wall foundation, undercutting and backfilling of weak surficial zones, installation of ground improvement, footing excavation, presplitting, sheeting, shoring, drilling, piles, lagging, grouting, concrete, reinforcing steel, reinforcement strips or mesh, tie strips or rods, fasteners, connectors, wire mesh baskets, prefabricated modular components, fabrication of models and samples, post tensioning, performance testing and evaluation, architectural treatment and/or texture finish, drainage system, water-stops and joint sealing material, coping, caps, end sections, moment slabs, and all miscellaneous material and labor for the complete installation of the wall. If the Contractor's design requires the use of select backfill, the unit price bid for the wall shall be full compensation for any additional backfill costs due to the use of select backfill material.

For an Embankment Contract (Special Provision 205A) with earth retaining wall, the select backfill material and unclassified backfill used behind the designed retaining wall shall be paid under item 203-10 Embankment (Compacted In Place) to the back face of the retaining wall. If the Contractor's design requires the use of select backfill, the unit price bid for the wall shall exclude any additional backfill costs due to the use of select backfill material.

If required for retaining wall protection against vehicle impact, the cost of the barrier wall and end terminals shall be included in the square foot cost of the wall.

Additional area of wall required due to unforeseen foundation conditions or other reasons and approved by the Engineer will be paid for on the basis of the unit price bid except as noted below.

The mechanically stabilized earth wall, complete in place and accepted as noted above, shall be paid for at the contract square foot bid price. No increase in unit price will be paid for increases in wall height less than or equal to 10 feet as compared to the contract plans and wall heights. Wall height increases greater than 10 feet will be paid for by supplemental agreement.

The cast-in-place concrete cantilever or counterfort retaining wall, complete in place and accepted shall be paid for at the contract square foot bid price except as noted below.

If the actual quantity of concrete piles driven varies more than 10 percent from the estimated quantity, in the absence of a bid item, a unit price of 90 dollars, per linear foot for the adjusted piling quantity will be paid or deducted. If the Engineer orders additional test piles, they will be paid for at the contract bid price, or in the absence of a bid item, a unit price of 90 dollars per linear foot for the piling quantity will be paid. If the Contractor changes friction pile types or sizes, additional load test(s) may be required at the Engineer's discretion and at the Contractor's expense.

If the Contractor uses a different type of pile than those that have estimated lengths shown on the contract plans, the price of the wall shall include all costs associated with piles and pile installation with no additional payment for any variation in pile lengths. All pile types and pile driving procedures, lengths, and bearings shall be in accordance with the Standard Specifications and shall be approved by the Engineer.

The retaining wall design drawings submitted for approval shall show the estimated quantity of steel piles on the design. If the actual quantity of steel piles driven varies more than 10 percent from this approved estimated quantity due to variations in the rock line, in the absence of a bid item, a unit price of 70 dollars per linear foot, for the adjusted piling quantity will be paid or deducted.

If the Engineer orders changes in the work which alters the surface area of the wall without increasing the height of the wall, payment will be increased or decreased accordingly based on the square foot bid price. If the Engineer orders changes in the work which increases the height of the wall, the unit price bid for the wall sections that were increased up to a maximum of 10 feet will be adjusted according to the following tables. Adjustments exceeding 10 feet will be made by supplemental agreement.

RETAINING WALL COST ADJUSTMENT FACTORS
Level Backfill with Slope <= 3 : 1 (Run : Rise)

Original Height (ft.)	Height Increase (ft.)									
	1	2	3	4	5	6	7	8	9	10
1 - 10	1.01	1.02	1.04	1.06	1.08	1.10	1.13	1.16	1.20	1.24
11	1.01	1.03	1.05	1.07	1.09	1.12	1.15	1.19	1.22	1.26
12	1.02	1.03	1.06	1.08	1.11	1.14	1.17	1.21	1.25	1.29
13	1.02	1.04	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31
14	1.02	1.04	1.07	1.10	1.13	1.17	1.21	1.25	1.29	1.34
15	1.02	1.05	1.08	1.11	1.14	1.18	1.22	1.26	1.31	1.36
16	1.03	1.05	1.08	1.12	1.15	1.19	1.24	1.28	1.33	1.38
17	1.03	1.06	1.09	1.13	1.16	1.21	1.25	1.29	1.34	1.40
18	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.41
19	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.42
20	1.03	1.07	1.11	1.15	1.19	1.23	1.28	1.33	1.38	1.44
21	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.39	1.45
22	1.04	1.07	1.11	1.15	1.20	1.25	1.29	1.35	1.40	1.45
23	1.04	1.07	1.12	1.16	1.20	1.25	1.30	1.35	1.41	1.46
24	1.04	1.08	1.12	1.16	1.21	1.25	1.30	1.36	1.41	1.47
25	1.04	1.08	1.12	1.16	1.21	1.26	1.31	1.36	1.41	1.47
26	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.36	1.42	1.47
27	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.37	1.42	1.48
28	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
29	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
30	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
31	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	
32	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.36		
33	1.04	1.08	1.12	1.17	1.22	1.26	1.31			
34	1.04	1.08	1.12	1.17	1.21	1.26				
35	1.04	1.08	1.12	1.17	1.21					
36	1.04	1.08	1.12	1.17						
37	1.04	1.08	1.12							
38	1.04	1.08								
39	1.04									

RETAINING WALL COST ADJUSTMENT FACTORS
Level Backfill with Slope > 3 : 1 (Run : Rise)

Original Height (ft.)	Height Increase (ft.)									
	1	2	3	4	5	6	7	8	9	10
1 - 10	1.03	1.07	1.11	1.16	1.22	1.28	1.35	1.43	1.51	1.60
11	1.04	1.08	1.13	1.18	1.25	1.31	1.39	1.47	1.56	1.65
12	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.50	1.59	1.69
13	1.05	1.10	1.15	1.22	1.29	1.36	1.44	1.53	1.62	1.72
14	1.05	1.10	1.16	1.23	1.30	1.38	1.46	1.55	1.65	1.75
15	1.05	1.11	1.17	1.24	1.32	1.40	1.48	1.57	1.67	1.77
16	1.05	1.12	1.18	1.25	1.33	1.41	1.49	1.59	1.68	1.78
17	1.06	1.12	1.19	1.26	1.33	1.42	1.50	1.59	1.69	1.79
18	1.06	1.12	1.19	1.26	1.34	1.42	1.51	1.60	1.70	1.80
19	1.06	1.12	1.19	1.27	1.34	1.42	1.51	1.60	1.70	1.80
20	1.06	1.13	1.19	1.27	1.34	1.43	1.51	1.60	1.69	1.79
21	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.60	1.69	1.79
22	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.59	1.68	1.78
23	1.06	1.13	1.19	1.27	1.34	1.42	1.50	1.59	1.68	1.77
24	1.06	1.13	1.19	1.26	1.34	1.41	1.50	1.58	1.67	1.76
25	1.06	1.12	1.19	1.26	1.33	1.41	1.49	1.57	1.66	1.74
26	1.06	1.12	1.19	1.26	1.33	1.40	1.48	1.56	1.64	1.73
27	1.06	1.12	1.19	1.25	1.32	1.40	1.47	1.55	1.63	1.72
28	1.06	1.12	1.18	1.25	1.32	1.39	1.46	1.54	1.62	1.70
29	1.06	1.12	1.18	1.25	1.31	1.38	1.46	1.53	1.61	1.69
30	1.06	1.12	1.18	1.24	1.31	1.38	1.45	1.52	1.60	1.67
31	1.06	1.11	1.17	1.24	1.30	1.37	1.44	1.51	1.58	
32	1.06	1.11	1.17	1.23	1.30	1.36	1.43	1.50		
33	1.05	1.11	1.17	1.23	1.29	1.36	1.42			
34	1.05	1.11	1.17	1.22	1.29	1.35				
35	1.05	1.11	1.16	1.22	1.28					
36	1.05	1.10	1.16	1.22						
37	1.05	1.10	1.16							
38	1.05	1.10								
39	1.05									

Specific Wall Construction and Materials Requirements

Cast in Place walls are covered through the Contractor's design. All other walls are approved through approved systems listed on the Qualified Products List.

A. Cast-in-Place (CIP) Concrete Gravity Retaining Walls

Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications.

B. Cast-In-Place (CIP) Concrete Cantilever and Counterfort Retaining Walls

Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications. If the use of piles is anticipated, the foundation information shown on the contract plans shall include the skin friction (Fs) and end bearing (Qb) values, or the location of the rock line. Based on this information, estimated pile lengths shall be shown on the contract plans for 50- and 100-tons ultimate bearing capacity for Size 1 concrete friction piles. The Contractor shall estimate point bearing steel pile refusal lengths based on the given rock line information.

Concrete friction piles shall be installed to provide a minimum factor of safety of 2.0 if a load test is used and a minimum factor of safety of 3.0 if a load test is not used. Pile types, load test procedures, and driving equipment shall be in accordance with the Standard Specifications and shall be approved by the Engineer. The number and location of test piles and load tests shall be approved by the Engineer. Test pile lengths shall be 10 feet longer than the estimated pile lengths. Test piles shall be driven in accordance with the Standard Specifications and shall be required at least every 50 feet along the wall, unless otherwise approved by the Engineer. No pile shall be any farther than 500 feet from a load test, if a load test is used, unless otherwise approved by the Engineer. The length of production piles to be driven and the required bearing based on the driving equation shall be determined by the Engineer based on the required design bearing, the results of the test piles and load tests (if used), and applicable safety factors. Driven pile lengths and final bearings shall be approved by the Engineer.

Point Bearing Steel Piles shall be driven to refusal. Pile tips shall be used when indicated on the contract plans.

All reinforcing steel projecting from footing into the wall in the back face (fill side) shall be epoxy coated.

C. Gravity Wall Systems

1. Materials

The following items are the construction materials requirements necessary for gravity wall system design fabrication. All materials shall be approved prior to use.

- Pre-Cast Concrete Gravity Wall Systems

  The pre-cast gravity wall systems are to be made of Class X concrete with a compressive strength of 4,000 psi conforming to **604** of the Standard Specifications.

2. Fabrication of Precast Concrete Gravity Wall Systems

- Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e., aggregate quality reports, cement/steel mill test reports, etc.)

  The fabricator shall provide two precast modular units to the Engineer for approval.

  i. These approved precast modular units will serve as standard models. The finished exposed faces of the production precast modular units should be similar to the exposed faces of the model precast modular units.

  ii. One of the model precast modular units should be kept at the production plant for relative comparison to future modular units. The other model should be kept on the construction site for comparison to the other delivered units.

- To assure uniform unit production, steel forms must be used.
- The placement of reinforcing steel within the precast units should conform to the design placement shown in the shop drawings.
- Final acceptability of the precast units shall be determined on the basis of certification and shall be verified by compression tests production defects and tolerances, and visual inspection. The manufacturer shall furnish all sampling and testing facilities.
- Section **604** of the Standard Specifications states the units shall be steam or moist cured until developing the specified compressive strength set forth in the shop drawings. Any unit not developing the specified compressive strength shall be rejected.
- The precast units should not be delivered before samples have been verified by Regional Materials and Tests and attained the required compressive strength of 4,000 psi (f'_c).
- Prior to shipment, the finished units are subject to visual inspection by the Engineer. Individual gravity wall system may be rejected for any of the reasons listed below.
  i. Variations in the exposed face texture relative to the approved model face texture.
  ii. The length or height of the unit not satisfying the unit allowable tolerance limit of 3/16 inch.
  iii. Honeycombed or open texture units which are not properly repaired.
  iv. Individual defects which could affect the structural integrity of the unit Variations in the exposed face texture relative to the approved model face texture.
- The Department will verify products before shipment. If products are manufactured out of state, the Department may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests that products need to be verified.
- Upon delivery, the exposed surface of the precast units shall be examined. If the exposed faces of any of the units are below the standards of the approved model on site, the units shall be replaced or properly repaired until conforming to the appearance, strength, and durability of the approved model.
- The date of manufacture shall be clearly and permanently marked on one of the

inside surfaces of each unit. Each shipment must be accompanied with a certification letter.

3. Construction

- The Contractor should perform any soil improvement, such as undercutting and backfilling before foundation preparation.
- Compact the top 12 inches of soil on which the structure will rest to at least 95 percent of the maximum laboratory dry density as specified in AASHTO T-99.
- No Gravity Wall System should be built upon frozen ground.
- Following excavation for the gravity wall system, the Contractor shall notify the Engineer for approval of the footing depth and character of the foundation material. No gravity wall work shall proceed until approval has been granted.
- The correct batter of the wall shall not exceed ½ inch per 10 feet. of wall height.
- The gravity wall system backfill should be placed and compacted to at least 95 percent of the maximum laboratory dry density (AASHTO T-99) in layers no thicker than 12 inches.
- Backfilling behind the gravity wall system shall follow erection as closely as possible. The wall height should never be greater than three feet above the backfill.
- Any underdrain shall be placed in accordance with the details of the working plans.
- The Contractor shall furnish, install, operate, and maintain satisfactory dewatering systems as required to maintain the site in a dry and workable condition. These systems shall be continued as long as necessary. No separate measurement or payment will be made for dewatering.

D. Gabion Wall (See Qualified Products List (QPL) for Approved Manufacturer/Supplier)

1. General

This section covers the furnishing, assembling, filling with stone, and tying open wire mesh rectangular compartmented gabions placed on filter cloth or filter stone as specified herein, and in reasonably close conformity with the lines, grades, dimensions, and cross-sections shown on the plans or as directed by the Engineer, and the design, working drawings, materials, construction, measurement, and payment for gabions.

Included in the scope of this section are: grading and compaction of the wall foundation, general and local dewatering as required for proper execution of the work, installation of wall drainage systems as specified on the plans, erection of units, the placement of stone within the units and compaction of the soils behind the units as well as the construction of any required reinforced concrete appurtenances such as caps, copings, or end sections as specified on the plans. For the purposes of this section, the gabions foundation shall include all areas underlying the gabion wall. All other items included in the construction of the retaining wall not specifically mentioned herein this special provision shall conform to the applicable sections of the Standard Specifications and the *AASHTO LRFD Bridge Design Specifications* with interims.

2. Design Criteria

The current AASHTO LRFD Bridge Design Specifications with interims shall be used as the basis for design for the Gabion Wall utilized as a gravity type retaining wall.

3. Materials

- Gabion Wire Mesh

  Gabion basket units shall be fabricated from either a double twisted hexagonal wire mesh (metallic or PVC coated as required in contract plans) or welded wire mesh (metallic or PVC coated as required in contract plans) that meets property requirements described in:

  ASTM Designation: A974 Standard Specification for Welded Wire Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated)

  ASTM Designation: A975 Standard Specification for Double–Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly (Vinyl Chloride) (PVC) Coating

  All other components of the gabion construction such as selvedge wire, lacing wire, spiral connectors, clips, galvanization, PVC coating shall be in accordance with the above specifications.

- Stone Fill

  All stone fills shall be listed on the Department's Producer List and shall be of suitable quality to ensure durability. The inclusion of objectionable quantities of shale, dirt, sand, clay, rock fines, and other deleterious material will not be permitted. Stone fill shall be of well-graded mixture with sizes ranging between 4 inches and 10 inches in diameter, based on U.S. Standard square mesh sieves. No stone shall have minimum dimension less than 4 inches. Stone fill material selected for use in the gabions shall meet the minimum in-place density specified on the plans.

- Filter Cloth

  All filter cloth shall meet the applicable requirements specified in **921.l2**.

- Filter Stone

  All filter stone shall meet the applicable aggregate quality requirements of **903.25** and aggregate grading requirements specified in **903.22** for Size 68 or 57.

4. Construction

- Clearing and Grubbing

  Clearing and grubbing, removal of structures and obstructions, and excavation and undercutting shall be performed in accordance with the provisions of **201**, **202**, and **203**, respectively, of the Standard Specifications. Cost of these items, however, shall be included in the square foot price bid retaining walls as shown in contract plans.

- Foundation Preparation

  Foundation preparation for the gabions shall be made to the required depth below the finished surface and to such a width as to permit the proper installation of the gabions. Prior to wall construction, the top 12 inches of the foundation shall be compacted to at least 95 percent of maximum laboratory dry density as specified in AASHTO T 99. All soft and unsuitable material shall be removed and replaced with suitable material, which shall then be compacted. The finished subgrade shall be smooth and uniform, with no protruding debris or rock formations. A Size 57 stone may be required to obtain the smooth uniform surface and shall be in reasonably

close conformity with the dimensions and designs shown on the plans or established by the Engineer. No gabions shall be constructed upon frozen foundation material.

- Filter Cloth or Filter Stone

  Upon final foundation preparation and acceptance by the Engineer, the filter cloth or filter stone shall be placed directly on the foundation at those locations shown on the plans or as directed by the Engineer. All end and side laps shall be a minimum of 18 inches for the filter cloth.

- Assembly (Fabrication)

  Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh. Gabion units shall be equally divided, by diaphragms of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. All perimeter edges of the mesh forming the gabion shall be securely joined so that the joints formed by tying the selvedges or installation of spiral ties have at least the same strength as the body of the mesh. Lacing wire or connecting wire shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

- Assembly (Field)

  i. Empty gabion units shall be placed on the filter blanket when required on contract drawings and shall be assembled individually to the lines and grades indicated on the Plans or as directed by the Engineer, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position. All adjoining empty gabion units must be connected by tie wire lacing along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at intervals of not more than 5 inches. All lacing wire terminals shall be securely fastened. The use of expedient clip connections for this purpose or as final lid closing will not be permitted. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling and distortion.

  ii. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, to prevent damage to the underlying filter blanket, and to ensure the maintenance of alignment throughout the filling process. The maximum height from which the stone may be dropped into the basket units shall be 36 inches. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact

appearance. The last layer of stone shall be leveled with the top of the gabions to allow for the proper closing of the lid and to provide an even surface that is uniform in appearance.

iii. Lids shall be stretched tight over the stone fill using crowbars or lid closing tools until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced with tie wire along all edges, ends and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 inches. Special attention shall be given to see that all projections or wire ends are turned into the baskets. Where shown on the drawings or as directed by the Engineer, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded, and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

- Backfill

  Backfilling of the gabion wall shall follow erection as closely as possible and in no case should the height of the wall be greater than seven feet above the backfill. Underdrains, if required, shall be placed in accordance with the details shown on plans. Gabion walls backfill shall have a density of 100 pounds per cubic foot or as specified on contract plans and shall be compacted to at least 95 percent of the maximum laboratory dry density as defined in AASHTO T 99 to within one foot of the top of the wall. The top 12 inches shall be compacted to at least 100 percent of the maximum laboratory dry density. The backfill material shall consist of broken or crushed stone, gravel, sand, slag, or other suitable coarse granular material to insure proper drainage. Shale, clay, or cinders shall not be permitted as backfill material. Prior to placement, the backfill material must be approved by the Engineer. The Contractor shall furnish, install, operate, and maintain satisfactory dewatering system as required to maintain the site in a dry and workable condition so as to permit grading and compaction of the wall foundation and proper erection and backfill of the wall. These systems shall include all equipment and materials and shall be continued as long as necessary. No separate measurement or payment will be made for dewatering or dewatering systems.

  All backfill material shall be tested prior to use and at the established frequencies in SOP 1-1: "Quality Assurance for the Sampling, Testing of Materials and Products."

- Vertical Wall Tolerance

  The overall vertical tolerance of the wall (plumbness from top to bottom) shall not deviate more than ½ inch per 10 feet of wall height from the contract drawings batter of the wall.

- On Site Inspection

  The quality of materials, the process of manufacture, and the finished members shall be subject to inspection and approval by the Engineer. Any gabions damaged prior to acceptance shall be repaired or reconstructed as directed by the Engineer. All costs of repairs or reconstruction shall be at the Contractor's expense.

E. Segmental, Precast Facing Mechanically Stabilized Earth (MSE) Wall (See QPL for Approved Manufacturer/Supplier)

1. Materials

General - The Contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or the Standard Specifications or from sources not listed in the contract document shall not be used without written consent from the Engineer.

Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e., aggregate quality reports, cement/steel mill test reports, etc.)

- Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with contract drawings.

  i. Verification of the precast units will be determined on the basis of compressive strength tests, production tolerances, and visual inspection. The Contractor, or the supplier, shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner as directed by the Engineer.

  ii. The hydraulic cement shall be as specified in **901.01** and shall conform to the requirements of AASHTO M 85 (ASTM C150). Concrete for precast panels shall be Class X concrete with a compressive strength of 4,000 psi as specified in **604** of the Standard Specifications. Admixtures containing chlorides shall not be used.

  iii. The panels shall be cast using steel forms. The front face of the panel (face exposed to view when installed in the wall) shall be cast against a steel form or architectural form liner. The back face is to be float finished. The concrete in each panel shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pocket or cleavage planes. Clear form oil of the same type shall be used throughout the casting operation.

  iv. Unless otherwise indicated on the plans or elsewhere in the Standard Specifications, the concrete surface for the front and rear face shall have a Class 1 finish as defined by Section 8.12.2 of AASHTO, Division II, and for the rear face a uniform surface finish. The rear face of the panel shall be float finished sufficiently to eliminate open aggregate pockets and surface distortions in excess of 1/4 inch. The panels shall be cast on a flat area. The strips or other galvanized attachment devices shall not contact or be attached to the face panel reinforcement steel.

  v. Curing and forms removal shall be in accordance with the requirements of **604.20** and **604.24** of the Standard Specifications, unless otherwise approved by the Engineer. The forms shall remain in place until they can be removed without damage to the panel.

  vi. The units shall be fully supported until the concrete reaches a minimum compressive strength of 1000 psi. The units may be shipped after reaching

a minimum specified compressive strength of 4,000 psi. the Department will verify products before shipment. If products are manufactured out of state, the Department may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

vii. Marking - The date of manufacture, the production lot number, and the piece mark shall be clearly scribed on an unexposed face of each panel.

viii. Handling, Storage, and Shipping - All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels damaged during handling or storage at the casting plant shall be repaired at the plant as directed by the Engineer. Any panels damaged during handling, storing, or shipping may be rejected upon delivery at the option of the Engineer. Panels in storage shall be supported in firm blocking located immediately adjacent to embedded connection devices to avoid bending the connection devices.

ix. Tolerances - All units shall be manufactured within the following tolerances:

- Panel Dimensions - Position panel connection devices within 1 inch, except for all other dimensions within 3/16 inch.
- Panel Squareness - Squareness as determined by the difference between the two diagonals shall not exceed 1/2 inch.
- Angular distortion with regard to the height of the panel shall not exceed 3/16 inch in 5 feet.
- Panel Surface Finish - Surface defects on smooth formed surfaces measured over a length of 5 feet shall not exceed 1/8 inch. Surface defects on the textured-finish surfaces measured over a length of 5 feet shall not exceed 5/16 inch.

x. Steel - In accordance with the Standard Specifications

xi. Compressive Strength - Verification of the concrete panels, with respect to compressive strength, will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single compressive strength sample and will consist of a single day's production.

xii. During the production of the concrete panels, Materials and Test will sample the concrete in accordance with AASHTO T 141 (ASTM C 172). A single compressive strength sample, consisting of a minimum of 6 cylinders, will be randomly selected for every production lot.

xiii. Cylinders for compressive strength tests shall be prepared in accordance with AASHTO T 23 (ASTM C31) on 6 x 12 inch or 4 x 8 inch specimens. For every compressive strength sample, a minimum of 2 cylinders will be cured in the same manner as the panels and tested for acceptance no later than 28 days. The average compressive strength of these two cylinders, when tested according with AASHTO T 22 (ASTM C39), will determine the compressive strength of the production lot.

xiv. If the Contractor wishes to remove forms or ship the panels prior to 28 days, a set of 2 backup cylinders will be cured in the same manner as the panels.

The average compressive strength of these cylinders when tested in accordance with AASHTO T 22, will determine whether the forms can be removed, and the panels are acceptable for shipment.

xv. Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4,000 psi when tested for acceptance no later than 28 days.

xvi. In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected. Such rejection shall prevail unless the manufacturer, at their own expense, obtains and submits cores for testing and the results show that the strength and quality of the concrete placed within the panels of the production lot is acceptable. The cores shall be taken from the panels within the production lot and tested in accordance with the specifications of AASHTO T 24 (ASTM C 42). Two cores per each cylinder that failed will be required. In addition, any or all of the following defects shall be sufficient cause for rejection:

- Defects that indicate imperfect molding.
- Defects indicating honeycombing or open texture concrete.
- Defects in the physical characteristics of the concrete such as cracked or severely chipped panels.
- Color variation on front face of panel due to excess form oil or other reasons.
- Damage due to handling, storing, or shipping.

xvii. The Engineer shall determine whether spalled, honeycombed, chipped or otherwise defective concrete shall be repaired or rejected. Repair of concrete, if allowed, shall be done with a Department approved cementitious polymer patching mortar in a manner satisfactory to the Engineer. Repair to concrete surface which will be exposed to view after completion of construction must be approved by the Engineer.

- Soil Reinforcing and Attachment Devices - All reinforcing and attachment devices shall be shop fabricated and carefully inspected to ensure they are true to size and free from defects that may impair their strength and durability.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A36) or AASHTO M 223 (ASTM A572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A123).

ii. Tie Strips - The tie strips shall be shop- fabricated of hot rolled steel conforming to the minimum requirements of ASTM 570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M 111 (ASTM A123). Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A 82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A185). Galvanization shall be

applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M 111 (ASTM A123).

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM F3125 Grade A325). Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A82) and welded in accordance with AASHTO M 55 (ASTM A185) and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A82).

viii. Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111 (ASTM A123). Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232 (ASTM A153). Alignment pins are to be hot dip galvanized.

ix. All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

x. Any damage sustained to any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

- Geosynthetic Reinforcement Material - Where geosynthetic reinforcements are used for the construction of MSE walls the following requirements shall apply:

i. Geotextiles and Thread for Sewing-Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO T 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The

geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport, and installation.

iii. Required Properties - The specific geosynthetic material(s) shall be preapproved by the Department and shall have certified long-term strength (T_{al}) as determined by:

- Long-Term strength (T_{al}) based on the Equation where RF_{CR} is from creep tests performed in accordance with ASTM D5262, RF_{ID} obtained from site installation damage testing and RF_{ID} from hydrolysis or oxidative degradation testing extrapolated to 75- or 100-year design life.

$$T_{al} = \frac{T_{ult}}{RF_D \times RF_{ID} \times RF_{CR}}$$

- Ultimate Strength (T_{ULT}) based upon minimum average roll values (MARV, lb/ft), ASTM D4595.
- Pullout Resistance Factor developed in accordance with Chapter 3 of NHI-10-024.

iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this document.

The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of value, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this document. The purpose of the QC testing program is to verify that the reinforcement geosynthetic being supplied to the project is representative of the material used for performance testing and approval by the Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum, the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	Test Procedure
Specific Gravity (HDPE only)	ASTM D1505 Wide
Width Tensile	ASTM D4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D1238
Intrinsic Viscosity (PET only)	ASTM D4603
Carboxyl End Group (PET only)	ASTM D2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D4354. Conformance testing procedures

shall be as established under section v. Manufacturing Quality Control. Geosynthetic product acceptance shall be based on ASTM D 4759.

The quality control certificate shall include:

- Roll numbers and identification.
- Sampling procedures.
- Result of quality control tests, including a description of test methods used.

vii. Select backfill Material for use with Geosynthetic Reinforcement – The backfill material shall conform to the requirements as stated above in Select Backfill Material of the Materials section; however, the maximum size of the backfill material shall be 3/4 inch, unless full scale installation damage tests are conducted in accordance with ASTM D5818.

- Joint Materials - Installed to the dimensions and thicknesses in accordance with the plans or approved shop drawings.

  i. If required, provide flexible foam strips for filler for vertical joints between panels, and in horizontal joints where pads are used, where indicated on the plans.

  ii. Provide in horizontal joints between panels preformed EPDM rubber pads conforming to ASTM D2000 for 4AA, 812 rubbers, neoprene elastomeric pads having a Durometer Hardness of 55 ± 5, or high-density polyethylene pads with a minimum density of 59 lb/ft^3 in accordance with ASTM D1505.

  iii. Cover all joints between panels on the back side of the wall with a geotextile meeting the minimum requirements for filtration applications as specified by AASHTO M 288. The minimum width and lap shall be 12 inches. Adhesive used to attach the filter fabric to the back of the panels shall be approved by the wall supplier.

- Concrete Leveling Pad, Traffic Barrier, and Coping - The concrete shall conform to the requirements of the Standard Specifications for 3,000 psi concrete.

- Acceptance of Material - The Contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

  Acceptance will be based certification.

2. Construction

a. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus 1 foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select backfill material compacted to 95 percent of the maximum density as determined by AASHTO T 99. The Contractor shall conduct any ground improvements required by the contract plans as part of foundation preparation.

At each panel foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be concrete with compressive strength of 3000 psi (28-day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

b. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After construction of the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier. The installation of bolted strap connections shall be as recommended by the fabricator and consistent with the design. For erection, panels are handled by means of a lifting device set into the upper edge of the panel. Precast concrete panels shall be placed such that a final vertical face will be obtained.

It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a vertical face for the final wall. Panels should be placed in successive horizontal lifts as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations. External bracing shall also be required for this initial lift. The wedges shall remain in place until the fourth layer of panels is placed, at which time the bottom layer of wedges shall be removed. Each succeeding layer of wedges shall be removed as the succeeding panel layers are placed. When the wall is completed, all wedges shall be removed. No wedges shall be used as a means of leveling panels on leveling pads. Wedges placed below the ground line on the front face of the wall shall be removed before this area is backfilled.

Tolerances and alignment shall be as follows:

i. Horizontal and vertical joint openings between panels shall be uniform. The maximum allowable offset in any panel joint shall be 3/4 inch.

ii. Vertical tolerance (plumbness) and horizontal alignment tolerances as the wall is constructed shall not exceed 3/4 inch when measured along a 10-foot straightedge.

The overall vertical tolerance of the wall (plumbness from top to bottom) in its final position shall not exceed 3/4 inch per 10 feet of wall height.

Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

Prior to placing any select backfill material on any soil reinforcement device, all connections to the panels shall be completed.

c. Backfill Placement - Backfill placement shall closely follow the erection of each lift of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including panels, soil reinforcements, and connections, or misalignment of the facing panels or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due

to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer at the Contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or truck equipment equivalent or larger than a Caterpillar D6 Bulldozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall be placed at a moisture content not more than 2 percentage points less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within three feet of the back face of the wall facing panel shall be achieved with at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be 10 inches and shall closely follow panel erection. The Contractor shall decrease this lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

F. Prefabricated Modular Block Facing Mechanically Stabilized Earth (MSE) Wall (See QPL for Approved Manufacturer/Supplier)

1. Materials

General - The Contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or from sources not listed in the contract document shall not be used without written consent from the Engineer.

- Concrete Modular Block Facing - The concrete modular blocks shall be either hollow or solid concrete structural retaining wall units, machine made from

Hydraulic cement, water, and mineral aggregates with or without the inclusion of other materials. The units are intended for use in the construction of mortarless, modular block retaining walls (MBW).

i. Cementitious Materials - Materials shall conform to the following:
   - Hydraulic Cement – Shall be as specified in **901.01** and conform to AASHTO M 85 (ASTM C150).
   - Pozzolans – Class C or Class F fly ash -AASHTO M 295 Blast Furnace Slag Cement – grade 100 or 120- AASHTO M 302 (ASTM C989).

ii. Aggregates - Aggregates shall conform to the following specifications, except that grading requirements shall not necessarily apply:
   - Normal Weight Aggregates – Standard Specification **903.01** and **903.03**.
   - Lightweight Aggregates - Standard Specification **903.19**.

iii. Other Constituents Air-entraining agents, coloring pigments, integral water repellants, finely ground silica, and other constituents shall be previously established as suitable for use in concrete MBW units and shall conform to applicable AASHTO Standards or, shall be shown by test or experience to be not detrimental to the durability of MBW units or any material customarily used in masonry construction.

iv. Physical Requirements. Prior to delivery to the work site, the units shall conform to the following physical requirements:
   1. Minimum required compressive strength = 4,000 psi (Average 3 coupons)
   2. Minimum required compressive strength = 3,500 psi (Individual coupon)
   3. Maximum water absorption = 5 percent
   4. Maximum number of blocks per lot = 2,000

   Prior to delivery, the Department will conduct verification testing on the modular blocks in accordance with SOP 1-1: "Quality Assurance for the Sampling, Testing of Materials and Products."

   If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests that products need to be verified.

v. Tolerances. Blocks shall be manufactured within the following tolerances:
   - The length and width of each individual block shall be within 1/8 inch of the specified dimension. Hollow units shall have a minimum wall thickness of 1-1/4 inch.
   - The height of each individual block shall be within 1/16 inch of the specified dimension.
   - When a broken face finish is required, the dimension of the front face shall be within 1 inch of the theoretical dimension of the unit.
   - Finish and Appearance. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g., no greater than 1/32 inch in width and no longer than 25 percent of the unit height) incidental to the usual method of

manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

The face or faces of units that are to be exposed shall be free of chips, cracks or other imperfections when viewed from 30 feet under diffused lighting. Up to 5 percent of a shipment may contain slight cracks or small chips not larger than 1 inch.

Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

- If pins are required to align MBW units, they shall consist of a non-degrading, polymer or galvanized steel and be made for the express use with the MBW units supplied.
- Cap units shall be cast to or attached to the top MBW units in strict accordance with the manufacturer's requirements and the adhesive manufacturer's recommended procedures. The Contractor shall provide a written 10-year warranty acceptable to the Department that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

vi. Sampling and Testing. Verification of the concrete block with respect to compressive strength and absorption will be determined on a lot of basis. The lot will be randomly sampled in accordance with ASTM C140. Compressive strength and absorption tests shall be performed by the manufacturer and submitted to the Department. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of section 6.2.4 of ASTM C140. Blocks represented by test coupons that do not reach an average compressive strength of 4,000 psi or an individual strength of 3,500 psi or have less than 5 percent absorption will be rejected.

vii. Rejection. Blocks shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

- Defects that indicate imperfect molding.
- Defects indicating honeycomb or open texture concrete.
- Cracked or severely chipped blocks.
- Color variation on front face of block due to excess form oil or other reasons.

Blocks may also be rejected if Departmental verification test results do not comply with the requirements specified above.

- Unit Fill - The unit fill and drainage aggregate shall be a well- graded crushed stone or granular fill meeting the following gradation:

U.S. Sieve Size	Percent Passing
1 inch	100-75
3/4 inch	50-75
No. 4	0-60
No. 40	0-50

No. 200	0-5

- Geosynthetic Reinforcement Material - The following requirements shall apply for geosynthetic reinforcement material:

  i. Geotextiles and Thread for Sewing - Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO M 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

  ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport, and installation.

  iii. Required Properties - The specific geosynthetic material(s) shall be pre-approved by the Department and shall have certified long-term strength (T_{al}) as determined by:

    - Long-Term strength (T_{al}) based on the Equation where RF_{CR} is from creep tests performed in accordance with ASTM D5262, RF_{ID} obtained from site installation damage testing and RF_{ID} from hydrolysis or oxidative degradation testing extrapolated to 75 or 100 year design life.

$$T_{al} = \frac{T_{ult}}{RF_D \times RF_{ID} \times RF_{CR}}$$

    - Ultimate Strength (T_{ULT}) based upon minimum average roll values (MARV) (lb/ft), ASTM D4595.
    - Pullout Resistance Factor developed in accordance with Chapter 3 of NHI-10-024.

  iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this section of this special provision. The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of values, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

  v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is

responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this special provision. The purpose of the QC testing program is to verify that the geosynthetic being supplied to the project is representative of the material used for performance testing and approval by the Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	Test Procedure
Specific Gravity (HDPE only)	ASTM D1505
Wide Width Tensile	ASTM D4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D1238
Intrinsic Viscosity (PET only)	ASTM D4603
Carboxyl End Group (PET only)	ASTM D2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D4354. Conformance testing procedures shall be as established under section v. Manufacturing Quality Control. Geosynthetic product acceptance shall be based on ASTM D4759.

The quality control certificate shall include:

- Roll numbers and identification
- Sampling procedures
- Result of quality control tests, including a description of test methods used.

vii. Select backfill Material for use with Geosynthetic Reinforcement The backfill material shall conform to the requirements as stated below in Select Backfill Material except that the maximum size of the backfill shall be 3/4 inch unless full scale installation damage tests are conducted in accordance with ASTM D5818.

All backfill material shall be tested prior to use and at the established frequencies in SOP 1-1: "Quality Assurance for the Sampling, Testing of Materials and Products."

- Soil Reinforcing and Attachment Devices - Where steel reinforcing and attachment devices are used in the construction of the MSE wall the following requirements shall apply.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A36) or AASHTO M 223 (ASTM A572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A123).

ii. Tie Strips - The tie strips shall be shop-fabricated of hot rolled steel conforming to the minimum requirements of ASTM A570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M111. Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A185). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M 111.

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM F3125 Grade A325). Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 and welded in accordance with AASHTO M 55 and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111. Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232. Alignment pins are to be hot dip galvanized.

All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

Any damage sustained by any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

- Concrete Leveling Pad, Traffic Barrier, and Coping - The concrete shall conform to the requirements of the Standard Specifications for 3,000 psi concrete.
- Acceptance of Material - The Contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

2. Construction

a. Wall Excavation - Unclassified excavation shall be in accordance with the requirements of the Standard Specifications and in reasonably close conformity with the limits and construction lines shown on the plans. Temporary excavation support as required shall be the responsibility of the Contractor.

b. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus 1 foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select backfill material compacted to 95 percent of the maximum density as determined by AASHTO T 99. The Contractor shall conduct any ground improvement required by the contract plans as part of foundation preparation.

   At each block foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be Class A concrete with compressive strength of 3,000 psi (28-day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

c. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier.

   It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a vertical face for the final wall. Blocks should be placed in successive horizontal lifts as backfill placement proceeds per the manufacturer's recommendations.

   Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

   Prior to placing any select backfill material on any soil reinforcement device, all connections to the blocks shall be completed.

d. Backfill Placement - Backfill placement shall closely follow the erection of each lift of blocks. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including blocks, soil reinforcements, and connections, or misalignment of the facing blocks or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing blocks due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or tracked equipment equivalent or larger than a Caterpillar D6 Dozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within 3 feet of the back of the wall facing shall be achieved with at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be 10 inches and shall closely follow modular block erection. The Contractor shall decrease this lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

G. Anchored Wall (See QPL for Approved Manufacturer/Supplier)

Part A - Part A covers specifications for permanent ground anchor walls exclusive of the ground anchors.

1. Design Criteria

Unless otherwise directed the Contractor shall select the type of wall element to be used. The wall shall be designed for shear, moment, and lateral and axial capacity in accordance with AASHTO LRFD procedures. The Contractor shall be responsible for determining the length of the wall element and required section necessary to resist loadings due to earth, and water forces while controlling ground movements. Structure design life and corrosion protection requirements for sheet-piles and soldier beams will be provided on the contract drawings. The design shall accommodate the sequence of construction as shown in the Contractor's erection plan. Soil properties, load and resistance factors, anchor tendon corrosion protection requirements, wall finish and color requirements, and appurtenance locations are given in the contract plans or specifications.

The Contractor shall be familiar with the requirements for ground anchors described in Part B, "Ground Anchors". The Contractor shall incorporate all dimensional and location

restrictions on ground anchor locations, spacing, and length of anchor bond length and unbonded length that may affect the design of the wall system covered by this section.

- The wall system shall be designed to resist maximum anticipated loadings calculated for the effects of any special loadings shown on the contract plans.
- The wall shall be designed to ensure stability against passive failure of the embedded portion of the vertical wall elements (below the base of excavation).
- The axial load carrying capacity of the embedded portion of the vertical wall elements (below the base of the excavation) shall be evaluated. The wall shall be designed to resist vertical loads including vertical anchor forces and the weight of the lagging and the vertical wall elements. Relying on transfer of vertical load into the soil behind the wall by friction shall not be permitted, unless approved by the Engineer.
- Permanent facing shall be precast or cast-in-place reinforced concrete. Architectural facing treatments, if required, shall be as indicated on the contract drawings. The facing shall extend a minimum of 2 feet below the gutter line or, if applicable, the ground line adjacent to the wall unless otherwise indicated on the contract drawings.
- The Contract Plans will provide minimum requirements of design elements in order to provide global stability requirement such as minimum embedment of vertical pile elements or minimum lengths of unbonded (free length) zone for anchors. The wall design shall provide these minimum requirements.
- Wall Drainage. The wall drainage system shall operate by gravity and shall be capable of relieving water pressures on the back face of the wall under anticipated worst case water pressure conditions. When drainage systems are incorporated into the specific design, hydrostatic head on the back of the wall shall not exceed 6 inches above the elevation of the drainage collection pipe.

2. Materials

The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in Section 3.0 in Part B below. The Contractor shall protect the materials from the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be stored under cover and protected against moisture.

- Soldier Beam and Structural Steels
  - i. Steel Soldier Beams, Structural Steel Shapes, and Steel Plate - Shall be of the type and weight indicated on the approved working drawings and shall conform to the requirements of AASHTO M 270 (ASTM A709) Grade 50.
  - ii. Steel Sheet Piles - Steel sheet piles shall be of the type and weight indicated on the approved working drawings. Steel sheet piles shall conform to the requirements of AASHTO M 202 (ASTM A328) or AASHTO M 270 (ASTM A 709) Grade 50.
  - iii. Steel Studs – Steel Studs shall conform to the requirements of AASHTO M 169 (ASTM A108)
  - iv. Steel Tube - Steel tube shall conform to the requirements of ASTM 1085 or ASTM A500, Grade B or Grade C.

v. Reinforcing Steel - Reinforcing steel shall conform to ASTM A615. The required Grade of all reinforcing shall be shown on the plans.

- Concrete

  i. Cement - Hydraulic cement shall be as specified in **901.01** or a Type II and shall conform to AASHTO M 85 (ASTM C150).

  ii. Structural Concrete - Structural concrete shall conform to the requirements of **604** of the Standard Specifications. Structural concrete shall have a minimum 28-day compressive strength of 3000 psi, unless otherwise noted on the contract drawings.

  iii. Lean-Mix Concrete Backfill - Lean-mix concrete backfill shall consist of hydraulic cement conforming to **901** of the Standard Specifications, fine aggregate, and water. Each cubic yard of lean-mix concrete backfill shall consist of a minimum of one sack (94lbs) of hydraulic cement.

- Drainage Materials

  i. Drainage Aggregate - Drainage aggregate to be used as a drainage medium shall conform to **903.17** of the Standard Specifications.

  ii. Preformed Permeable Geocomposite Drains – The preformed permeable geocomposite drains shall be continuous and a minimum of 1 foot wide. The drains shall be placed in sections with a minimum overlap of 1 foot and be spliced to assure continuous drainage.

  iii. Pipe and Perforated Pipe - Pipe and perforated pipe shall conform to **610** of the Standard Specifications.

- Lagging

  i. Temporary Timber Lagging - Temporary timber lagging shall be construction grade rough cut and shall be a minimum of 3 inches thick. Where necessary, the Contractor shall provide certification that the timber conforms to the grade, species, and other specified requirements. If the timber is to be treated with a preservative, a certificate of compliance shall be furnished.

  ii. Permanent Timber Lagging – Permanent timber lagging shall conform to all requirements of Temporary Timber Lagging and shall be constructed from structural stress-graded lumber.

3. Construction

- Submit an erection plan prepared and stamped by a Professional Engineer licensed in the State of Tennessee. Include the sequences of erection as the wall is built, vertical limits of excavation without anchors, when anchors installed and stressed, minimum backfill heights above anchor stressing, and maximum exposed heights allowed during each phase. Submit this plan to the Engineer at least 30 days before starting erection or removal.

- General Considerations

  Wall elements for anchored walls designed and constructed in accordance with this special provision shall be either continuous interlocking sheet-piles or steel soldier beams that are either driven or placed in pre-drilled holes that are subsequently backfilled with lean mix or structural concrete.

- Excavation

  Excavation below a level of anchors shall be limited to 2 feet below the anchor level and shall not commence below this level until anchors at that level have been installed, load tested, locked off and accepted by the Department. Placement of timber lagging shall immediately follow excavation in the front of the wall.

- Driven Sheet Pile and Soldier Beam Installation.

  Driven sheet piles and soldier beams shall be driven to the specified minimum tip elevation shown on the approved working drawings. The Contractor shall select a sheet pile or soldier beam section that satisfies all design criteria. The Contractor shall select a driving method and pile driving and ancillary equipment consistent with the expected ground conditions at the site. The sheet-pile or soldier beam shall be driven to the specified minimum tip elevation or to the approved elevation based on bearing capacity without damaging the sheet pile or soldier beam. The interlocks between adjacent sheet piles shall not be damaged. Equipment shall be used to permit the impact energy to be distributed over the tops of the sheet pile or soldier beam.

- Soldier Beam Installation in Pre-drilled Holes

  i. Excavations required for soldier beam placement shall be performed to the dimensions and elevations on the approved working drawings. The methods and equipment used shall be selected by the Contractor.

  ii. The Contractor shall ensure that the sidewalls of the pre-drilled holes (i.e., shafts) do not collapse during drilling. Uncased shafts may be used where the sides and the bottom of the shaft are stable and may be visually inspected prior to placing the soldier beam and concrete. Casing or drilling muds shall be used where the sides of the shaft require additional support.

  iii. The Contractor shall provide equipment for checking the dimensions and alignment of each shaft excavation. The dimensions and alignment shall be determined by the Contractor but shall be observed by the Inspector. The Inspector will check the alignment of the drilling equipment at the beginning of shaft construction and periodically thereafter. Final shaft depth shall be measured after final cleaning by the Contractor.

  iv. Loose material shall be removed from the bottom of the shaft. No more than 2 feet of standing water shall be left in the bottom of the shaft prior to beginning soldier beam installation.

  v. The soldier beam shall be placed in the shaft without difficulty and aligned prior to general placement of concrete. The Contractor may place up to 2 feet of concrete at the bottom of the shaft to assist in aligning the soldier beam. The soldier beam shall be blocked or clamped in place at the ground surface, prior to placement of concrete.

  vi. For shafts constructed without casing or drilling muds, concrete (either structural or lean-mix backfill) may be placed by free- falling the concrete from the ground surface down the shaft and around the soldier beam. If casing is used, the placement of concrete shall begin prior to casing removal. Remove the casing while the concrete remains workable. For shafts constructed using slurry, concrete shall be placed using the tremie method from the bottom of the shaft. The tremie pipe shall be withdrawn slowly as

the level of the concrete rises in the shaft and the level of the tremie pipe outlet shall never exceed the height of the slurry.

- Wall Tolerances

  i. Soldier beams shall be placed at the locations shown on the approved working drawings and shall not deviate by more than 1 foot along the horizontal alignment of the wall. The wall shall not deviate from the vertical alignment shown of the contract drawings by more than 4 inches in each plane.

  ii. The soldier beam or sheet pile tip shall be installed to within 1 foot of the specified tip elevation shown on the approved working drawings.

  iii. Whenever a soldier beam deviates in location or plumbness by more than the tolerance given in these guidelines, the Contractor, has the option, may provide corrective measures such as 1) rebuilding soldier beams; 2) redesigning soldier beam; 3) adjust soldier beam spacing by adding additional soldier beams; 4) redesigning concrete facing; 5) building up the soldier beam section, or 6) other methods.

- Welding and Splicing

  Splicing of sheet piles or soldier beams shall not be permitted, unless approved by the Department. All structural welding of steel and steel reinforcement shall be performed by certified welders qualified to perform the type of welding shown on the shop drawings. All sheet piles or soldier beams shall be cutoff to a true plane at the elevations shown on the approved working drawings. All cutoff lengths shall remain the property of the Contractor and shall be properly disposed.

- Timber Lagging Installation

  i. Timber lagging shall be placed from the top-down in sufficiently small lifts immediately after excavation to prevent erosion of materials into the excavation. Prior to lagging placement, the soil face shall be smoothed to create a contact surface for the lagging. Large gaps behind the lagging shall be backfilled and compacted prior to applying any loads to the ground anchors.

  ii. A gap shall be maintained between each vertically adjacent lagging board for drainage between adjacent lagging sections. In no case shall lagging be placed in tight contact to adjacent lagging.

- Drainage System Installation

  i. The Contractor shall handle preformed permeable geocomposite drains in such a manner as to ensure the geocomposite drain is not damaged in any way. Care shall be taken during placement of the geocomposite drain not to entrap dirt or excessive dust in the geocomposite drain that could cause clogging of the drainage system. Delivery, storage, and handling of the geocomposite drains shall be as provided in the plans or based on manufacturer's recommendations.

  ii. Drainage geocomposite strips shall be placed and secured tightly against the timber lagging with the fabric facing the lagging. A continuous sheet of drainage geocomposite that spans between adjacent soldier beams shall not be allowed. Seams and overlaps between adjacent composites shall be made

according to the special provisions or manufacturer's recommendations and specifications. Repairs shall be performed at no additional cost to the Department and shall conform to the plans or manufacturer's recommendation.

iii. Where drainage aggregate is used to construct a vertical drain behind the permanent wall and in front of the lagging, the drainage aggregate shall be placed in horizontal lifts. The construction of the vertical drain should closely follow the construction of the precast facing elements. Care should be exercised to ensure that connection devices between wall elements and facing elements are not damaged during the placement of the drainage aggregate.

iv. Perforated collector pipe shall be placed within the permeable material to the flow line elevations and at the location shown on the approved working drawings. Outlet pipes shall be placed at the low end of the collector pipe and at other locations shown or specified in the approved working drawings.

- Concrete Facing Installation

  For permanent cast-in-place and precast concrete facings, concrete manufacture, handling, placement, and finishing shall conform to the requirements in Section 8 "Concrete Structures" of the AASHTO-*LR FD Bridge Construction Specifications with interims.* Connections used to secure the facing to wall elements shall conform to the details shown on the approved working drawings. The exposed surface of the concrete facing shall receive a Class I finish as specified in Section 8 "Concrete Structures," unless a special architectural treatment is specified.

Part B, Anchored Wall (See QPL for Approved Systems) – Part B covers specifications for the design, construction, and testing of Permanent Ground Anchors.

1. Description

The work covered under this section includes the furnishing of all materials, labor, tools, equipment, and other incidental items for the designing, detailing, and construction of permanent ground anchors. All other items included in the construction of the permanent ground anchors not specifically mentioned herein shall conform to all applicable sections of the Standard Specifications, henceforth referred to as the Standard Specifications, the current *AASHTO LRFD Bridge Design Specifications* with latest revisions, the current *AASHTO LRFD Bridge Construction Specifications* with interims, and the latest version of Post Tensioning Institute (PTI) Standards, including: 1. *PTI, "Post Tensioning Manual"*, 2. *PTI "Specification for Unbonded Single Strand Tendons"*, 3. *PTI "Recommendations for Prestressed Rock and Soil Anchors."*

Unless otherwise noted the Contractor shall select the ground anchor type, drilling method, grouting method, and grout pressures, determine the ground anchor capacity, bond length, free stressing (unbonded) length, and anchor diameter. The Contractor shall be responsible for installing ground anchors that will develop the load-carrying capacity indicated on the approved working drawings in accordance with the testing subsection of this section. The anchor tendon shall be protected from corrosion as shown on the approved working drawings and in accordance with the requirements of this specification.

2. Design Criteria

- Unless otherwise directed the Contractor shall select the type of tendon to be used. The tendon shall be sized so the design load does not exceed 60 percent of the specified

minimum tensile strength of the prestressing steel. The lock-off load for the tendon shall be chosen based on anticipated time or activity dependent load changes but shall not exceed 70 percent of the specified minimum tensile stress of the prestressing steel. The prestressing steel shall be sized so the maximum test load does not exceed 80 percent of the specified minimum tensile strength of the prestressing steel.

- The Contractor shall be responsible for determining the bond length necessary to develop the design load indicated on the approved working drawings. The minimum bond length shall be 15 feet for strand tendons in rock and 10 feet for bar tendons in rock. The minimum bond length shall be 15 feet for strand and bar tendons in soil. The minimum tendon bond length shall be 10 feet.
- The free stressing length (unbonded length) for rock and soil anchors shall not be less than 10 feet for bar tendons and 15 feet for strand tendons. The free stressing length shall extend at least 5 feet or 20 percent of the height of the wall, whichever is greater, behind the critical failure surface. The critical failure surface shall be evaluated using slope stability or similar procedures.

3. Submittals

Requirements for submittals are as outlined above and include the following:

- Contractor should be familiar with the requirements as outlined in Part A, of these anchored wall design and construction requirements.
- The working drawings and design submission shall include the following:
  a) A ground anchor schedule giving:
     - Ground anchor number
     - Ground anchor design load
     - Type and size of tendon
     - Minimum total anchor length
     - Minimum bond length
     - Minimum tendon bond length
     - Minimum unbonded length
  b) A drawing of the ground anchor tendon and the corrosion protection system including details for the following:
     - Spacers and their location
     - Centralizers and their location
     - Unbonded length corrosion protection system
     - Bond length corrosion protection system
     - Anchorage and trumpet
     - Anchorage corrosion protection system
- Certificates of Compliance for the following materials, if used. The certificate shall state that the materials or assemblies to be provided will fully comply with the requirements of the contract.
  a) Prestressing steel, strand, or bar
  b) Hydraulic cement
  c) Prestressing hardware
  d) Bearing plates
  e) Corrosion protection system
- The Contractor shall submit to the Engineer for review and approval or rejection mill

test reports for the prestressing steel and the bearing plate steel. The Engineer may require the Contractor to provide samples of any ground anchor material intended for use on the project. The prestressing steel and bearing plates shall not be incorporated in the work without the Engineer's approval.

- The Contractor shall submit to the Engineer for review and approval or rejection calibration data for each test jack, load cell, primary pressure gauge and reference pressure gauge to be used. Testing cannot commence until the Engineer has approved these calibrations.
- The Contractor shall submit to the Engineer within twenty calendar days after the completion of the ground anchor work a report containing the following:

  a) Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation.
  b) Grouting records indicating the cement type, quantity injected and the grout pressures.
  c) Ground anchor test results.
  d) As-built drawings showing the location and orientation of each ground anchor, anchor capacity, tendon type, total anchor length, bond length, unbonded length, and tendon bond length as installed, and locations of all instruments installed by the Department.

4. Materials

- General

  a) The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in Section 3 in Part B of Anchored Walls.

  b) The Contractor shall protect all materials from theft, vandalism, and the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be protected from the elements at all times. Cement and additives for grout shall be stored under cover and protected against moisture.

- Anchorage Devices

  a) Stressing anchorages shall be a combination of either steel bearing plate with wedge plate and wedges, or a steel bearing plate with a threaded anchor nut. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices shall be capable of developing 95 percent of the specified minimum ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the latest edition of the PTI "*Guide Specifications for Post- Tensioning Materials."*

  b) The bearing plate shall be fabricated from steel conforming to AASHTO M 183 or M 222 specifications, or equivalent, or may be a ductile iron casting conforming to ASTM A536.

  c) The trumpet shall be fabricated from a steel pipe or tube or from PVC pipe. Steel pipe or tube shall conform to the requirements of ASTM A53 for pipe or ASTM A500 for tubing. Steel trumpets shall have a minimum wall thickness of 0.1 inch for diameters up to 4 inches and 0.2 inch for larger diameters. PVC

pipe shall conform to ASTM D1785, Schedule 40 minimum. PVC trumpets shall be positively sealed against the bearing plate and aligned with the tendon to prevent cracking during stressing.

d) Anchorage covers shall be fabricated from steel or plastic with a minimum thickness of 0.1 inch. The joint between the cover and the bearing plate shall be watertight.

e) Wedges shall be designed to preclude premature failure of the prestressing steel due to notch or pinching effects under static and dynamic strength requirements of Section 3.1.8 (1) and 3.1.8 (2) of the PTI *"Post Tensioning Manual."* Wedges shall not be reused.

f) Wedges for epoxy coated strand shall be designed to be capable of biting through the epoxy coating and into the strand. Removal of the epoxy coating from the strand to allow the use of standard wedges shall not be permitted. Anchor nuts and other threadable hardware for epoxy coated bars shall be designed to thread over the epoxy coated bar and still comply with the requirements for carrying capacity.

- Prestressing Steel

a) Ground anchor tendons shall be fabricated from single or multiple elements of one of the following prestressing steels:
   - Steel bars conforming to AASHTO M 275
   - Seven-wire, low relaxation strands conforming to AASHTO M 203
   - Compact, seven-wire, low-relaxation strands conforming to ASTM A779l
   - Epoxy coated strand conforming to ASTM A882
   - Epoxy coated reinforcing steel bars conforming to ASTM A775

b) Centralizers shall be provided at maximum intervals of 10 feet with the deepest centralizer located 1 foot from the end of the anchor and the upper centralizer for the bond zone located no more than 5 feet from the top of the tendon bond length. Spacers shall be used to separate the steel strands of strand tendons. Spacers shall be provided at maximum intervals of 10 feet and may be combined with centralizers.

- Prestressing Steel Couplers

Prestressing steel bar couplers shall be capable of developing 100 percent of the minimum specified ultimate tensile strength of the prestressing steel bar. Steel strands used for a soil or rock anchor shall be continuous with no splices, unless approved by the Engineer.

- Centralizers

a) Centralizers shall be fabricated from plastic, steel, or material, which is non-detrimental to the prestressing steel. Wood shall not be used. The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 2 inches of grout cover is provided and shall permit grout to freely flow around the tendon and up the drill hole.

b) Centralizers are not required on pressure injected anchors installed in coarse grained soils when the grouting pressure exceeds 145 psi or on hollow stem-augured anchors when they are grouted through the auger with grout having a

slump of 9 inches or less.

- Spacers

  Spacers shall be used to separate elements of a multi-element tendon and shall permit grout to freely flow around the tendon and up the drill hole. Spacers shall be fabricated from plastic, steel, or material, which is non-detrimental to the prestressing steel. Wood shall not be used. A combination centralizer- spacer may be used.

- Tendon Bond Length Encapsulations

  When the contract plans require the tendon bond length to be encapsulated to provide additional corrosion protection, the encapsulation shall be fabricated from one of the following:

  a) High density corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 0.06 inch except pre-grouted tendons, which may have a minimum wall thickness of 0.04 inch.

  b) Deformed steel tubing or pipes conforming to ASTM A52 or A500 with a minimum wall thickness of 0.2 inch.

  c) Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D1784, Class 13464- B.

  d) Fusion-bonded epoxy conforming to the requirements of AASHTO M 284.

- Heat Shrinkable Sleeves

  Heat shrinkable sleeves shall be fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube shall have a nominal wall thickness of 0.025 inch. The adhesive sealant inside the heat shrinkable tube shall have a nominal thickness of 0.02 inch.

- Sheath

  A sheath shall be used as part of the corrosion protection system for the unbonded length portion of the tendon. The sheath shall be fabricated from one of the following:

  a) A polyethylene tube pulled or pushed over the prestressing steel. The polyethylene shall be Type II, III or IV as defined by ASTM D1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  b) A hot-melt extruded polypropylene tube. The polypropylene shall be cell classification B55542-11 as defined by ASTM D4101 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  c) A hot-melt extruded polyethylene tube. The polyethylene shall be high density Type III as defined by ASTM D1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  d) Steel tubing conforming to ASTM A500. The tubing shall have a minimum wall thickness of 0.2 inch.

  e) Steel pipe conforming to ASTM A53. The pipe shall have a minimum wall thickness of 0.2 inch.

  f) Plastic pipe or tube of PVC conforming to ASTM D1784 Class 13464-B. The pipe or tube shall be Schedule 40 at a minimum.

  g) A corrugated tube conforming to the requirement of the tendon bond length

encapsulation Subsection 4.g. above.

- Bondbreaker

  The bondbreaker shall be fabricated from a smooth plastic tube or pipe having the following properties: (1) resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compound; (2) resistant to aging by ultraviolet light; (3) fabricated from material non- detrimental to the tendon; (4) capable of withstanding abrasion, impact, and bending during handling and installation; (5) enable the tendon to elongate during testing and stressing; and (6) allow the tendon to remain unbonded after lockoff.

- Cement Grout

  Hydraulic cement conforming to **901** of Standard Specifications and AASHTO M 85 shall be used for grout. The grout shall be a pumpable neat mixture of cement and water and shall be stable (bleed less than 2 percent), fluid, and provide a minimum 28-day compressive strength of at least 3,000 psi measured in accordance with ASTM C109 at the time of stressing.

- Admixtures (Approved on the QPL)

  Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the approval of the Engineer. Admixtures, if used, shall be compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendation. Expansive admixtures may only be added to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerators shall not be permitted.

- Water

  Water for mixing grout shall be potable, clean, and free of injurious quantities of substances known to be harmful to hydraulic cement or prestressing steel.

- Corrosion Inhibiting Compound

  The corrosion inhibiting compound placed in either the free length or the trumpet areas shall be an organic compound (i.e., grease or wax) with appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound shall permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and anchor grout.

- Grout Tubes

  Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes shall be strong enough to withstand a minimum grouting pressure of 145 psi. Post-grout tubes shall be strong enough to withstand post-grouting pressures.

5. Construction

a. Tendon Storage and Handling

- Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel, the corrosion protection, and/or the epoxy coating as a result of abrasions, cuts, nicks, welds, or weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity.

Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, or other deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer shall reject the affected tendons.

- The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Inspector shall examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Inspector, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the inspector, the smooth sheathing has been damaged, the Contractor shall repair it with ultra-high molecular weight polyethylene tape. The tape should be spiral wound around the tendon to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.
- Banding for fabricated tendons shall be padded to avoid damage to the tendon corrosion protection. Upon delivery, the fabricated anchors, or the prestressing steel for fabrication of the tendons on site and all hardware shall be stored and handled in such a manner to avoid mechanical damage, corrosion, and contamination with dirt or deleterious substances.
- Lifting of the pre-grouted tendons shall not cause excessive bending, which can debond the prestressing steel from the surrounding grout.
- Prestressing steel shall not be exposed to excessive heat (i.e., more than 446° F).

b. Anchor Fabrication

- Anchors shall be either shop or field fabricated from material conforming to Part B, Anchored Wall, Part 4 Materials and as shown in the approved working drawings and schedules.
- Prestressing steel shall be cut with an abrasive saw or, with the written approval of the prestressing steel supplier, an oxyacetylene torch.
- All of the tendon bond length, especially for strand, must be free of dirt, manufacturer's lubricants, corrosion-inhibitive coatings, or other deleterious substances that may significantly affect the grout- to-tendon bond or the service life of the tendon.
- Pre-grouting of encapsulated tendons shall be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

c. Drilling

- Drilling methods shall be left to the discretion of the Contractor, whenever possible. The Contractor shall be responsible for using a drilling method to establish a stable hole of adequate dimensions, within the tolerances specified. Drilling methods may involve, amongst others, rotary, percussion, rotary/percussive or auger drilling, or percussive or vibratory driven casing.
- Holes for anchors shall be drilled at the locations and to the length, inclination and diameter shown on the approved working drawings. The drill bit or casing crown shall not be more than 0.12 inch smaller than the specified hole diameter. At the ground surface the drill hole shall be located within 1 foot of

the location shown on the approved working drawings. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, the ground anchor hole shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry, the ground anchor shall be installed within plus/minus 3 degrees of the inclination from horizontal shown on the approved working drawings. At the point of entry, the horizontal angle made by the ground anchor and the structure shall be within plus/minus 3 degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the approved working drawings. The ground anchors shall not extend beyond the right of- way or easement limits shown on the contract drawings.

d. Tendon Insertion

- Tendons shall be placed in accordance with the approved working drawings and details and the recommendations of the tendon manufacturer or specialist anchor Contractor. The tendon shall be inserted into the drill hole to the desired depth without difficulty.
- Each anchor tendon shall be inspected by Department field personnel during installation into the drill hole or casing. Damage to the corrosion protection system shall be repaired, or the tendon replaced if not repairable. Loose spacers or centralizers shall be reconnected to prevent shifting during insertion. Damaged fusion bonded epoxy coatings shall be repaired in accordance with the manufacturer's recommendations. If the patch is not allowed to cure prior to inserting the tendon in the drill hole, the patched area shall be protected by tape or other suitable means.

e. The rate of placement of the tendon into the hole shall be controlled such that the sheathing, coating, and grout tubes are not damaged during installation of the tendon. Anchor tendons shall not be subjected to sharp bends. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing, or sheathing.

f. Grouting

- The Contractor shall use a neat cement grout or a sand- cement grout. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendation.
- The grouting equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor pressures. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressure used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.
- The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casings, hollowstem-augers, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout take shall be controlled to prevent excessive heave or

- After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting shall not be used in the free length zone. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.
- If the ground anchor is installed in a fine-grained soil using drill holes larger than 6 inches in diameter, then the grout above the top of the bond length shall be placed after the ground anchor has been tested and stressed. The Engineer will allow the Contractor to grout the entire drill hole at the same time if the Contractor can demonstrate that their particular ground anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the ground anchor.
- If grout protected tendons are used for ground anchors anchored in rock, then pressure grouting techniques shall be utilized. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for at least 5 minutes.
- The grout tube may remain in the hole on completion of grouting if the tube is filled with grout.
- After grouting, the tendon shall not be loaded for a minimum of 3 days.

g. Anchorage Installation

- The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon, within plus/minus 3 degrees and centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout, and dirt.
- The stressing tail shall be cleaned and protected from damage until final testing and lock-off. After the anchor has been accepted by the Engineer, the stress tail shall be cut to its final length according to the tendon manufacturer's recommendations.
- The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 4 inches into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.
- The corrosion protection surrounding the unbonded length of the tendon shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

h. Corrosion Protection

- Protection Requirements

  Corrosion protection requirements shall be determined by the Department and shall be shown on the contract plans. The corrosion protection systems shall be designed and constructed to provide reliable ground anchors for temporary and permanent structures.

- Anchorage Protection

  a) All stressing anchorages permanently exposed to the atmosphere shall receive a grout-filled cover, except, for restressable anchorages where a corrosion inhibiting compound must be used. Stressing anchorages encased in concrete at least 2 inches thick do not require a cover.

  b) The trumpet shall be sealed to the bearing plate and shall overlap the unbonded length corrosion protection by at least 4 inches. The trumpet shall be long enough to accommodate movements of the structure and the tendon during testing and stressing. On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the unbonded length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

  c) The trumpet shall be completely filled with grout, except restressable anchorages must use corrosion inhibiting compounds. Compounds may be placed any time during construction. Compound filled trumpets shall have a permanent seal between the trumpet and the unbonded length corrosion protection. Grout must be placed after the ground anchor has been tested and stressed to the lock-off load. Trumpets filled with grout shall have either a temporary seal between the trumpet and the unbonded length corrosion protection or the trumpet shall fit tightly over the unbonded length corrosion protection for a minimum of 4 inches.

- Unbonded Length Protection

  a) Corrosion protection of the unbonded length shall be provided by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound, depending on the tendon class. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

  b) The corrosion protective sheath surrounding the unbonded length of the tendon shall be long enough to extend into the trumpet but shall not come into contact with the stressing anchorage during testing. Any excessive protection length shall be trimmed off.

  c) For pre-grouted encapsulations and all Class I tendons, a separate bond breaker or common sheath shall be provided for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

- Unbonded Length/Bond Length Transition

  The transition between the corrosion protection for the bonded and unbonded lengths shall be designed and fabricated to ensure continuous protection from corrosive attack.

- Tendon Bond Length Protection for Grout Protected Tendons (Class II)

  a) Cement grout can be used to protect the tendon bond length in non-aggressive ground when the installation methods ensure that the grout will

remain fully around the tendon. The grout shall overlap the sheathing of the unbonded length by at least 1 inch.

b) Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the tendon bond length.

- Tendon Bond Length Protection for Encapsulated Tendons (Class I)

  a) A grout-filled, corrugated plastic encapsulation or grout-filled, deformed steel tube shall be used. The prestressing steel can be grouted inside the encapsulation prior to being placed.

  b) Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the encapsulation.

- Epoxy

  A fusion-bonded epoxy may be used to provide a layer of protection for the steel tendon in addition to the cement grout.

- Coupler Protection

  a) On encapsulated bar tendons (Class I), the coupler and any adjacent exposed bar sections shall be covered with a corrosion-proof compound or wax-impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube, complying with the requirements set forth in 4.9, overlapping the adjacent sheathed tendon by at least 1 inch. The two joints shall be sealed each by a coated heat shrink sleeve of at least 6 inches in length or approved equal. The corrosion-proof compound shall completely fill the space inside the cover tube.

  b) Corrosion protection details for strand couplers, if specifically permitted, shall be submitted for approval of the Engineer.

i. Stressing, Load Testing, and Acceptance

- General

  Each ground anchor shall be tested. No load greater than 10 percent of the design load can be applied to the ground anchor prior to testing. The maximum test load shall be no less than 1.33 times the design load and shall not exceed 80 percent of the specified minimum ultimate tensile strength of the prestressing steel of the tendon. The test load shall be simultaneously applied to the entire tendon. Stressing of single-element tendons shall not be permitted.

- Stressing Equipment

  The testing equipment shall consist of:

  a) A dial or vernier scale capable of measuring to the nearest .001 inch shall be used to measure the ground anchor movement. The movement measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and it shall have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.

  b) A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated primary pressure gauge shall be used to measure the

applied load. The jack and primary pressure gauge shall be calibrated by an independent firm as a unit. The calibration shall have been performed within 45 working days of the date when the calibration submittals are provided to the Engineer. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge shall be graduated in 100 psi increments or less. The ram travel shall be at least 6 inches and preferably not be less than the theoretical elongation of the tendon at the maximum test load. If elongations greater than 6 inches are required, re-stroking can be allowed.

c) A calibrated reference pressure gauge shall also be kept at the site to periodically check the production (i.e., primary pressure) gauge. The reference gauge shall be calibrated with the test jack and primary pressure gauge. The reference pressure gauge shall be stored indoors and not subjected to rough treatment.

d) The Contractor shall provide an electrical resistance load cell and readout to be used when performing an extended creep test.

e) The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

f) The stressing equipment, the sequence of stressing and the procedure to be used for each stressing operation shall be determined at the planning stage of the project. The equipment shall be used strictly in accordance with the manufacturer's operating instructions.

g) Stressing equipment shall preferably be capable of stressing the whole tendon in one stroke to the specified test load and the equipment shall be capable of stressing the tendon to the maximum specified test load within 75 percent of the rated capacity. The pump shall be capable of applying each load increment in less than 60 seconds.

h) The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications and allow the anchor to be lift-off tested to confirm the lock off load.

i) Stressing equipment shall have been calibrated, within an accuracy of plus or minus 2 percent, a maximum of 45 days prior to use. The calibration certificate and graph shall be available on site at all times. The calibration shall be traceable to the National Institute of Standards and Technology (NIST).

- Load Test Setup

a) Dial gauges shall bear on the pulling head of the jack and their stems shall be coaxial with the tendon direction. The gauges shall be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation.

b) Prior to setting the dial gauges, the Alignment Load (AL) shall be accurately placed on the tendon. The magnitude of the AL depends on the type and

length of the tendon.

c) Re-gripping of strands, which would cause overlap wedge bites, or wedge bites on the tendon below the anchor head, shall be avoided.

d) Stressing and testing of multiple element tendons with single element jacks is not permitted.

e) Stressing shall not begin until the grout has reached adequate strength.

- Performance Tests

Five percent of the ground anchors or a minimum of 3 ground anchors, whichever is greater, shall be performance tested in accordance with the procedures described in this section. The Engineer shall select the ground anchors to be performance tested. The remaining ground anchors shall be tested in accordance with the proof test procedures.

The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the schedule provided below. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest (0.001) of an inch with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with the primary pressure gauge. The reference pressure gauge shall be placed in series with the primary pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than 10 percent, the jack, primary pressure gauge and reference pressure gauge shall be recalibrated at no expense to the Department. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

- The maximum test load in a performance test shall be held for 10 minutes. A load cell shall be used to monitor small changes in load during constant load-hold periods.
- The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement, with respect to a fixed reference, shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between 1 minute and ten 10 minutes exceeds 0.04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movement shall be recorded at 15, 20, 30, 40, 50 and 60 minutes.

Steps for the Performance Test – The steps for the performance test are detailed in the table on the following page:

Performance Test Steps

Step	Loading	Applied Load	Record and Plot Total Movement (d_{ti})	Record and Plot Residual Movement (d_{ri})	Calculate Elastic Movement (d_{ei})
1	Apply alignment load (AL)				
2	Cycle 1	0.25DL	$\mathbf{d_{t1}}$		$\mathbf{d_{t1} - d_{r1} = d_{e1}}$
		AL		$\mathbf{d_{r1}}$	
3	Cycle 2	0.25DL	$\mathbf{d_2}$		$\mathbf{d_{t2} - d_{r2} = d_{e2}}$
		0.50DL	$\mathbf{d_{t2}}$		
		AL		$\mathbf{d_{r2}}$	
4	Cycle 3	0.25DL	$\mathbf{d_3}$		$\mathbf{d_{t3} - d_{r3} = d_{e3}}$
		0.50DL	$\mathbf{d_3}$		
		0.75DL	$\mathbf{d_{t3}}$		
		AL		$\mathbf{d_{r3}}$	
5	Cycle 4	0.25DL	$\mathbf{d_4}$		$\mathbf{d_{t4} - d_{r4} = d_{e4}}$
		0.50DL	$\mathbf{d_4}$		
		0.75DL	$\mathbf{d_4}$		
		1.00DL	$\mathbf{d_{t4}}$		
		AL		$\mathbf{d_{r4}}$	
6	Cycle 5	0.25DL	$\mathbf{d_5}$		$\mathbf{d_{t5} - d_{r5} = d_{e5}}$
		0.50DL	$\mathbf{d_5}$		
		0.75DL	$\mathbf{d_5}$		
		1.00DL	$\mathbf{d_5}$		
		1.2DL	$\mathbf{d_{t5}}$		
		AL		$\mathbf{d_{r5}}$	
7	Cycle 6	0.25DL	$\mathbf{d_6}$		
		0.50DL	$\mathbf{d_6}$		
		0.75DL	$\mathbf{d_6}$		
		1.00DL	$\mathbf{d_6}$		
		1.2DL	$\mathbf{d_6}$		
		1.33DL	$\mathbf{d_{t6}}$**, zero reading for creep test**		
8	Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value, then the load hold should be extended to a total of 60 minutes.				
9	Cycle 6 cont'd	AL		$\mathbf{d_{r6}}$	Cycle 6: $\mathbf{d_{tn} - d_{r6} = d_{e6}}$

Notes: AL = Alignment Load, DL = Design Load, d_i = total movement at a load other than maximum for cycle, i = number identifying a specific load cycle.

- Proof Tests

  The proof test shall be performed by incrementally loading the ground anchor in accordance with the following schedule. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment load. The load shall be monitored with the primary pressure gauge. At load increment other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Proof Test Schedule

Step	Load
1	AL
2	0.25DL
3	0.50DL
4	0.75DL
5	1.00DL
6	1.20DL
7	1.33DL
8	Reduce to lock-off load
9	AL (optional)
10	Adjust to lock-off load

  - The maximum test load in a proof test shall be held for 10 minutes. The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement with respect to a fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between 1 minute and 10 minutes exceeds 0.04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movements shall be recorded at 15, 20, 30, 40, 50, and 60 minutes.

- Extended Creep Tests

  a) The Department shall determine if extended creep testing is required and select those ground anchors that are to be creep tested. If creep tests are required, at least 2 ground anchors shall be tested. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 50 psi.

  b) The extended creep test shall be made by incrementally loading and unloading the ground anchor in accordance with the performance test schedule. At the end of each loading cycle, the load shall be held constant for the observation period indicated in the creep test schedule below. The times for reading and recording the ground anchor movement during each observation period shall be 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270 and 300 minutes as appropriate for the load increment. Each load-hold period shall start as soon as the test load is applied. In a creep test, the primary pressure gauge and reference pressure

gauge will be used to measure the applied load and the load cell will be used to monitor small changes in load during constant load-hold periods. The jack shall be adjusted as necessary in order to maintain a constant load.

c) The Contractor shall plot the ground anchor movement and the residual movement measured in an extended creep test. The Contractor shall also plot the creep movement for each load hold as a function of the logarithm of time.

Extended Creep Test Schedule

Load	**Observation period (min)**
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

- Ground Anchor Acceptance Criteria

  A performance-tested or proof-tested ground anchor with a 10-minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with less than 0.04 inch of movement between 1 minute and 10 minutes; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

  a) A performance-tested or proof-tested ground anchor with a 60-minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

  b) A ground anchor subjected to extended creep testing is acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

  c) The initial lift-off reading shall be within plus or minus 5 percent of the designated lock-off load. If this criterion is not met, then the tendon load shall be adjusted accordingly and the initial lift-off reading repeated.

- Procedures for Anchors Failing Acceptance Criteria

  a) Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced at no additional cost to the Department or locked off at no more than 50 percent of the maximum acceptable load attained. In this event, no further acceptance criteria are applied.

  b) Regroutable anchors which satisfy the minimum apparent free length criteria, but which fail the extended creep test at the test load may be post

grouted and subjected to an enhanced creep criterion. This enhance criterion requires a creep movement of not more than 0.04 inch between 1 and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion shall be locked off at the design lock-off load. Anchors which cannot be post grouted or regroutable anchors that do not satisfy the enhanced creep criterion shall be either rejected or locked off at 50 percent of the maximum acceptable test load attained. In this event, no further acceptance criteria are applied. The maximum acceptable test load with respect to creep shall correspond to that where acceptable creep movements are measured over the final log cycle of time.

c) In the event that the anchor fails, the Contractor shall modify the design and/or construction procedures. These modifications may include, but are not limited to, installing additional anchors, modifying the installation methods, reducing the anchor design load by increasing the number of anchors, increasing the anchor length, or changing the anchor type. Any modification of design or construction procedures shall be at no change in the contract price. A description of any proposed modifications must be submitted to the Engineer in writing. Proposed modifications shall not be implemented until the Contractor receives written approval from the Engineer.

- Anchor Lock-Off

  a) After testing has been completed, the load in the tendon shall be such that after seating losses (i.e., wedge seating); the specified lock-off load has been applied to the anchor tendon.

  b) The magnitude of the lock-off load shall be specified in the approved working drawings, or as determined by the designer.

  c) The wedges shall be seated at a minimum load of 50 percent Fpu. If the lock-off load is less than 50 percent Fpu, shims shall be used under the wedge plate and the wedges seated at 50 percent Fpu. The shims shall then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70 percent F_{pu}.

- Anchor Lift-Off Test

  After transferring the load to the anchorage, and prior to removing the jack, a lift-off test shall be conducted to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate (or anchor nut) without unseating the wedges (or turning the anchor nut). This moment represents zero time for any long-time monitoring.

S T A T E **O F** **T E N N E S S EE**

Rev. 5/18/17 January 1, 2021
(Rev. 9/1/21)

SPECIAL PROVISION

REGARDING

DRILLED SHAFT SPECIFICATIONS

625.01 Description

This work consists of constructing cast-in-place reinforced concrete drilled shafts and rock sockets, as required, to serve as a structural foundation. This work shall provide reinforced concrete shafts cast in cylindrically excavated holes extending sufficiently into soil or sound rock to adequately support the structure and all externally applied loads for which the shaft was designed. The drilled shaft foundation, including the rock socket, where required, shall be constructed in accordance with these Specifications, as shown on the Plans and in accordance with other Specifications included in the contract documents.

625.02 Qualifications of Drilled Shaft Contractor

The driller and/or foreman or superintendent on the project site shall be experienced in the drilled shaft specialty and have installed drilled shafts of both diameter and length similar to those shown on the Plans. The driller and/or foreman or superintendent on site shall have a minimum of three years of experience in the geologic conditions associated with the project site prior to the bid date for this project. This work shall be performed under the direct supervision of driller, foreman or superintendent knowledgeable and experienced in the method of constructing drilled shafts as required by the project. Supply all equipment required to complete the work within the specified contract time. Furnish evidence of experience and expertise that meets the following requirements:

A list containing a description of at least five projects either on-going or completed in the last three years on which the driller, foreman or superintendent responsible for the drilled shaft construction, have installed drilled shafts of similar size as shown in the Plans and with similar excavation techniques anticipated for this project. This list of projects shall contain a brief description of the project as well as names and phone numbers of the project owner's representatives who can verify the participation on the project.

625.03 Drilled Shaft Work Plan

Develop a work plan for all the drilled shafts and submit the plan for review and acceptance by the Engineer 30 days prior to beginning construction of the drilled shafts. The Drilled Shaft Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications in **625.02.**
2. List and size of proposed equipment; including cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout buckets, airlifts and/or submersible pumps, tremies and/or concrete pumps, casing (diameters, thicknesses, and lengths), etc.

3. Details of the sequence and proposed schedule of drilled shaft construction, including the anticipated order in which shafts will be constructed.

4. Details of excavation methods.

5. Details of proposed methods to clean the excavation bottom.

6. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. If appropriate, this shall include a review of method suitability to the anticipated site and subsurface geotechnical conditions.

7. Details of reinforcement placement including support and method to center in the excavation.

8. Details of concrete placement including proposed operational procedures for the concrete tremie or pump (if applicable); including initial placement, how the tremie or pump will be raised during concrete placement and what type of discharge control will be used to prevent concrete contamination when the tremie or pump is initially placed in the excavation.

9. If applicable, details of casing installation and temporary casing removal including order of telescoped casing removal and minimum concrete head in each casing during removal.

10. Required submittals for concrete mix designs.

11. Details on how drilling spoils will be handled including environmental control procedures used to prevent the loss of concrete and spoils.

12. Detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided. A detailed mix design (including all additives and their specific purpose in the slurry mix), and a discussion of its suitability to the anticipated subsurface geotechnical conditions, shall also be provided for the proposed slurry.

13. Other information shown in the Plans or requested by the Engineer.

The Engineer will review the Drilled Shaft Work Plan for conformance with the Plans and Specifications. Within 15 days of receiving the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary to satisfy the Plans, Specifications, and special provisions. If any part of the plan that is unsatisfactory and rejected by the Engineer, submit proposed changes for re-evaluation. The Engineer will respond to the Contractor within 7 days after receiving the proposed changes.

Review of the Drilled Shaft Work Plan by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with Plans and Specifications. The Drilled Shaft Work Plan is intended to provide an opportunity to explain the approach to the work and to allow the Engineer to comment on equipment and procedures before Work begins.

625.04 Preconstruction Conference

After the Drilled Shaft Work Plan has been reviewed by the Engineer, a drilled shaft preconstruction conference shall be scheduled with the Contractor/Drilling Subcontractor to discuss construction and inspection of the drilled shafts. At a minimum, the attendees should include the General Contractor's Superintendent, the Drilling Subcontractor's Superintendent, the State's representatives, the Geotechnical Engineer, the Structural Engineer, and members of the Inspection Team. This conference shall be completed prior to beginning any drilled shaft work.

Construction Requirements

625.05 Materials

All materials shall be in accordance with the Plans and in accordance with other Specifications included in the contract document.

625.06 Self-Consolidating Concrete (SCC)

Drilled shafts shall be constructed of the class concrete and concrete strength specified on Plans, and all material, proportioning, mixing, and transporting of concrete shall be in accordance with Standard Specifications for Road and Bridge Construction. The concrete mix for drilled shafts shall be dense, homogeneous, fluid, and resistant to segregation, and shall consolidate under self-weight such that vibrating, or rodding will not be required as specified in **604.03.A.1.b** Self-Consolidating Concrete (SCC) Design and Production Parameters. The concrete mix shall have a set time that ensures that fluidity is maintained throughout the shaft concrete placement and removal of temporary casing, if used.

625.07 Casing

When applicable, select the rigid casing used to stabilize shaft during construction unless casing is specified on Plans. A casing with sufficient strength to safely resist all imposed loads, including those from the soil and ground water, shall be used. Insure the stability of casing during all drilled shaft operations.

Shop drawings for permanent steel casings shall be submitted to and approved by the Engineer prior to installation of the casings.

Casings shall be smooth, clean, and watertight. Out-of-round tolerance shall not exceed one inch at any portion of the casing. Demonstrate the casing is within tolerance after installation. Telescoping casing shall not be allowed in bridges located in Seismic Zones 3 or 4.

Permanent casings, if required, shall be continuous wherever possible or practical. The permanent casing shall terminate at the specified elevation. Where drilled shafts are located in open water areas, casings shall be extended at least 18 inches above the datum defined water elevation as shown on the plans. Adjustment casing at the time of installation due to water fluctuations, if needed.

The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

Splicing of permanent casings is not desirable and will only be permitted when approved by the Engineer. If splices are required, the welding process shall be in accordance with the requirements specified in **602.19**. Ensure the adequacy of welds during driving.

Welding of casings shall be in accordance with the current edition of *AASHTO/AWS Bridge Welding Code* and Standard Specification for Road and Bridge Construction and as specified in Plans, except that shop welding of casings will not require radiographic inspection. Inspection of welds will be of a visual nature. If evidence indicating poor welding is found, the Engineer may require ultrasonic testing at no additional cost to the Department.

625.08 Slurry

Drilling slurry will be defined as mineral slurry, polymer slurry, natural slurry formed during the drilling process, water or other fluids used to maintain stability of the drilled shaft excavation to aid in the drilling process or to maintain the quality of the rock socket. In addition, the terms

mineral slurry and polymer slurry, as used herein, will be defined as the final mixed composite of all additives, including manufactured mineral or polymer slurry additives required to produce the acceptable drilling slurry.

Drilling slurry shall be used if detailed in the approved installation plan, if in accordance with the contract documents or if approved in writing by the Engineer. Drilling slurry may be used at the Contractor's option if the slurry is not in accordance with the contract documents; however, any slurry shall be approved by the Engineer prior to use. Drilling slurry, when used, will be non-compensable and effect on time of performance due to the use of the slurry will be non-excusable.

The material used to make the slurry shall not be detrimental to the concrete or surrounding ground strata. Mineral slurries shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Polymer slurries shall have sufficient viscosity and gel characteristics to transport excavated material to suitable screening systems or settling tanks. The percentage and specific gravity of the material used to make the slurry shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. If approved by the Engineer, water and on-site soils as drilling slurry may be used. In that case, the range of acceptable values for density, viscosity, and pH, as shown in the following table for bentonite slurry, shall be met, except that maximum density (unit weight) shall not exceed 70 pounds/cubic foot. When water is used as the drilling fluid to construct rock sockets in limestone, dolomite, sandstone, or other formations that are not erodible, the requirements for slurry testing will not apply.

Prior to introduction into the shaft excavation, the manufactured mineral or polymer slurry admixture shall be pre-mixed thoroughly with clean, fresh water and for adequate time in accordance with the slurry admixture manufacturer's recommendations allotted for hydration. Potable water can be used for mixing although stream or river water may be used when approved by the engineer. Slurry tanks of adequate capacity will be required for slurry mixing, circulation, storage, and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without written approval from the Engineer. Adequate de-sanding equipment will be required as necessary to control slurry properties during the drilled shaft excavation in accordance with the values provided in the table below.

Perform the Control tests using suitable apparatus on the slurry to determine density, viscosity, sand content and pH of freshly mixed slurry, recycled slurry, and slurry in the excavation. Tests of slurry samples from within one foot of the bottom and at mid-height of the shaft shall be conducted in each shaft excavation during the excavation process to establish a consistent working pattern. A minimum of four sets of tests shall be conducted during the first eight hours of slurry use on the project. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use, or as otherwise approved by the Engineer. Reports of all tests, signed by an authorized representative, shall be furnished to the Engineer on completion of each drilled shaft. An acceptance range of values for the physical properties will be as shown in the table 625.08-01.

When slurry samples are found to be unacceptable, bring the slurry in the shaft excavation to within specification requirements. Concrete shall not be poured until re-sampling and testing results produce acceptable values. Prior to placing shaft concrete, take slurry samples from within one foot of the bottom and at mid-height of the shaft. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be removed. Disposal of all slurry shall be done in areas approved by the Engineer. Perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.

Table 625.08-01: Slurry Control Test Physical Properties

Range of Acceptable Values for Mineral and Polymer Slurries in Fresh Water Without Additives					
Property	**Bentonite**	**Emulsified Polymer**	**Dry Polymer**	**Units**	**Test Method**
Density (Unit Weight)					
At Introduction	63.5- 66.8	< 63	< 63	lb/ft3	Density Balance
Prior to Concreting	63.5- 70.5	< 63	< 63		
Marsh Funnel Viscosity					
At Introduction	32 – 60	33 – 43 **b**	50 – 80 **b**	sec/qt	Marsh Funnel
Prior to Concreting	32 – 60	33 – 43 **b**	50 – 80 **b**		
pH					pH
At Introduction	8 – 10	8 – 11	7 – 11	--	Paper or pH
Prior to Concreting	8 – 10	8 – 11	7 – 11	--	Meter
Sand Content					
At Introduction	< 4	< 1	< 1	Percent by Volume	API Sand Content Kit
Prior to Concreting	< 2	< 1	< 1		
Maximum Contact Time **a**	4	72	72	Hours	

a. Without agitation and sidewall cleaning.

b. Higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

625.09 Protection of Existing Structures

All precautions shall be taken to prevent damage to existing structures and utilities as stated in Standard Specifications for Road and Bridge Construction or noted in plans. These measures shall include, but are not limited to, monitoring and controlling the vibrations from the driving of casing or drilling of the shaft, and selecting construction methods and procedures that shall prevent excessive caving of the shaft excavation.

625.10 Technique Shafts

When required by the contract documents, demonstrate the adequacy of methods and equipment used during construction of the first drilled shaft, which shall be an out of position technique shaft, constructed with reinforcement as identified for production shafts on the Plans. This technique shaft shall be drilled in the position as directed by the Engineer and drilled to the maximum depth for any production shaft shown on the Plans. If at any time the demonstration of the adequacy of methods or equipment and alterations required, at the Engineers discretion, an additional technique shaft(s) may be required. Technique shafts shall be cut off three feet below ground line, buried, or otherwise disposed of as specified in the contract documents or as directed by the Engineer. Once approval has been given to construct production shafts, no changes will be permitted in the methods of equipment used to construct the shaft without approval from the Engineer. When a technique shaft is not required, construction of the first production shaft will be used to determine if the methods and equipment used are acceptable. Failure at any time to demonstrate to the Engineer the adequacy of methods or equipment will be cause for the Engineer to require appropriate alterations in equipment or methods to eliminate unsatisfactory results.

625.11 Construction Sequence

Where construction of a footing is applicable, excavation to footing elevation shall be completed before shaft construction begins, unless otherwise authorized by the Engineer. Any disturbance to the footing area caused by shaft installation shall be repaired prior to pouring the footing. When drilled shafts are to be installed in conjunction with embankment placement, the construct drilled shafts after placement of fills. Drilled shafts constructed prior to the completion of fills shall not be capped until the fills have been placed as near to final grade as possible, leaving only the necessary work room for construction of the caps.

625.12 General Equipment and Methods

Perform excavations through whatever material is encountered to the dimensions and elevations shown on the Plans. The methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

Provide equipment capable of constructing the shafts to a depth equal to the deepest shaft tip elevation shown on the Plans plus a minimum of 15 feet. When a rock socket is identified on the Plans at a shaft location, the definition of “shaft tip elevation”, for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

Excavations required for shafts and rock sockets shall be completed in a continuous operation. ensure the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, notify the Engineer promptly. The dry method, wet method, temporary casing method, permanent casing method if specified, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects and or anomalies. The permanent casing method shall be used only when required by the contract documents or approved by the Engineer. Blasting excavation methods will not be permitted. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, immediately notify the Engineer. Use an airlift, or other method approved by the Engineer, to clean the bottom of the shaft excavation.

625.13 Dry Construction Method

The dry construction method shall be used only at sites where the groundwater table and site conditions, generally stiff to hard clays or rock above the water table, are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft remain stable without any caving, sloughing, or swelling and allow visual inspection prior to concrete placement. The dry method shall consist of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation, and placing the shaft reinforcing and concrete in a relatively dry excavation. Dry construction will be allowed only if less than 3 inches of standing water is found at the bottom of the shaft and the seepage rate is less than 12 inches of water per hour. Loose material and water shall be satisfactorily removed from the shaft before inspection and placement of rebar and concrete.

625.14 Wet Construction Method

The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the shaft concrete. This method shall consist of drilling the shaft excavation below the water table, keeping the shaft filled with water, natural slurry formed during the drilling process, mineral slurry, or polymer slurry to control seepage, groundwater movement and stability of the hole perimeter until excavation to the final depth and placement of the reinforcing cage and concrete has been completed. This procedure will require placing the shaft concrete with either a tremie or concrete pump beginning at the shaft bottom, and displacing the water or slurry as concrete is placed. Temporary partial depth casings near the ground surface shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Where drilled shafts are located in open water areas, shafts shall be constructed by the wet method using casings extending from above the water elevation to the Plans casing tip elevation or top of rock socket to protect the shaft concrete from water action during placement and curing. The casing shall be installed in a manner that produces a positive seal at the bottom of the casing.

625.15 Temporary Casing Construction Method

The temporary casing construction method shall be used at all sites where the stability of the excavated hole, the effects of groundwater cannot be controlled by other means, or other conditions exist in which the Engineer deems it necessary. In this method, the hole shall be advanced through caving material by the wet method in accordance with **625.14**. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed. Drilling may proceed by the dry method to the projected depth. The placement of concrete shall proceed by the dry or wet method, except that the casing shall be withdrawn after the concrete is placed. In the event seepage conditions prevent use of the dry method, excavation shall be completed by the wet method. Before and during casing withdrawal, a 5-foot minimum head of fresh concrete above the bottom of the casing shall be maintained at such a level that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be removed while the concrete is still workable, and the slump of the concrete is between four and eight inches. Vibratory hammers shall not be used for casing installation or removal with a clear spacing between the edge of the shafts less than three shaft diameters 3 shaft diameters of other shafts that have been completed less than 24 hours earlier. The reinforcing cage shall not be damaged or displaced when withdrawing the temporary casing.

625.16 Permanent Casing Construction Method

The permanent casing construction method shall be used only when required by the contract documents or authorized by the Engineer. The casing shall be continuous between top and bottom elevations shown on the Plans. Vibratory hammers shall not be used for casing installation within

a clear spacing between the edge of the shafts less than 3 shaft diameters of shafts which have had concrete poured within the past 24 hours

625.17 Time Limitations

When bentonite slurry is used, adjust operations such that the maximum time that slurry is in contact with the bottom five feet of the shaft, the time from the end of drilling to the beginning of concrete placement, does not exceed four hours without agitation. If the four-hour limit is exceeded, the bottom five feet of the shaft shall be over reamed prior to performing other operations in the shaft. For rock sockets constructed in shale using polymer slurry, concrete placement shall begin within 72 hours of starting the rock socket excavation to avoid degradation of the shaft sidewall. Before concrete placement begins, foundation inspection, when required, cleaning operations, and reinforcing steel placement shall be completed and approved by the Engineer. These operations will be included in the 72 hour time limit. If concrete placement is not begun within the time limit, take corrective measures to the satisfaction of the Engineer.

625.18 Level of Slurry

During construction, the level of slurry is not less than five feet above the water table and shall be maintained at a height sufficient to prevent caving of the excavation. If the Engineer determines that the slurry construction method is failing to produce the desired final results, discontinue operations and propose an alternate method for approval from the Engineer. Correction for a failed slurry construction method will be non- compensable and any effect on time of performance non-excusable.

625.19 Slurry Manufacturer's Representative

When manufactured mineral or polymer slurry additives are to be incorporated into the drilling slurry mix, provide the technical assistance of a representative of the mineral or polymer slurry additive manufacturer at the site prior to introduction of the slurry into the first shaft where slurry use will be required, and during drilling and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

625.20 Cleaning of Shaft or Casing Sidewalls

Cleaning of the shaft or casing sidewalls shall occur by a method approved by the Engineer as necessary to remove the depth of softening or to remove excessive slurry cake buildup.

625.21 General Excavation Considerations

The Plans will indicate the top of shaft elevations and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed. Drilled shafts may be extended or shortened as approved by TDOT Geotechnical Engineering Section and TDOT Structures if the foundation material encountered is unsuitable or better than anticipated, or based on the results of load tests.

625.22 Time Restrictions

Drilled shaft excavation shall begin only if, the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a complete continuous daily operation. No shaft with a clear spacing between the edge of the shafts less than 3 shaft diameters of another shaft shall be excavated at the same time. Shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the clear spacing between the edge of the shafts is less than 3 shaft diameters.

625.23 Disposal of Excavated Material

Excavated material removed from the shaft and any drilling fluids used shall be disposed of in accordance with the contract documents, as directed by the Engineer, and in compliance with federal and state regulatory requirements.

625.24 Worker Entry Into Shaft Excavation

Do not allow workers to enter the shaft excavation for any reason, unless both a suitable casing has been installed and adequate safety equipment and procedures have been provided to workers entering the excavation.

625.25 Rock and Obstructions

Subsurface obstructions at drilled shaft locations shall be removed. Employ special procedures or tools when the hole cannot be advanced using conventional equipment. Blasting will not be permitted. Any man-made material that significantly limits excavation advancement such as concrete, steel, timber, etc. will be classified as an "obstruction". Drilling tools lost in the excavation will not be considered obstructions and shall be promptly removed. The presence of an obstruction for pay purposes must be verified by the Engineer. Boulders or rock layers of such size that do not allow the use of soil excavation tools as described will not be considered an obstruction but will be considered Drilled Caisson Rock as described.

625.26 Inspection Equipment

Maintain at the job at all times, all equipment suitable for use in the shaft inspection.

625.27 Removal of Excess Sediment

Final shaft depth shall be measured with approved methods after final cleaning by airlift, or other method approved by the Engineer. Unless otherwise stated in the contract documents, a minimum of 50 percent of the base of each shaft shall have less than ½ inch of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 ½ inches. Shaft cleanliness will be verified by the Engineer for wet or dry shafts.

625.28 Inspection, Supervision, and Records

Provide aid to the Engineer in maintaining accurate records during all phases of the drilled shaft installation. Provide the Engineer with any information required for the drilled shaft inspection reports. Provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, cameras, personnel, etc. and all assistance that may be required for the Engineer to inspect the drilled shaft excavations. Perform any corrective work found necessary as a result of inspections. Necessary time shall be allowed for performance of these inspections.

625.29 Inspection for Side Walls

At the Engineer's request, lower the Inspector to the level of the bottom of the casing and allow visual examination of the side walls of the rock socket to confirm the top of rock socket has been reached once the casing has been extended to the top of rock. Preferably, the sidewall inspection should not be performed until the drilled shaft excavation has extended to the anticipated base of rock socket and before any inner casing is set below the top of rock. Should the observed rock excavation reveal soil inclusions or voids, the drilled shaft excavation shall be extended as directed

by the Engineer. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, side wall inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that casing has been properly seated into rock and that side walls are free from soil inclusions or voids.

625.30 Inspection of Bottom of Shaft

Where groundwater can be effectively controlled (that is, less than one foot of standing water is maintained in excavation bottom) after reaching the anticipated base of rock socket, lower the Inspector to the level of the bottom of the socket and allow visual examination of the bottom of the shaft. Temporary casing should extend to the base of the rock socket to allow the Inspector to safely enter the excavation. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, bottom of shaft inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that excess sediment has been removed in accordance with **625.27**. The determination of the shaft's tip elevation after excavation to the anticipated base of rock socket will either be made by the Engineer's judgment of conditions found in previously performed test borings drilled within the dimensions of the rock socket, examination of rock socket shaft excavation results (recovered cores or observation of shaft drilling response) or by examination of rock cores taken at least 8 feet below the shaft bottom as required in **625.31**.

625.31 Core Drilling

When required by contract documents, core drilling shall be performed as described in the Plans and paid for under Core Drilling and Sampling at the contract unit price. The Engineer may require rock core samples to be taken a minimum depth of 8 feet and up to a maximum depth of 20 feet below the bottom of the drilled shaft excavation to either aid in predetermining acceptable rock socket elevations prior to beginning of shaft excavation or to provide information to determine the acceptability of a completed rock socket. Core sampling should be performed in accordance with ASTM D 2113 using a double or triple wall core barrel of NX (54.7 mm / 2.16 in.) or NQ (47.5 mm / 1.87 in.) size. Perform this core sampling or schedule a qualified representative to do the Work.

625.32 Log of Confirmation Drilling. Maintain a log of core drilling and sampling (confirmation drilling) for each foundation inspection hole, and such logs shall be delivered to the Engineer within 24 hours of completion of the boring. The log shall include the following:

(a) The amount of NX or NQ cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX or NQ core. The bedding thickness and degree of weathering shall also be noted.

(c) Location and elevation of holes.

625.33 Storage and Labeling of Rock Cores

Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, Contract Number, and date, and shall be delivered to the Engineer.

625.34 Reinforcing Steel Cage Fabrication and Placement

The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement. Temporary internal cage stiffeners shall be removed as the cage is placed in the shaft such that interference with the placement of concrete does not occur. The Contractor shall verify the stability of the reinforcing steel cage. Submit verification calculations to the Engineer for review and approval. Calculations shall be sealed by a Professional Engineer licensed in the State of Tennessee.

625.35 Reinforcing Ties, Splices and Clearances

All reinforcing steel in the shaft shall be tied at every intersection and supported such that the steel remains within the allowable tolerances specified in Table 625.35-01 during placement of concrete or casing removal. The reinforcing steel cage shall have sufficient rigidity to prevent racking or permanent deformations during delivery or installation.

Table 625.35-01: Concrete Cover

Concrete Cover			
Shaft Diameter	**Uncased**	**Casing Remains**	**Casing Withdrawn**
3'-0" or less	3"	3"	4"
>3'-0" & <5'-0"	4"	4"	4"
5'-0" or larger	6"	6"	6"

625.36 Spacers

Rolling spacers for reinforcing steel shall be used to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Sets of concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient vertical intervals, near the bottom and along the shaft at intervals not exceeding five feet, to ensure concentric location of the cage within the shaft excavation. When the vertical steel is greater than one inch in diameter, the maximum spacing may be increased to 10 feet. As a minimum, a set of spacers shall be provided within two feet of both the top and bottom of the shaft. In addition, one set of spacers shall be provided at both two feet above and below each change in shaft diameter. Non-corrosive spacers shall be provided at a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each vertical level to maintain the required reinforcement clearances. The spacers shall be of adequate dimension to maintain the specified clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

625.37 General Considerations

Accumulations of water in casings and excess sediment at the base shall be removed as described herein before the concrete is placed. No concrete shall be placed until all casings, if used, within a 15 foot radius has been installed. Within the 15 foot radius, all driving or vibratory installation methods shall be discontinued until the concrete in the last shaft has set at least five days. Concrete placement shall begin as soon as possible after completion of the excavation, inspection and setting of the reinforcing cage, and shall proceed in a continuous operation from the bottom of the shaft to the Plans construction joint or above as specified herein. An unplanned stoppage of work may require an emergency construction joint during the shaft construction.

625.38 Placement of Concrete in the Shaft

Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft. Concrete shall be placed by free fall or through a tremie or concrete pump. The free fall placement method will only be permitted in dry holes. Concrete placed by free fall shall fall directly to the base without contacting either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

625.39 Time Limitations

Maintain a continuous pour until the shaft is complete. All admixtures shall be adjusted for the conditions encountered on the job, so that the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, provide test results of a trial mix that demonstrates the concrete meets the two-hour placement limit. When the estimated placement time exceeds the two-hour limit, provide a concrete mix design that will maintain a slump of 4 inches or greater throughout the estimated placement time, as demonstrated by the slump loss test. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions and recorded on form MT-0334.

625.40 Concrete Placement by Tremie

Tremies used to place concrete shall consist of a tube of sufficient length to discharge concrete at the shaft base elevation. The tremie shall have sufficient weight to rest on the shaft bottom before the start of concrete placement and to prevent curling of the tremie line during placement of the concrete. The tremie shall not contain aluminum parts that may come in contact with the concrete. A tremie shall consist of a watertight tube having an inside diameter of no less than 10 inches and fitted with a hopper at the top. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The tremie wall thickness shall be adequate to prevent crimping or sharp bends that restrict concrete placement.

625.41 Tremie Operation

Underwater placement of concrete shall not begin until the tremie is at the shaft base elevation. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain immersed as deep as practical in the concrete, but shall be no less than five feet at all times. The tremie shall be supported such as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work to prevent water from entering the tube before the tube is filled with concrete. After placement has started, the level of the concrete in the tremie shall be maintained above the level of slurry or water in the shaft at all times to prevent water or slurry intrusion into the shaft concrete. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed.

625.42 Removal of Tremie Orifice from Concrete

If at any time during the concrete pour, when using the wet construction method, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

625.43 Concrete Placement by Pump

Concrete pumps and lines may be used for concrete placement by either the wet or dry construction method. All pump lines shall have a minimum diameter of 5 inches and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation. For the wet construction method, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or shall be of a material that does not cause a defect in the shaft if the plug is not removed. The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

625.44 Adjustment of Concrete Free Fall or Rate of Concrete Flow

If the free fall concrete causes the shaft excavation to cave, control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the excavation and follow the details of the method(s) to be used to ensure shaft stability as required by **625.03.6.**

625.45 Drop Chutes

Drop chutes may be used to direct placement of free fall concrete down the center of the shaft excavations. Drop chutes shall be a smooth tube constructed either as a continuous one-piece unit or as removable sections. Aluminum drop chutes will not be permitted. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement.

625.46 Construction Joints

Construction joints shall not be utilized unless otherwise approved by the Structural Engineer. All planned reinforcing steel shall extend uninterrupted through joints. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and to intentionally leave the surface in a roughened condition.

625.47 Concrete Curing

Portions of drilled shafts exposed to a body of water shall be protected from the action of water by leaving the temporary casing in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 3,375 psi. After placement, the temporarily exposed surfaces of the shaft concrete shall be cured to prevent loss of water.

625.48 Construction Tolerances

During excavation of the shaft, monitor the plumbness, alignment and dimensions of the shaft. Any deviation exceeding the allowable construction tolerances specified herein shall be corrected with a procedure approved by the Engineer. Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances will not be accepted. Correction methods shall be submitted for the Engineer's approval. Drilled shaft construction shall not begin until final approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations originally submitted and have signed by a

Professional Engineer licensed in the State of Tennessee. The following construction tolerances will apply to drilled shafts unless stated otherwise in the contract documents:

(a) Temporary casing diameters shall provide a final shaft diameter as shown on the Plans. When approved by the Engineer, the Contractor may provide a larger casing at the Contractor's expense.

(b) Shafts shall be constructed such that the center of the top of the shaft is within 3 inches of Plans position in the horizontal plane at the plan elevation for the top of the shaft.

(c) For shafts in rock, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than ¼ inch per foot of depth. For shafts in soil, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than 3/16 inch per foot of depth.

(d) The bottom of the shaft excavation shall be normal to the axis of the shaft within a tolerance of 3/8 inch per foot of shaft diameter.

(e) Shaft steel reinforcing bar shall be no higher than six inches above or three inches below Plans elevation.

625.49 Integrity Testing

The completed shaft shall be subjected to the testing methods specified by Plans such as concrete coring, cross-hole sonic logging (CSL) , and/or thermal integrity profiling (TIP), to determine the extent of any defects that may be present. If CSL or TIP testing are indicated in the plans, the Department will supply a consultant to perform the testing. If CSL testing reveals voids or discontinuities in the concrete which indicate that the shaft is not structurally adequate, the shaft will be retested within 3 to 7 days of receiving the report or 10 days from test, whichever is sooner. In the event retesting confirms the results of the initial test, further measures as specified in **625.50** shall be conducted at the no additional cost to the Department. The Department may also conduct TIP testing to further evaluate the extent of the integrity of the shaft.

Concrete shall not be placed in additional drilled shafts until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required as a result of shaft defects will be non- compensable and any effect on time of performance non-excusable.

625.50 Concrete Coring

Upon completion of placing concrete and after waiting a minimum of 48 hours, the top surface of concrete shall be cleaned of laitance and any unsound concrete. One or more core holes, at the location and number indicated in the contract documents or as directed by the Engineer, shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of the shaft. Provisions for the inspection of the concrete surface shall be in accordance with the applicable requirements described herein. Core holes shall be drilled at locations specified by the Engineer. The holes shall be drilled to recover 4 inch diameter cores. The core samples recovered shall be labeled as to the location from which the samples were taken. The samples shall be delivered to the Engineer for examination. If the cores indicate defective concrete in the shaft, which in the judgment of the Engineer impairs the strength of the completed shaft, drill additional cores as directed by the Engineer. If the concrete is found to be defective, submit to the Engineer in writing a proposal for correction, and those corrective procedures shall be approved by the Engineer before such corrective work is undertaken. The

cored holes in non-defective concrete shall be filled with grout such that all voids are filled. Grout shall be non-shrink and obtain a compressive strength equal to or in excess of that specified for the drilled shaft concrete. Grout shall be selected from Qualified Products List or alternate submitted for to the Engineer for approval. No direct payment will be made for grout and grouting.

625.51 Non-Destructive Testing

A. Cross-Hole Sonic Logging (CSL)

If CSL testing is indicated on a project with CEI oversight, the CEI firm shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing. Shafts six feet in diameter and larger require the addition of 3D tomography. Testing will be performed after the shaft concrete has cured as specified in Table 625.51-1. Provide reasonable access to the shaft top for performance of CSL testing.

Table 625.51-1 Sonic Logging Time Requirements

Shaft Diameter	Minimum Cure Time (prior to testing)
4 to 6 ft.	72 hours
6 to 8 ft.	96 hours
>8 ft.	120 hours

Furnish and install ≥1 ½" nominal inside diameter steel pipes with 0.145" minimum wall thickness, ASTM A 53, Standard Weight, for use in sonic testing of each drilled shaft. Pipes shall be installed in each drilled shaft at the locations shown on the Plans, as required by the testing agency, or as directed by the Engineer. The pipes shall be sufficiently regular and free from defects to permit the free and unobstructed passage of the probes. The pipe shall be installed such that all internal joints are flush. Stiffening devices such as mandrels, tape, or similar material to seal the joints shall not be used. Pipe shall be watertight with clean internal and external faces, the latter to ensure a good bond between the concrete and the pipes. The pipes shall be fitted with a screw-on watertight shoe and cap and shall be securely fixed to the interior of the reinforcement cage with a minimum cover of three inches from the shaft periphery. The pipes shall be as near too parallel as possible, equally spaced, and vertical. Where several sections of pipe are required to reach the full length, joints shall be made watertight. The pipes shall be filled with water and plugged or capped before shaft concrete is poured. The upper end of the pipe shall not be left open after the pour. The pipes shall extend at least three feet above the top of the concrete in the shaft to compensate for water displaced by insertion and removal of the transmitter, receiver, and cable. For shafts with a rock socket, the lower end of the pipes shall extend to the bottom of the rock socket. Care shall be taken during the drilled shaft concrete pour to not damage the pipes. If a tremie is used, the tremie shall not be permitted to rest on top of the pipes during the pour. After completion of the sonic logging and final acceptance of the drilled shaft, fill the access pipes with grout.

The sonic logging equipment furnished by the CSL consultant/subconsultant shall consist of all necessary supplies, support equipment and power to perform the sonic logging testing requirements as described herein.

The drilled shaft shall be tested between three and 7 days after concrete placement. The following procedures shall apply:

(a) Pipes shall be checked to ensure the pipes are free from blockages and are filled with water.

(b) Levels shall be taken on top of each pipe; each pipe shall be plumbed, and the length shall be recorded.

(c) Testing shall be performed between each pair of adjacent pipes around the shaft perimeter and also in pairing combinations between each pipe with all other pipes in the shaft.

(d) All tests shall be carried out with the probes in the same horizontal plane unless the Engineer directs that defects be further evaluated with the probes on different horizontal planes.

(e) The probes shall be raised simultaneously from the bottom of the pipes ensuring that all slack is taken out of the cables before the analyzer is switched on, and that the distance between transducers remains constant during the course of the test. The speed of ascent shall be less than 12 inches per second. Measurements shall be taken at three inch intervals or less. Anomalies indicated by longer pulse first- arrival times (FAT) and significantly lower amplitude per energy signals shall be reported. If anomalies are detected, additional tests with two or more sources per receiver vertical offsets of greater than or equal to 20 inches shall be conducted between the same tubes unless the anomaly is within 20 inches of the bottom of the shaft.

(f) The CSL consultant/subconsultant shall provide accurate measurements of probe depths on the logs.

Preliminary results of the testing shall be provided on site prior to the CSL consultant/subconsultant leaving the site. A detailed CSL report and test data shall be submitted to the Engineer within seven days. The CSL report shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The CSL report shall include, but is not limited to, the following: project identification and dates of testing, a table and schematic showing shafts tested with accurate identification of tube coordinates and collar elevation, name of personnel that performed the tests and interpretation and those personnel's affiliation, equipment used, data logs, interpretation, analysis, and results. The data logs shall include XY plots of FAT, amplitude, and velocity versus depth. CSL data shall be processed to provide easy to understand 2D cross-sections between tubes for all tube pair combinations. These plots shall be annotated by the CSL consultant/subconsultant as appropriate to delineate anomalous results. For shafts six feet in diameter and larger, 3D tomography will be required along with CSL testing. If 3D tomography is requested, the data shall be submitted to the Engineer within ten days. If offset surveys are performed as part of 3D tomography , data plots shall include 3D volumetric images for the entire shaft, color-coded, to indicate velocity variations along the shaft. Locations and geometry of anomalies or unconsolidated zones shall be identified in 3D color images with detailed discussion. The results for CSL and 3D surveys shall be based on the percentage decrease in velocity as correlated to the Table 625.51-02 Concrete Condition Rating Criteria (CCRC). The velocity datum of good concrete shall be established by averaging the velocities in the good concrete along the drilled shaft. Deviations from the velocity datum shall be used for determining the Concrete Condition Rating.

Table 625.51-2: Concrete Condition Rating Criteria

		Overall Rating shall be the lower of the two criteria		
Concrete Condition Rating	**Rating Symbol**	**Velocity Reduction**	**Signal Distortion/Strength**	**Indicative Results**
Good	G	0 to 10%	None / normal Energy Reduction ≤ 6 dB	Acceptable concrete
Questionable	Q	10% to 20%	Minor / lower Energy reduction = 6.1 to 9 dB	Minor concrete contamination or intrusion. Questionable quality concrete.
Poor	P/D	> 20%	Severe / much lower Energy reduction > 9 dB	Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete.
Water	W	V= 4760 to 5005 ft/sec (≈60% reduction)	Severe / much lower Energy reduction > 12 dB	Water intrusion, or water filled gravel intrusion with few or no fines present.
No Signal	NS	No signal received	None	Soil intrusion or other severe defect absorbed the signal, tube debonding if near top.

a The baseline velocity shall be 13,000 feet per second for normal weight concrete.

The CSL consultant/subconsultant shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant/subconsultant shall duly perform further tests as directed by the Engineer to evaluate the extent of any detected anomalies. Core drilling, or other investigative methods as approved by the Engineer, shall be performed to further investigate the anomaly. If a defect is confirmed, the Contractor shall bear all costs involved with the shaft coring, grouting and remediation. Within 14 days of the completion of testing, provide a report signed and sealed by a Professional Engineer licensed in the State of Tennessee providing the results of the additional investigations and recommendations to accept or repair the shaft. The report shall also contain recommendations for modification of construction procedures to prevent defects for subsequent shaft installations. The dates of the completion of drilling, cleaning, steel placement and concrete pour shall also be provided. Work above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

B. Thermal Integrity Profiling (TIP)

TIP testing data, which will monitor the temperature of the shaft concrete while it is curing, will be collected based on the ASTM D7949. The testing period differs based on diameter and testing method. If TIP testing is indicated on a project with CEI oversight, the CEI shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing.

The installation of Access Ducts method A could allow the use of the CSL tubes to be utilized for the temperature probe to be lowered into the shaft. The depth the probe should be lowered following ASTM D7949 7.2.3.

The installation of Thermal Wire method B will allow for continuous monitoring during the concrete curing cycle. The thermal wire cable with the thermal sensors for the TIP should be attached to the reinforcing cage before placement in the shaft. One cable per foot of diameter of the shaft is expected. All cables should be connected to Thermal Acquisition Port (TAP) that will collect data on site at any given time.

After data collection, the TIP consultant/subconsultant shall provide a written report along with analysis of data within 7 days of the final readings. The TIP report shall include all ASTM D7949 TIP report elements. Analysis should include the Effective Average Radius of the shaft based on the collected data and the location of any anomalies detected in the shaft.

625.52 Drilled Shaft Load Tests

All load tests, when required by the contract documents, shall be completed, and submitted to the Engineer for review and approval before construction of any production drilled shafts. The locations of load test shafts, the maximum loads to be applied, the test equipment to be furnished by the Contractor, and the actual sequence of the load testing shall be as shown on the Plans or as specified in the contract documents. After completion of testing, test shafts not used as production shafts shall be cut off at an elevation three feet below the finished ground line. The portion of shafts cut off shall be disposed of, at no additional cost to the department, in a manner approved by the Engineer.

Compensation

625.53 Method of Measurement

A. The Department will measure the accepted drilled shafts Drilled Shaft Excavation (Soil) to the nearest 0.10 vertical foot of length along the axis of each shaft. For shafts without a rock socket, measurement will be from the Plans elevation for the top of shaft to the bottom of the shaft. For shafts with a rock socket, measurement will be from the Plans elevation for the top of shaft to the top of the rock socket as defined in section "Drilled Shaft Excavation (Rock)".

B. The Department will measure the accepted rock sockets and drilling through rock as Drilled Shaft Excavation (Rock) to the nearest 0.10 vertical foot of length along the axis of the shaft for the cumulative length of rock, as determined by the Engineer. The "top of rock" is defined as the elevation at which natural material cannot be drilled by conventional drilling tools and requires the use of special rock augers, core barrels, air tools, or specialized removal methods.

C. The Department will measure Drilled Shaft Concrete by the cubic yard and computed from the dimensions indicated on the Plans or directed in writing by the Engineer.

D. The Department will measure Drilled Shaft Reinforcing Steel for payment by the pound, unless otherwise stipulated in the Plans, in accordance with **604.30**.

E. The Department will measure Permanent Drilled Shaft Casing by the vertical foot of permanent casing installed. Additional permanent drilled shaft casing installed for the convenience of the Contractor will not be measured for payment.

F. The Department will not measure Temporary Drilled Shaft Casing for payment and shall be incidental to the work.

G. The Department will measure Foundation probe holes will be measured for payment to the nearest 0.10 linear foot of length along the axis of each hole and paid for as Item Rock Drilling Bridges.

H. The Department will measurement Core Drilling And Sampling for foundation core holes to the nearest 0.10 linear foot of length along the axis of each hole.

I. The Department will measurement Concrete Coring to the nearest 0.10 vertical foot of length along the axis of the shaft from the top of concrete to a point determined by the Engineer, and may extend the entire length of the shaft plus one foot below the bottom of the rock socket.

J. When testing is not performed by the CEI, The Department will measure Sonic Logging Testing per each drilled shaft as required.

K. The Department will measure Load tests for each load test performed.

625.54 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
625-01.07	PIEZOMETER	L.F.
625-01.08	INCLINOMETER	L.F.
625-01.10	CAMERA INSPECTION - DRILLED SHAFT (DRY)	EACH
625-01.11	CAMERA INSPECTION-DRILLED SHAFT (UNDERWATER)	EACH
625-02.XX	DRILLED SHAFT-SOIL (DIA.)	V.F.
625-02.XX	DRILLED SHAFT-ROCK (DIA.)	V.F.
625-02.XX	DRILLED SHAFT CASING-PERMANENT (DIA.)	V.F.
625-02.40	DRILLED SHAFT (SH-SCC) CONCRETE	C.Y.
625-02.43	CONCRETE CORING	V.F.
625-02.44	DRILLED SHAFT REINFORCING STEEL	LB.
625-02.45	DRILLED SHAFT REINFORCING STEEL (GRADE 75)	LB.
625-02.46	SONIC LOGGING TESTING	EACH
625-02.47	DRILLED SHAFT LOAD TEST	EACH
204-05.01	CORE DRILLING AND SAMPLING	L.F.
204-05	ROCK DRILLING (BRIDGES)	L.F.

A. Such payment for Drilled Shaft (Soil) will be considered full compensation for all temporary steel casing required, costs of drilling, excavation, slurry, dewatering, cleaning, and incidental work, and materials required to complete the excavation. Payment for any drilled shaft excavation will be at the contract unit price per vertical foot for the diameter of the drilled shafts specified. No additional compensation will be made for concrete required to fill an oversized casing or for oversized excavation.

B. Such payment for Drilled Shaft (Rock) will be considered full compensation for drilling, excavation, slurry, cleaning, dewatering, and incidental work, and material required to complete the excavation. For payment purposes the length of any rock socket installed and accepted shall be paid for at the contract unit price per vertical foot for the diameter of the rock socket specified. If the method of construction requires that drilled shaft casing be seated into the sound rock such that the bottom of the casing is below the determined top of sound rock elevation, payment for excavation below the top of the sound rock layer (top of the rock socket) will be included in the payment for the rock socket. In the event that the Engineer orders additional rock socket

construction, payment for the additional length will be at the contract unit price per vertical foot of rock socket. Payment will be considered full compensation for the additional excavation into rock including all incidentals necessary to complete the work down to the elevation designated by the Engineer. Additional reinforcing steel and concrete shall be paid for at the contract unit bid price.

C. Removal of obstruction(s) will be paid at two times the unit price bid for Item Drilled Shaft (Rock) V.F. for the shaft length from the first occurrence of the obstruction until such depth that the shaft is advanced to the point of removal of the obstruction and normal shaft excavation methods can resume.

D. Such payment for Drilled Shaft Concrete will be considered full compensation for all costs associated with furnishing and placing concrete in the drilled shaft in the unit price bid per cubic yard for Drilled Shaft Concrete in accordance with the Contract Plans. Include all costs associated with furnishing and installing Sonic logging access tubes and any required extensions in the unit price bid per cubic yard for Item Drilled Shaft Concrete. No payment will be made for construction delays resulting from the initial sonic logging testing of the drilled shaft. The Department will pay the costs for the initial sonic logging testing. The Contractor shall pay for all costs associated with coring, engineering design, cost required to correct defects and any construction delay costs, if a defect is found based on the sonic logging. The Contractor shall pay the costs of sonic logging testing to re-test the repaired drilled shafts.

E. Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and placing reinforcing steel, including but not limited to spacers, ties, and splices, in the drilled shaft at the unit price bid per pound for Reinforcing Steel in accordance with **604.31**

F. Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and installing permanent casing in the drilled shaft in the unit price bid per vertical foot of Drilled Shaft Casing. Temporary Casing, including all costs associated with installation and removal, shall be included in the bid price for item Drilled Shaft Excavation.

G. Such payment for Core Drilling and Sampling will be considered full compensation for drilling or coring the holes, extracting, and packaging the samples or cores, laboratory testing, delivering the samples or cores to the specified TDOT location and for all other expenses necessary to complete the work. Payment shall be full compensation for completing the core drilling as specified.

H. Such payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work.

I. When testing is not performed by the CEI, but required by contract documents, or directed by the Engineer, such payment for sonic logging testing will be considered full compensation for providing all equipment, conducting the actual probing measurements as specified, furnishing reports, removing equipment, and all tools, labor, and any incidentals necessary to complete the work. The number of sonic logging inspections may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation. No payment will be made for supplementary sonic logging testing to evaluate defects.

J. When required by contract documents, such payment for drilled shaft load test will be considered full compensation for all work related to performing and reporting load tests as specified.

S T A T E **O F** **T E N N E S S E E**

Rev. 5-14-18 January 1, 2021

SPECIAL PROVISION

REGARDING

PREFABRICATED VERTICAL DRAINS

627.01 Description – The work shall consist of furnishing all necessary labor, equipment, materials, incidentals and transportation for the installation of Prefabricated Vertical Drains (PVDs) in accordance with the details shown on the Plans and the requirements of these Specifications.

627.02 Testing Standards – Use the latest edition of the testing standards indicated in this Special Provision. Substitution of standards will require the prior written approval of the Engineer. The Contractor or the PVD Installer is to provide copies of all substituted standards to the Engineer.

The most recent version of the following testing method(s) may be employed:

- Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method); ASTM D3884
- Grab Breaking Load and Elongation of Geotextiles; ASTM D4632
- Trapezoid Tearing Strength of Geotextiles; ASTM D4533
- Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products; ASTM D4833
- Mullen Burst Test; ASTM 3786
- Water Permeability of Geotextiles by Permittivity; ASTM D4491
- Apparent Opening Size of a Geotextile; ASTM D4751
- Tensile Properties of Geotextiles by the Wide-Width Strip Method; ASTM D4595
- (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head; ASTM D4716
- Particle-Size Analysis of Soils; ASTM D422

627.03 Materials - The PVDs shall consist of newly manufactured materials and shall consist of a continuous polymeric drainage core and nonwoven geotextile filter fabric (jacket). The jacket shall allow

free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage. The core and jacket material may be either non-bonded or bonded. For non-bonded PVDs, the jacket material is wrapped around the core and seamed to itself. For bonded PVDs, the jacket material is fused to both faces of the core along the peaks of the corrugations.

JACKET MATERIALS – The jacket components shall conform to the following:

- The jacket material shall be a synthetic nonwoven polymeric geotextile meeting the criteria listed in Table 1.
- The jacket material shall not be subject to localized damage (e.g., punching through the filter fabric by sand/gravel particles).
- The jacket material shall be rigid enough to withstand lateral earth pressures due to embedment and surcharge so that the vertical flow capacity through the core will not be adversely affected.
- The jacket material shall be flexible enough to bend smoothly during installation and during any induced consolidation settlement without damage.
- The jacket material shall not undergo cracking and peeling during installation of the vertical drain.

Table 1 – Jacket Material Properties

PROPERTY[1]	TEST METHODS	UNITS	REQUIREMENTS
Mass	ASTM D5261	oz./yd^2	$\geq$ 4.0
Grab Elongation	ASTM D4632	%	$\geq$ 50
Grab Strength[2]	ASTM D4632	lbs.	$\geq$ 130
Tear Strength[3]	ASTM D4533	lbs.	$\geq$ 60
Permittivity	ASTM D4491	sec.$^{-1}$	$\geq$ 0.5
AOS	ASTM D4751	Sieve Size (mm)	#100 ($\leq$ 0.15)
Ultraviolet Stability (Retained Strength)	ASTM D4355	%	$\geq$ 50 after 500 hrs. of exposure

Notes:

[1]All numeric values represent Minimum Average Roll Value (MARV) in the weaker principal direction. Provide geotextiles whose average test results from any roll sampled in a lot for conformance or quality assurance testing meets or exceeds minimum values provided in this Table.

[2]For bonded drains, grab tensile strength tests shall be conducted on the assembled drain using ASTM D4595.

[3]For bonded drains the trapezoidal tear strength test shall be waived.

CORE MATERIALS – The core materials shall conform to the following:

- The core material shall be continuous polymeric material fabricated with grooves to promote drainage along the axis of the vertical drain. Studded cores are not allowed.
- The core material shall meet the criteria listed in Table 2.

Table 2 – Core Material Properties

PROPERTY	TEST METHODS	UNITS	REQUIREMENTS
Thickness	ASTM D5199	in.	0.09375 (3/32)
Mass	ASTM D3776	oz./ft.	≥ 0.60
Tensile Strength	ASTM D638	lbs.	300
Crush Strength	ASTM D1621	psi	450
Ultraviolet Stability (Retained Strength)	ASTM D4355	%	≥ 50 after 500 hrs. of exposure

ASSEMBLED PVD – The assembled PVD shall conform to the following:

- The mechanical properties (strength and modulus) of the assembled drain shall equal those specified for the component jacket and core.
- The assembled PVDs shall be resistant against wet rot, mildew, bacterial action, insects, dissolved salts, acids, alkalis, solvents, and other components in the site ground water.
- Use only one single type of assembled PVD on the project.
- Provide an assembled PVD that meets the properties indicated in Table 3

Table 3 – Assembled PVD Properties

PROPERTY	TEST METHODS	UNITS	REQUIREMENTS
Perimeter	--	in.	≥ 7.75
Width	Measure with caliper	in.	≥ 3.75
Thickness	ASTM D5199	in.	≥ 0.1250 (1/8)
Discharge Capacity	ASTM D4716	gpm	1.5 (at 50 psi)
	ASTM D6918		1.5 (at 25% compression)

TRANSPORTATION AND STORAGE OF ASSEMBLED PVD – The transportation and storage of the assembled PVD shall conform to the following:

- Label or tag the assembled PVDs in such a manner that the information for sample identification and other quality control purposes can be read from the label. As a minimum, identify each roll of assembled PVD by the manufacturer as to lot or control numbers, individual roll number, date of manufacture, manufacturer and product identification of the jacket and core.
- During shipment and storage, wrap the PVDs in burlap or similar heavy duty protective covering. Protect the PVDs from sunlight, mud, dirt, dust, debris, and other detrimental substances during shipping and on-site storage. The PVDs shall be free of defects, rips, holes, and/or flaws. Material which is damaged during shipment, unloading, storage, or handling, or which does not meet the requirements of the drain material will be rejected by the Engineer.

SPLICING PVD

- Non-bonded PVDs may be field spliced. Remove approximately 6 inches of the jacket material from the current assembled PVD roll exposing the core. Insert the exposed core into the new roll of assembled PVD and secure using methods approved by the PVD supplier and accepted by the Engineer. The core material shall not be exposed after splicing. The core materials from each roll should be in firm contact with the corrugated peaks of one core overlapping the corrugated valleys of the other core.
- For bonded PVDs, provide to the Engineer the PVD Manufacturer's splicing procedure for review and acceptance by the Engineer prior to any PVD material being installed.

PVD DRAINAGE LAYER – Unless otherwise stated in the Plans, the PVD drainage layer shall conform to the following:

- Place a drainage layer consisting of at least 24 inches, unless otherwise specified in the plans, prior to PVD installation.
- Unless otherwise specified in the plans, the drainage layer material shall conform to the following gradation requirements (ASTM D422), as shown in Table 4:

Table 4 – Drainage Layer Gradation

SIEVE	PERCENT PASSING
2-inch	100
½-inch	65-100
¼-inch	50-100
No. 10	40-70
No. 40	10-40
No. 200	0-5

- Material not meeting the gradation defined above will be rejected. Acceptance of materials will be at the project site.

627.04 Submittals – At least 30 calendar days before the beginning of the PVD installation, the Contractor shall submit to the Engineer for review, full details of the materials, equipment, sequence and method of installation. Review by the Engineer of these items shall not relieve the Contractor of the responsibility to install PVDs in accordance with this Special Provision. As a minimum, the submittal shall contain the following:

PREFABRICATED VERTICAL DRAIN MATERIAL - Acceptance of the sample PVD material by the Engineer will be required prior to delivery of the PVD material to the Project. At least 30 calendar days before beginning PVD installation, the Contractor and PVD Installer shall:

- Identify the proposed source of the assembled PVDs prior to delivery to the site.
- Supply, to the Engineer, a manufacturer's material certification that the assembled PVD meets or exceeds the material requirements of this specification. The manufacturer's literature shall document the physical and mechanical properties of the PVD. The PVD Manufacturer shall be a specialist in the manufacture of PVDs and shall have produced a minimum of 5,000,000 linear feet of the PVD material similar to that proposed for the Project and that has been successfully used in similar applications within the past 5 years, including details on prior performance on these projects.
- Submit to the Engineer, for review and visual inspection, 3 samples of the un-spliced PVD to be used and 3 samples of proposed splices, if splices are allowed on the project. The samples of un-spliced PVD shall be at least 5 feet long. Samples of spliced PVD shall be long enough to include the splice plus 2 feet of un-spliced drain on both sides of the splice. The samples shall be stamped or labeled by the manufacturer as being representative of the PVD material having its specified trade name.
- Submit to the Engineer, for review and visual inspection, 3 samples of the proposed anchor plate to be used to anchor the PVDs at the design depth shown on the plans.

PREFABRICATED VERTICAL DRAIN INSTALLER - Provide proof to the Engineer of the experience of the PVD Installer for the work described at least 30 calendar days prior to PVD installation. The PVD Installer shall:

- Document successful installation of at least 5,000,000 linear feet of PVDs during the last 5 years and shall be a certified installer of the PVD Manufacturer.
- Document at least 5 successfully completed projects within the last 5 years of similar size and complexity to that of the Project. Document the PVD Installer's experience by providing a project summary that includes for each referenced project, the project start and completion dates, total quantity of PVDs installed, and a detailed description of the project, site conditions,

and subsurface conditions. Include in the project description details of the PVD materials, the equipment and technique used to install the PVDs, the average and maximum length of PVD installed, the client name and address, the name and telephone number of the representative of the consultant and owner for whom the work was performed and who can attest to the successful completion of the work, and any other information relevant to demonstrating the PVD Installer's qualifications.

- Identify a full-time supervisor who has been in responsible charge of supervising PVD installation operations for at least 5 projects in the last 5 years. The supervisor shall be present at the work site at all times during PVD installation operations. Provide a detailed resume of the supervisor's experience and qualifications. Provide a detailed resume for the replacement supervisor, if required.

PREFABRICATED VERTICAL DRAIN INSTALLATION PLAN - At least 30 calendar days prior to PVD installation, the Contractor shall submit to the Engineer, for review, a PVD Installation Plan that includes as a minimum the following information:

- The configuration of the installation equipment including size, type, weight, maximum pushing force, and vibratory hammer rated energy.
- Dimensions and length of the mandrel.
- Details of the PVD anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for securing splices in non-bonded PVDs or the manufacturers splicing procedure for bonded PVDs, if splicing is allowed.
- Proposed methods and equipment for pre-augering or spudding.
- Submit documentation of the successful application of the proposed PVD installation operations.
- Provide shop drawings showing the planned locations and bottom elevations of all PVDs, a unique identification number for each PVD, the proposed installation sequence, the location of all potential conflicts with the locations of the PVDs.

627.05 Submittal Reviews – Acceptance of the proposed materials, equipment, construction sequence, and installation method will be accepted by the Engineer. Acceptance of the PVD materials, equipment, construction sequence, or installation method does not relieve the Contractor and PVD Installer of its responsibility to install the PVDs in accordance with the plans and specifications. Acceptance by the Engineer of the method and equipment to be used to install the PVDs is contingent upon satisfactory demonstration of PVD installation at the project site. If, at any time, the Engineer

considers that the method of installation does not produce satisfactory PVDs, alter the method and/or equipment as necessary to comply with this Special Provision. The Engineer will determine the adequacy of the Contractor's methods and equipment.

627.06 Installation Requirements

- Install PVDs as indicated on the plans or as directed by the Engineer. Install the PVDs with equipment that will minimize the disturbance of the subsoil during the installation operation and maintain the mandrel in a vertical position. Size the equipment to minimize the disturbance of the subsoil during the installation operation. Provide equipment with sufficient push force to install the PVDs through all existing subsurface material to the depths shown on the plans. Size the equipment to have the capability of installing the PVDs to a depth of approximately 20 feet greater than the maximum PVD depth shown on the plans. Select equipment such that it will not force the fill soil into the existing soil, nor disturb the fill soil, nor cause any bearing capacity problems with the subgrade soils due to the weight of the equipment.
- Install the PVDs using a mandrel or sleeve that can be advanced through the soils to the required depth. The mandrel or sleeve shall protect the PVD material from tears, cuts, and abrasion during installation and shall be retracted after each PVD is installed. To minimize disturbance of the subsoil, the mandrel or sleeve shall have a maximum cross-sectional area of 10 square inches. The mandrel or sleeve shall be sufficiently stiff to prevent wobble or deflection during installation. In no case will alternative raising and lowering of the mandrel during advancement be permitted. Permit the raising of the mandrel only after completion of the PVD installation to the bottom PVD elevation shown on the plans or otherwise authorized by the Engineer.
- Install the PVDs using either a constant load or constant rate of advancement technique. Use a vibrator only when approved by the Engineer in areas where constant load or constant rate of advancement methods cannot install the PVDs to the design depths. Jetting or use of an impact hammer will not be allowed to install PVDs.
- Provide each PVD with an "anchor" plate or similar arrangement to anchor the bottom of the drain at the required depth during mandrel removal and to prevent soil from entering the bottom of the mandrel during PVD installation. The anchorage shall be adequate to keep the bottom of the PVD at the required depth subject to approval and field verification by the Engineer. The corresponding dimension of the anchor shall conform as closely as possible to the breadth dimensions of the mandrel to minimize soil disturbance. The projected cross-sectional area of the mandrel and anchor combination shall not be greater than 14 square inches.

- Notify the Engineer at least 3 working days prior to installation of the initial PVDs at the location(s) shown on the plans to allow the Engineer sufficient time to provide the necessary inspection for the initial PVD installation. Do not begin installation of the initial PVDs at the location(s) indicated without the presence of the Engineer or his/her representative. During the installation of the initial 10 PVDs at the indicated location(s), demonstrate that the equipment, method, and material produce a satisfactory installation, as determined by the Engineer. Following completion of the initial PVD installations at the indicated location(s), do not proceed with the installation of the remaining PVDs at the embankment location until authorized by the Engineer.
- If foundations have been previously installed, install the PVDs in a manner as to avoid these foundations. The location of the PVDs relative to the foundations shall be determined and staked out prior to the installation of the PVDs. In addition, take precautions to preserve the stake locations and re-stake PVD locations as necessary.
- Using a baseline and benchmark determined by the Contractor, locate, number, and stake out the PVDs. All other construction staking, for taking precautions to preserve the stake locations, and for re-staking, if necessary, is the responsibility of the Contractor. Do not vary the as-installed locations of the PVDs by more than 6 inches from the locations designated on the plans or approved shop drawings.
- PVDs that deviate from the plan locations by more than 6 inches, that are damaged, or improperly installed will be rejected. Abandon in place rejected PVDs. Replacement PVDs shall be placed as close as possible to the correct original locations.
- Provide the Engineer with a means of verifying the plumb-ness of the mandrel and determining the depth of the PVDs. Check the equipment for plumb-ness prior to installing each PVD. A deviation from the vertical of no more than 2 percent (2%) during installation is allowed.
- Splices, if allowed in the plans or by the Engineer, shall be done in accordance with approved PVD Installation plan.
- Cut off the PVDs neatly at least 6 inches above the working layer, unless otherwise shown on the plans.
- Provide the Engineer with a means of determining the depth of the advancing PVD at any given time and the length of the drain installed at each location. Submit a summary tabulation of the number and length (to nearest 1/2 foot) of acceptable PVD daily to the Engineer.
- Refusal is defined as the point where the soils resist a reasonable effort at further penetration of the PVDs. The Engineer will establish refusal criteria based on the existing soil borings and the initial PVD installations to be performed by the PVD Installer in the presence of the Engineer or his/her inspector, as specified herein. Terminate no PVDs above the design PVD bottom

elevations shown on the plans without the approval of the Engineer. The Engineer may vary the depths, spacing, and/or number of PVDs to be installed, and may revise the plan limits for this work based on the actual subsurface conditions encountered.

- Where obstructions are encountered below the working surface, install a new drain within a 1 foot radius of the original location of the obstructed PVD. As directed by the Engineer make a maximum of 2 additional installation attempts for each obstructed PVD. If the PVD still cannot be installed to the design bottom elevation, abandon the PVD location and install a new PVD at a location directed by the Engineer. Clearly mark in the field locations where PVDs do not meet the depth criteria due to obstructions. The Engineer will have the right to waive the replacement PVD requirement upon written notice to the Contactor and the PVD Installer.

- Pre-augering or spudding for the PVD installation shall be allowed to advance the PVDs through compacted fill material or other obstructions. Penetrate the overlying fill material or any dense layers or obstructions when encountered to satisfactorily install the PVDs. Obstructions are defined as any man-made or natural object or strata that prevents the proper insertion of the mandrel and installation of the PVD.

- The Contractor may use augering, spudding, or other approved methods to loosen the soil and obstructing material prior to the installation of the PVDs. The obstruction clearance procedure is subject to the approval of the Engineer; however, such approval shall not relieve the Contractor or PVD Installer of the responsibility to clear obstructions in accordance with the specifications.

- If augering is the selected method, the augers shall have a minimum outside diameter equal to the largest horizontal dimension of the mandrel, shoe, or anchor, whichever is greatest. The maximum outside diameter of the auger shall be no more than 3 inches greater than the maximum dimension of the mandrel.

- Limit the use of obstruction clearance procedures and use only when approved by the Engineer. Penetrate no more than 3 feet beneath the obstruction when using augering or other obstruction removal techniques.

- Provide the Engineer with “As-Built” plans of the PVD installation. Include in the plans the location, the date installed, and the length of each PVD below the fill soil surface elevation. In addition, include on the “As-Built” PVD plans the fill soil surface elevation at each location, the “As-Built” PVD bottom elevation, and identify any rejected or abandoned PVD installations. Submit “As-Built” plans at least weekly during PVD installation operations. Submit a final “As-Built” PVD plan within 7 calendar days of the completion of PVD installation in all embankment locations. The final “As-Built” plans will be subject to the approval of the Engineer.

627.07 Method of Measurement – Furnish all supervision, materials, equipment, mobilization, crews, tools, required permits, survey stake out of PVD locations, and other equipment and materials as necessary to properly execute the work. In addition, this item includes clearing of obstructions and the proper disposal of surplus materials brought to the ground surface by obstruction clearance, if required.

Mobilization will be paid for by lump sum.

PVDs will be measured and paid for as the number of linear feet satisfactorily installed, or abandoned as directed by the Engineer. Measure the length of acceptably installed PVDs to the nearest 1/2 foot. The length of the PVDs to be paid for shall be the distance the installation mandrel tip penetrates below the working grade plus the required cut-off length above the working surface. Payment will not be made for drains that are not anchored to the required depth, unless previously approved by the Engineer in writing.

The Engineer may vary the depths, spacing, or numbers of PVDs to be installed and may revise the PVD installation limits shown on the plans based on the actual subsurface conditions encountered. Such changes or revisions may increase or decrease the total quantity of the PVDs estimated based on the plans. In the event of such changes in required PVD quantity, the payment for PVDs shall be made on the basis of the contract unit price per linear foot.

Drainage Layer Material will be paid for in cubic yards of material, complete and in place.

627.08 Basis of Payment – Mobilization shall include the cost of furnishing of all equipment and materials necessary to properly execute the work.

PVD payment will be based on the sum total length of all acceptably installed. No payment will be made for PVDs, or for any delays or expenses incurred through changes necessitated by improper material, equipment, or installation. No payment will be made for PVDs placed deeper than the bottom elevation designated on the plans unless authorized in writing by the Engineer. The unit bid price for PVDs shall include the cost of survey and stakeout, installing PVDs, and furnishing all labor, tools, and incidentals necessary to complete the work.

Drainage layer material payment will be based on the sum total cubic yards of material in place. The unit bid price for the drainage layer material shall include the cost of furnishing all labor, tools, and incidentals necessary to complete the work.

Payment will be made under Item Number:

- 627-01.01 Mobilization Lump Sum
- 627-01.02 Prefabricated Vertical Drain Linear Feet
- 627-01.03 Drainage Layer Material Cubic Yard

S T A T E **O F** **T E N N E S S E E**

(Rev. 7-28-21) January 1, 2021

SPECIAL PROVISION

REGARDING

HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS

Scope

These design requirements shall apply to **713**-Highway Signing, **714**-Roadway and Structure Lighting, and **730**-Traffic Signals of the current Standard Specifications.

Description

The design of the supports for overhead sign bridges and butterfly configurations, high mast lighting, luminaires, CCTV camera poles, and traffic signal strain poles and mast arm structures shall be in accordance with the American Association of Highway and Transportation Officials (AASHTO) LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 1st edition, with addenda.

General Conditions

All overhead sign bridges and butterfly sign structures, traffic signal strain poles and mast arm structures and high mast light poles 90-feet or greater in height, shall be designed using the Fatigue Category 1 provisions found in the subject specifications except that, design for galloping-induced fatigue and truck-induced gust fatigue, are excluded. Fatigue designs are not required for luminaire poles less than 55-feet in height, span-wire poles, or roadside sign poles.

In lieu of designing for galloping-induced fatigue in mast arm pole assemblies, a 60-inch by 16-inch by 0.125 gauge aluminum or galvanized steel panel shall be installed horizontally near the end of the mast arm with the long axis of the panel collinear with the long axis of the mast. The panel shall be mounted at such a height as to provide a least a 6-inch clearance from the top of the signal assembly or sign blank located on the mast arm within the length of the anti-galloping panel. The panel and attachment hardware shall be shown on the shop drawings, and is considered an item included in the price bid for the mast arm assembly.

Additionally, all mast arm connections to the support pole shall be accomplished using a wrap-around ring stiffener assembly.

The design coordination instructions are as follows:

a. The Basic Wind Speed shall be 120 mph for Extreme 1 Limit State.
b. The Design Life shall be 50 years resulting in a 1,700 year Recurrence Interval.

S T A T E **O F** **T E N N E S S E E**

(Rev 10-31-11) January 1, 2021

SPECIAL PROVISION

REGARDING

TRAFFIC CONTROL SUPERVISOR

At the preconstruction conference the Contractor shall designate a Worksite Traffic Supervisor other than the Superintendent to be responsible for initiating, installing, and maintaining all traffic control devices in accordance with all applicable special provisions, standard drawings, plans, specifications, and the most current edition of the Manual on Uniform Traffic Control Devices.

Qualifications. The Worksite Traffic Supervisor shall be certified by the American Traffic Safety Services Association Worksite Traffic Supervisor Certification Program, or the National Highway Institute by having satisfactorily completed training in "Design and Operation of Work Zone Traffic Control" taught by the University of Tennessee Transportation Center. In addition, they shall have at least one-year's experience directly related to worksite traffic control in a supervisory or responsible capacity.

Responsibilities. The Worksite Traffic Supervisor shall:

1. Oversee all operations which contribute to the convenience, safety and orderly movement of traffic.

2. Be available on a twenty-four hour basis with access to all manpower, equipment and materials needed to maintain traffic control devices and handle traffic related situations.

3. Maintain documentation to become part of the final project records of all daily activities including deficiencies found, how they were corrected and the personnel, equipment and traffic control devices utilized.

4. Correct routine deficiencies within a twenty-four (24) hour period after discovery.

5. Be available on the site within 45 minutes after notification of an emergency situation, prepared to effect corrective measures immediately.

6. Make daily inspections of all traffic control devices (at least every third inspection shall be at night).

7. Prepare and submit for approval any revisions to the existing traffic control plan sufficiently in advance to allow Department review prior to implementation.

8. Coordinate project traffic control activities with appropriate local law enforcement and emergency agencies.

9. Coordinate public awareness of changing traffic conditions through TDOT.

10. Educate all employees of the Contractor utilized as flaggers on proper flagging procedures.

Emergency Maintenance. Emergency maintenance shall consist of maintenance, repair, or replacement of traffic control devices that have been damaged, vandalized, or otherwise rendered ineffective to the extent that a serious hazard exists. The Traffic Control Supervisor shall cause such emergency work to begin within two (2) hours after being notified. When emergency maintenance is required during nonworking hours, devices that are classified as "unacceptable" according to ATSSA Quality Standards for Workzone Traffic Control Devices may be used, provided that the devices are effective in reducing the existing hazard, and further provided that they are replaced not later than the next business day. The Traffic Control Supervisor shall keep the Resident Engineer informed of the name, address, and telephone number of the individual responsible for performing emergency maintenance.

Failure to Comply. In the event a routine traffic control deficiency is not corrected within twenty-four (24) hours after discovery, a deduction in the amount of one hundred dollars ($100.00) shall be made from monies due the Contractor for each calendar day that the deficiency is allowed to remain, not as penalty, but as liquidated damages.

In the event that immediate action is not taken to correct an emergency situation, a deduction in accordance with Subsection 712.04 shall be made from monies due the Contractor. In addition, if deemed necessary by the Engineer due to lack of response by the Contractor, State Maintenance Forces may be mobilized to correct the emergency situation with all costs of the corrective action being assessed against monies due the Contractor. This assessment for costs incurred shall be in addition to the assessment of the amount in accordance with Subsection 712.04.

The preceding assessments shall be in addition to any liquidated damages which may be assessed in accordance with Subsection 108.07.

Basis of Payment. The labor costs involved in the provision of the Traffic Control Supervisor, and any equipment, tools, or incidentals necessary to complete the work, are to be compensated fully by the lump sum price bid for Traffic Control Supervisor, Item No. 712-01.04.

STATE **OF** **TENNESSEE**

November 8, 2019
(Rev. 9-1-21)

January 1, 2021

SPECIAL PROVISION

REGARDING

DIGITAL SPEED LIMIT SIGN ASSEMBLY

(VARIABLE SPEED ZONE)

DESCRIPTION

This work shall consist of the furnishing, installation, and operation of a work zone Digital Speed Limit Sign Assembly on interstates and freeways with speed limits greater than 55 MPH or facilities that have significant traffic volumes and impacts. The signs are regulatory speed limit signs with LED displays for the speed limit numbers.

The purpose of Digital Speed Limit Sign Assembly is to easily change work zone speed limits between activities that necessitate the need for a lower speed limit and the ones that do not.

EQUIPMENT

Digital Speed Limit Sign Assembly shall meet the following:

1. The unit shall have a regulatory speed limit sign (R2-1) with minimum dimension of 48 inches x 60 inches.
2. The Digital Speed Limit sign shall be mounted such that the bottom of the sign is 7 feet above the roadway.
3. The LED panel shall be a minimum of 28 inches x 18 inches. The display legend on the LED panel shall be white.
4. The LED numbers shall have a minimum 5 wide by 7 high pixel array with a minimum height of 18 inches.
5. The LED panel shall have auto brightness/dimming capability.
6. The Digital Speed Limit Sign Assembly shall have flashing beacons. Beacons shall be 12 inch diameter LED circular yellow. They shall be mounted above and below sign assemblies and are to be centered horizontally. The beacons shall alternately flash at rates not less than 50 or more than 60 times per minute.
7. The Digital Speed Limit Sign Assemblies shall have operational software and wireless communications that allows for remote operation and data monitoring.

8. The Digital Speed Limit Signs may be trailer mounted or stationary mounted. The unit shall be solar powered and have the ability to operate continuously. It shall be supplemented with a battery backup system which includes a 110/120 VAC powered on-board charging system.
9. The batteries, when fully charged; shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source. Store the battery bank and charging system in a lockable, weather and vandal resistant box.
10. The Digital Speed Limit Sign Assembly shall be listed on the Department's Qualified Products List No.44. For project applications that require more than one assembly, the same style of digital speed limit sign assembly shall be used.

CONSTRUCTION REQUIREMENTS

The Speed Limit shall be continuously displayed on the signs. The speed limits are the sole authority of TDOT. All speed limits are to be ordinanced by the State Traffic Engineer in order to have a lawfully enforceable speed limit.

1. The Traffic Engineer or designee will approve all Work Zone Speed Limits based on activities and conditions that warrant.
2. All existing static Speed Limit signs within the work zone speed zone shall be covered or removed at the time of Digital Speed Limit Sign Assembly installation. Signs shall be covered with an opaque, form fitting, tear resistant material that fully obscures any text.
3. Coordinate with the Engineer when the Work Zone Speed Limits are to be changed and seek approval by the Engineer or his designee before the Speed Limit is changed.
4. Sign placement shall begin within the advanced warning area with 1 sign placed on the Right side of the road. Subsequent signs shall be positioned at intervals no greater than 2 miles with 1 placed after each entrance ramp within the work zone.
5. Placement of signs shall be on the right side of the road unless infeasible or as directed by engineer. Placement of signs shall not interfere with the function of roadside devices such as guard rail or terminals
6. Flashing beacons shall be activated at the time of any workers present, no earlier than 30 minutes prior to workers arriving and be deactivated at the conclusion of work no later than30 minutes after all workers depart.
7. On a weekly basis for the duration of the project, supply a printable copy of the Tracking Report, reflecting the times of the speed limit changes along with their corresponding speed values.

METHOD OF MEASUREMENT

The Department will measure by each the Digital Speed Limit Sign Assembly, complete in place and accepted, according to the number of Digital Speed Limit Sign Assemblies required per the spacing requirements. Payment will be made for each sign used for the duration of the project.

BASIS OF PAYMENT

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Item No.	Description	Unit
712-08.09	DIGITAL SPEED LIMIT SIGN ASSEMBLY	EACH

Such payment is full compensation to furnish, coordinate, install, maintain, operate, track, monitor, subsequently remove Digital Speed Limit Sign Assemblies as well as provide the weekly Tracking Report shall be included. The expense of covering or removal, and subsequent restoration of existing Speed Limit or Minimum Speed Limit signs, including any necessary supports, shall be included in the pay item for the Digital Speed Limit Sign Assembly. All installations, relocations, and removals, of supplemental signs, including signs and necessary supports, shall be included in the pay item for Digital Speed Limit Sign Assembly.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-20) January 1, 2021
(Rev. 2-13-23)
(Rev. 10-7-24)

SPECIAL PROVISION

REGARDING

TRAFFIC QUEUE PROTECTION

Description

This work consists of providing Traffic Queue Protection when Work activities are performed on control-access or limited access facilities. Pursue efforts for the protection of traffic queues caused by project Work and clearly demonstrate adequate good faith efforts. The queue protection trucks are expected to alert motorists (inside or outside of project limits) of all stopped traffic caused by Work activities or incidents within the project limits.

Equipment

For projected queues of less than 1 mile, provide a minimum of one (1) queue protection truck for each traveling direction where traffic flow is reduced. One (1) additional queue protection truck shall be onsite in reserve.

For projected or observed queues of greater than 1mile, two (2) Queue Protection Trucks shall be operational.

The queue trucks deployed shall meet the following minimum requirements:

1. A truck mounted attenuator that meets the requirements of and be listed on the Department's Qualified Products List.
2. Four (4) strobe lights (with auto-dimmers) positioned rear facing.
   - **a.** Two (2) mounted under rear bumper.
   - **b.** Two (2) mounted at cab level.
3. One (1) standard cab mounted light bar.
4. A truck mounted message board with a full matrix display and a minimum panel size of 72" W x 35" H mounted as per manufacturer specifications and in accordance with Sections 2L.04 and 6F.60 of the MUTCD for Portable Changeable Message signs.

5. All Queue truck operators shall have the following mandatory training:
   - **a.** Four Hour National Traffic Incident Management (TIM) Responder Training for Queue Truck Operators, or
   - **b.** Approved equal training program developed by ATSSA, or
   - **c.** The National Safety Council.

Maintenance of Traffic

The following procedures will be followed until free flow traffic conditions are present: ("free flow" is defined as the absence of a temporary lane or shoulder closure or absence of a temporary shift of traffic lanes with no queue present).

1. The queue protection trucks shall be positioned approximately 1/2 to 1 mile upstream from the back of the slow moving traffic. During use of the 2 or more queue protection trucks, the trucks should not be any closer than 1/2 mile from the other truck.
2. The queue protection trucks shall be positioned on the shoulder and clear of the traveled way so as not to impede traffic and shall reposition as the length of the queue changes.
3. The queue protection trucks message board shall display the message "STOPPED TRAFFIC AHEAD/USE CAUTION".
4. The use of the 2 queue protection trucks shall be to relocate as needed to maintain approximately 1/2 to 1 mile distance from the back of the slow moving traffic Queue protection trucks that do not adjust position during the course of the operation and fail to provide adequate queue protection will be considered as not meeting specification and will not be paid for that day.
5. The 2nd queue protection truck shall be held in reserve, on site, and support the primary truck if conditions prevent repositioning by reverse or if the primary truck is otherwise unable to effectively manage the queue. This truck shall not be paid for idle time.
6. The queue protection trucks and operators shall be onsite and ready to be utilized during planned lane closures and other project activities expected to cause a queue.
7. Queue length estimates and traffic conditions shall be reported to the Engineer or designee at the following periods:
   - **a.** At 30 minute intervals.
   - **b.** At significant changes.
   - **c.** When free flow traffic is achieved.

Method of Measurement

The Department will measure, either by the day or by the hour as provided in the contract, the Queue Protection Truck, for each truck providing queue protection. Idle or standby time shall be included in the bid price.

a. A day is defined as a work shift. A work shift will be considered 12 hours or less depending on the project schedule.

b. An hour shall be any hour or portion of an hour.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
712-08.12	QUEUE PROTECTION TRUCK	DAY
712-08.11	QUEUE PROTECTION TRUCK	HOUR

Such payment will be full compensation for all work specified including labor, materials, equipment, tools, and incidentals to complete the work.

If at any time the Department determines that a queue protection truck is not pursuing the efforts for the protection of traffic queues caused by project Work and not clearly demonstrating adequate good faith efforts, the Engineer shall not pay for the Queue Protection Truck for that day or hours.

STATE **OF** **TENNESSEE**

October 12, 2020 January 1, 2021
(Rev. 9-1-21)

SPECIAL PROVISION

REGARDING

SPEED FEEDBACK SIGN ASSEMBLY

Description

This work shall consist of the furnishing, installing and operation of a work zone Speed Feedback Sign Assembly. Equipped with Doppler radar and a LED display, these devices inform motorists of their current speed and/or advisory messages as well as generate data to be used in traffic management strategies.

The purpose of the Speed Feedback Sign Assembly is to provide speed awareness to the motoring public in areas where speed reduction is desired and provide real time information to the Engineer regarding speed and traffic volumes.

Equipment

Speed Feedback Sign Assembly shall meet the following:

1. The LED panel shall be a minimum of 18 inches high and legible at 1000 feet. The display on the LED panel shall be yellow. A placard shall be mounted above or below the feedback display with the legend "YOUR SPEED".

2. The unit shall be radar operated with operational software and capable of recording speed.

3. The LED panel shall have auto brightness/dimming capability.

4. The Speed Feedback Sign Assembly may be trailer mounted or stationary mounted. The unit shall be solar powered and have the ability to operate continuously. It shall be supplemented with a battery backup system.

5. The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source. The battery bank and charging system shall be stored in a lockable, weatherproof and vandal resistant box.

6. The unit shall have a static regulatory speed limit sign attached (R2-1) with minimum dimension of 36 inches x 48 inches.

7. The Speed Feedback Sign Assembly shall be listed on the Department's Qualified Products List No. 44. For project applications that require more than one assembly, the same style of speed feedback sign assembly shall be used.

Construction Requirements

1. The unit shall be located in the advance warning area or within the active work zone but shall not be located after the active work zone. The unit should be placed in area of reduced work zone speed limit.

2. Placement of the unit shall be on the right side of the road unless infeasible or as directed by the Engineer. Placement of signs shall not interfere with the function of roadside devices such as guardrail or terminals.

3. The unit should not be within 500 feet of Advanced Warning Sign or Digital Speed Limit Sign Assembly.

4. The regulatory speed limit sign on the unit shall match the reduced speed displayed on the digital speed limit sign. When the display on the digital speed limit sign is adjusted to the normal speed limit then the speed feedback sign shall be covered or removed so that there are no conflicting speed limits on the project.

5. Coordinate with the Engineer for location of the Speed Feedback Sign Assembly.

6. A data printout of the average vehicle speed and hourly vehicle volume shall be provided to the Engineer weekly.

Method of Measurement

The Department will measure, by Each, the Speed Feedback Sign Assembly, complete in place and accepted, according to the maximum number of Speed Feedback Sign Assemblies required at any given time on the project. Payment will be for the maximum number of assemblies in use with data received at any given time for the duration of the project.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Pay Item	Description	Unit
712-08.08	Speed Feedback Sign Assembly	Each

Such payment is full compensation to furnish, coordinate, install, maintain, operate, track, monitor, subsequently remove Speed Feedback Sign Assemblies and with the average speed and hourly volume data provided.

STATE **OF** **TENNESSEE**

October 17, 2019
(Rev. 6-30-20)
(Rev. 6-23-21)
(Rev. 3-30-22)

January 1, 2021

SPECIAL PROVISION

REGARDING

CONTRAST PAVEMENT MARKINGS

Description

This work shall consist of the placement of a Contrast Pavement Marking system and/or Contrast Pavement Shadow Marking on concrete surfaces and meet current Standard Specifications except as noted in this Provision.

For new installation of pavement markings on multi-lane concrete roadways, bridges, and ramps, the Contrast Pavement Marking System shall consist of either a white and black or yellow and black pavement marking, (see Details 716CPM-1, 2, 3, 5 & 6) and the Contrast Pavement Shadow Marking shall consist of a black spray thermoplastic pavement marking. (see Details 716CPM-4 & 5) The Contrast Pavement Marking system shall be used for the edge lines and dotted lines only and the Contrast Pavement Shadow Marking shall be used for the lane lines only.

For new installation of pavement markings on 2 lane concrete roadways, bridges, and ramps, the Contrast Pavement Marking System shall consist of either a white and black or yellow and black pavement marking, (see Details 716CPM-1, 2, 3, & 6). The Contrast Pavement Marking system shall be used for all lines.

To enhance existing pavement markings on multi-lane concrete roadways, bridges, and ramps, the Contrast Pavement Shadow Marking shall consist of a black spray thermoplastic pavement marking. (see Details 716CPM-4 & 7) The Contrast Pavement Shadow Marking shall be used as an addition to the existing lane lines only.

Materials

Provide materials that are specified as follows:

A. Thermoplastic Pavement Marking

1. White and Yellow thermoplastic pavement marking material shall meet requirements of **919.01** for the screed extrusion or ribbon dispenser methods.
2. Black contrast thermoplastic pavement marking material shall conform to material requirements in **919.01** for screed extrusion or ribbon dispenser methods or **919.02** for

the spray method. The black contrast thermoplastic pavement shadow marking material shall conform to the material requirements in **919.02** for the spray method. The material requirements should be met with the following exceptions:

a. No Intermix glass beads.

b. Calcium carbonate shall be 95% pure.

c. The percent of pigment shall be based on the manufacturer's recommendations. When applied, the black pigment must produce a completely opaque black pavement marking and 70 hrs. of weatherometer exposure in accordance with ASTM G 155 using Exposure Cycle 1 with a quartz inner filter glass and Type "S" Borosilicate outer filter glass. The black material shall be a colorfast and anti-skid material to form the pavement marking.

3. The thermoplastic material for contrast pavement marking systems shall provide white and black, or yellow and black thermoplastic as matching systems from the same manufacturer.

B. Alternate Contrast Pavement Markings

An alternate to contrast thermoplastic pavement marking material shall be selected from the Department's Qualified Products List 1: Section B, Preformed Plastic Pavement Markings with a thickness of 90 mils minimum or List 1: Section C.2, Preformed Contrast Tape with a thickness of 80 mils minimum.

C. Certification

1. Furnish a manufacturer's certification to the Engineer for each lot furnished, certifying that the material supplied conforms to all requirements specified.

2. The certification shall include or have attached typical results of all required tests and the requirements it represents.

Construction Requirements

Apply the Contrast Pavement Marking system and/or Contrast Pavement Shadow Marking according to the manufacturer's recommendations and specified in **716.03.** Apply to concrete surfaces with the proper application temperatures and after surface preparation as recommended by the material manufacturer.

Do not apply Contrast Pavement Marking to existing or new concrete surfaces unless the ambient air temperature and the temperature of the concrete pavement is 50°F and rising.

To ensure optimum adhesion of the thermoplastic pavement marking material to concrete surfaces, apply a binder sealer material as recommended by the manufacturer.

For new installations of contrast pavement marking on existing concrete surfaces, the existing pavement marking material, thermoplastic or tape, shall be removed by methods in **712.05** or as indicated in the plans and paid as Removal of Pavement Marking (Line).

A. Two Pass Application

1. Apply the black thermoplastic pavement marking material to the concrete surface at a thickness of 40 mils according to the manufacturer's recommendations.
2. Apply the white or yellow thermoplastic pavement marking material by the extruded or ribbon dispensed methods on top of the black thermoplastic pavement marking at a thickness of 100 mils according to the manufacturer's recommendations and Standard Specifications. The white or yellow pavement marking will be applied on top of the black pavement marking to create the Contrast Pavement Marking System with a total thickness of 140 mils.

Detail: 716CPM-1 Contrast Pavement Marking, Two-Pass Application



B. One Pass Application

Apply the White or yellow thermoplastic pavement marking material with black contrast thermoplastic pavement marking material simultaneously by the extruded or ribbon dispensed methods at a thickness of 110 mils according to the manufacture's recommendations.

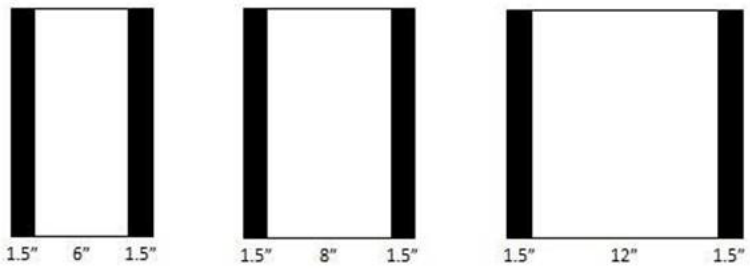
Detail: 716CPM-2 Contrast Pavement Marking, One-Pass Application



C. Alternate Contrast Pavement Markings

Apply the QPL approved Preformed Tape or Preformed Thermoplastic to the concrete surfaces according to manufacturer's recommendations and as specified in **716.06**.

Detail: 716CPM-3 Contrast Pavement Marking, A, B, & C



D. Contrast Pavement Shadow Marking

Apply the black thermoplastic pavement shadow marking material to the concrete surface at a thickness of 60 mils as an addition to the existing lane lines according to Detail: 716CPM-3 & 5 and meeting the manufacturer's recommendations.

Detail: 716CPM-4 Contrast Pavement Shadow Marking, D



Traffic Control

1. Traffic control shall be completed in accordance with the plans and/or contract documents.
2. All traffic control operations shall apply with the MUTCD at a minimum. Any changes must be approved by the engineer.

Method Of Measurement

The Department will measure the length of each of these markings, complete in place and accepted, as listed in the bid schedule, along the center of each line. Only the marked line will be measured for payment.

The Department will measure the pavement marking words and symbols complete in place and accepted, by each for these markings.

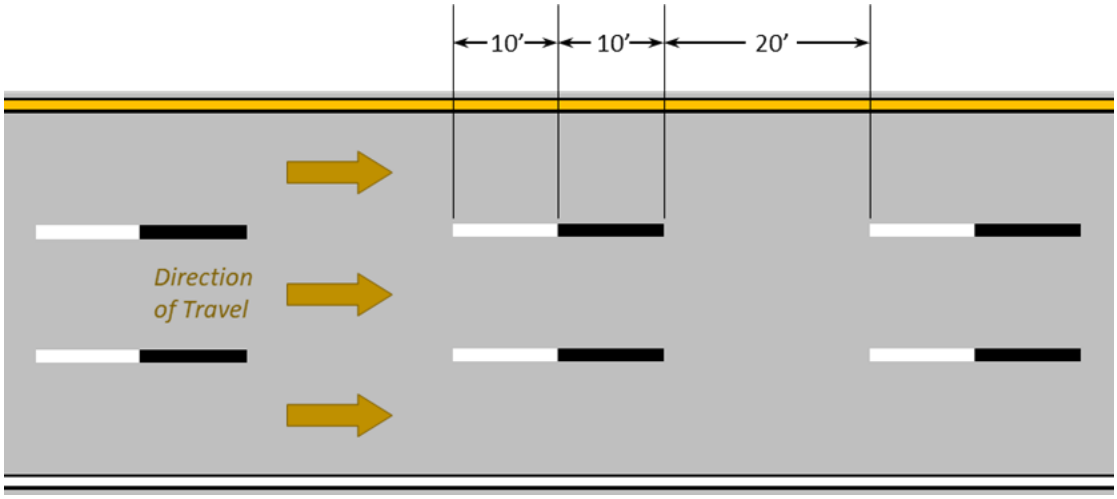
Basis Of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

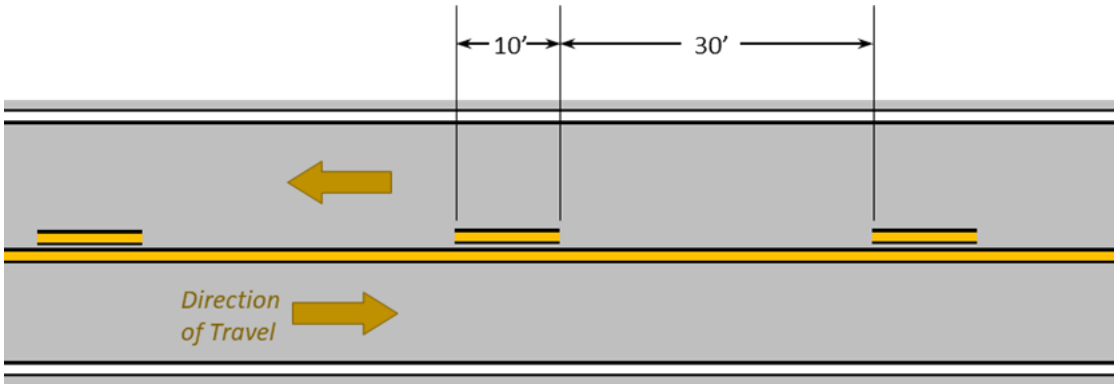
Item No.	Description	Unit
716-09.86	CONTRAST PAVEMENT MARKING 6 INCH	LINEAR MILE
716-09.88	CONTRAST PAVEMENT MARKING 8 INCH	LINEAR MILE
716-09.89	CONTRAST PAVEMENT MARKING 12 INCH	LINEAR FEET
716-09.90	CONTRAST PAVEMENT MARKING 6 INCH DOTTED	LINEAR FEET
716-09.87	CONTRAST PAVEMENT MARKING, WORDS, AND SYMBOLS	EACH
716-09.94	CONTRAST PAVEMENT SHADOW MARKING 6 INCH	LINEAR MILE
716-09.95	CONTRAST PAVEMENT SHADOW MARKING 8 INCH	LINEAR MILE

Such payment is full compensation for preparation, layout, materials, labor, equipment, tools, royalties, and all other incidentals necessary to complete the work.

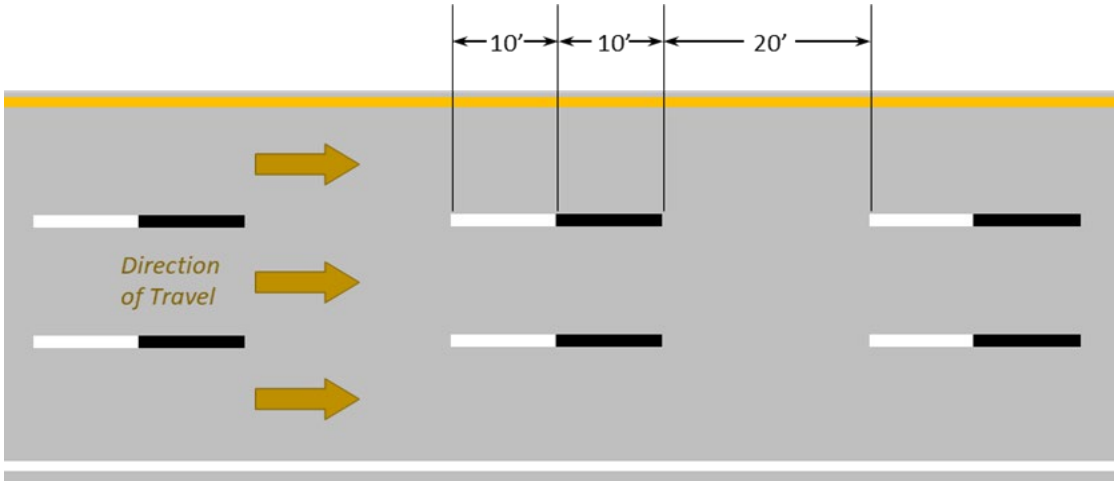
Detail: 716CPM-5: Contrast Pavement and Shadow Marking Multi-Lanes



Detail: 716CPM-6: Contrast Pavement Marking 2 Lanes



Detail: 716CPM-7: Contrast Pavement Shadow Marking Multi-Lanes



S T A T E **O F** **T E N N E S S E E**

(Rev. 10/12/20) January 1, 2021
(Rev. 2/13/23)

SPECIAL PROVISION

REGARDING

WET RETROREFLECTIVE PAVEMENT MARKING

Description

This work shall consist of the placement of a Wet Retroreflective Pavement Marking that is either hot applied thermoplastic pavement marking or preformed wet retroreflective tape. All work shall be accomplished in accordance with **716** and **919** of the Standard Specifications.

The Wet Retroreflective Pavement Marking available are approved on the Department's Qualified Products List (QPL) and composed of one of the following:

A. Microcrystalline Ceramic Elements for Double Drop System

Materials

Use thermoplastic pavement marking material meeting the requirements of **919.01** except as specified, and in accordance with the Department's Sampling and Testing Guide.

Double Drop System

The double drop system shall be capable of applying microcrystalline ceramic elements at the rate of 5.29 pounds per 100 square feet of pavement marking material. Followed by an application of Type 3 glass beads at a minimum rate of 5.29 pounds per 100 square feet of pavement marking material.

Use Microcrystalline ceramic elements listed on the Department's Qualified Products List for Wet Retroreflective Pavement Markings.

Use Type 3 drop on glass beads that meet the requirements **919.01.C** & **D**.

Equipment

Use equipment meeting **716.03** for extruded or ribbon-dispensed thermoplastic material.

Application

Apply thermoplastic pavement marking material meeting **716.03** for extruded or ribbon-dispensed thermoplastic material, except as noted.

When applying traffic stripes and marking over existing markings, ensure that not more than 2 inches on either end and not more than 1 inch on either side of the existing line is visible.

B. Preformed Wet Retroreflective Tape

Materials

Use preformed wet retroreflective pavement marking tape meeting **716.06** and **919.03** and listed on the Department's Qualified Products List (QPL) for Preformed Tape.

Equipment

Use equipment based on manufacturer's recommendations.

Application

Apply preformed wet retroreflective pavement marking tape meeting **716.06**, except as noted. The pavement surface shall be prepared in accordance with manufacturer's recommendations.

Apply preformed wet retroreflective pavement marking tape only to dry surfaces, and when the ambient air and surface temperature is at least 40ºF and rising.

On all Portland cement concrete surfaces, apply a primer, sealer or surface preparation adhesive that is recommended by the manufacturer for the specific pavement marking tape. Offset longitudinal lines at least 2 inches from construction joints of Portland cement concrete pavement.

C. Inverted Profiled Thermoplastic Pavement Marking

Materials

Use thermoplastic pavement marking material meeting the requirements of **919.01**, except as specified, and in accordance with the Department's Sampling and Testing Guide.

1. Composition

Thermoplastic pavement marking material composition shall meet the following requirements:

Component	White	Yellow
Binder, % minimum	19	19
TiO_2 Pigment, % minimum	10	N/A
Yellow Pigment % minimum	N/A	5
Intermix Glass Beads, % minimum	40	40
Calcium Carbonate/Fillers, % maximum	31 (1)	41 (1)

(1) The amount of Calcium Carbonate and inert fillers shall be as recommended by the manufacturer, provided all other specifications are met.

2. Glass Beads

Use retroreflective glass beads shall meet the requirements of **919.03** and in accordance with the Department's Sampling and Testing Guide.

3. Intermix Glass Beads

Intermix glass beads shall make up a minimum of 40% by weight of the thermoplastic formulation. These beads shall meet all requirements of AASHTO M247 Type 1 and 3 with a minimum of 80% true spheres.

4. Double Drop System

The double drop system shall be capable of applying glass beads at the specified application as specified in **919.01.E.** The retroreflective element drop-on rate shall meet or exceed Section **716** as specified by the manufacturer.

Use Type 3 drop on beads that are dual coated for moisture resistance and adhesion that meet the requirements of AASHTO M247 Type 3, and the beads shall be with 80% true spheres.

Use Type 1 drop on glass beads that are dual coated for moisture resistance and adhesion that meet the requirements of AASHTO M247 Type 1, and the beads shall be with 80% true spheres.

Equipment

Use equipment meeting **716.03** for extruded or ribbon-dispensed thermoplastic material, except as specified in Application, that will produce a consistent pattern for inverted profiled thermoplastic pavement marking. The use of rollers to place grooves in the pavement marking material utilizing a separate vehicle or grooves that are not pressed within 1 second of thermoplastic pavement marking material application will not be allowed.

Use equipment based on manufacturer's recommendations.

Application

Use equipment specially designed for placing hot thermoplastic pavement marking material in a hot molten state on the pavement surface utilizing a pressure type application method. An inverted profiled thermoplastic pavement marking die that can travel along in proximity with the road surface shall form the hot inverted profiled thermoplastic pavement markings. The die is pulled forward by a special linkage that will allow it to automatically level itself as to float and remain parallel with the road surface. The top of the die shall be enclosed and provide entry means for the hot molten thermoplastic to enter the die cavity. The bottom of the die shall contain a movable door that is remote controlled so as to start or stop the flow of thermoplastic on to the pavement surface. When the movable door is open, thermoplastic can flow through the die and will apply thermoplastic material that will be formed rearward of the advancing die. The road surface shall be at the bottom of the die enclosure. Thermoplastic material shall be fed to the die under pressure through flexible oil-jacketed stainless steel hoses. The die shall be formed from a single solid block of steel that is oil-jacketed on 4 sides to keep the die hot at all times.

The inverted profiled thermoplastic pavement marking system consists of a low-pressure drop-on type glass bead dispenser, moisture resistance bead coat. The glass beads shall be dispensed onto the hot thermoplastic material from a height of approximately 1 inch, above the road surface. The point at which the glass beads strike the surface of the pavement marking shall be approximately 3 inches, behind the strike point of the thermoplastic. The glass bead coat shall utilize Type 3 glass beads and shall provide a surface coating of 50% of the thermoplastic pavement marking surface, and at least 50% of the beads will be embedded to a depth of 60% of their diameter.

A second low-pressure drop-on glass bead dispenser capable of applying a continuous coating of glass beads shall follow approximately 10 inches behind the first bead dispenser. This second glass bead dispenser shall apply adhesion bead coat which will form a continuous drop-on coat of Type 1 glass beads immediately in front of the profile thermoplastic pavement marking die. The second coat of glass beads shall be applied with low impact so that they are not forced into the pavement marking under pressure.

The rotatable wheel for inverted profiled thermoplastic pavement marking die shall be located approximately 8 inches, behind the second bead dispenser. The inverted profiled pavement marking die shall be approximately 7 inches in diameter and shall have a plurality of spaced projections located around its circumference. The inverted profiled pavement marking die shall be wider than the pavement marking material being applied to ensure adequate coverage. The projections on the inverted profiled pavement marking die shall have an angular profiling surface set at an angle to the pavement surface. The inverted profiled pavement marking die shall be mounted with an automatic leveling device to the same carriage assembly as the thermoplastic dispenser. To ensure that no hot thermoplastic material adheres to the die as it rotates and invert profiles the pavement marking, a small air atomized water jet shall apply a thin mist of water to the rotatable die. No water droplets greater than ¼ inch in diameter shall be allowed to accumulate on the pavement surface in proximity to the freshly placed pavement marking.

All parts of the thermoplastic holding tank including manifolds, hoses, pipes, dies, etc., shall be oil-jacketed to insure accurate temperature control. The thermoplastic material shall be preheated in kettles designed specifically for that purpose. Each kettle of preheated thermoplastic material shall be properly mixed and heated to the correct application temperature. The preheated material shall then be fed to the thermoplastic gun for application.

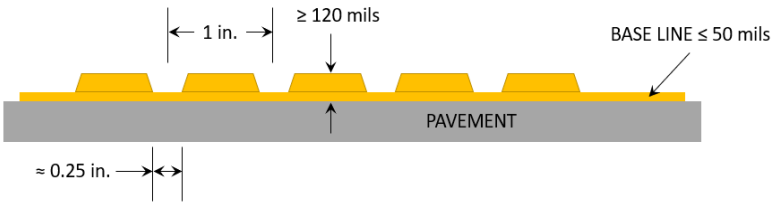
When placing inverted profiled thermoplastic pavement marking material on existing asphalt or concrete pavement that has more than one existing pavement marking material, the existing material shall be removed to the point that 80 percent of the pavement surface is visible.

Dimensions of Inverted Profiled Pavement Marking

The dimensions of the inverted profiled thermoplastic pavement marking shall have a minimum thickness of 120 mils measured from the pavement surface. The thermoplastic pavement marking material in the bottom of the inverted profiles shall have a thickness of up to 50 mils.

The individual inverted profiles shall be located transversely across the entire pavement marking surface at intervals of approximately 1 inch. The bottoms of these intervals shall be between 3/32 inch and 5/16 inch wide. It is acceptable for the top surface of the inverted profiles to be slightly irregular.

Detail: 716WR-1 Inverted Profiled Thermoplastic Pavement Marking



Notification

Notify the Engineer prior to the placement of pavement markings. Furnish the Engineer with the manufacturer's name and batch numbers of the thermoplastic materials, glass beads, and microcrystalline ceramic elements to be used. Ensure that the batch numbers appear on the thermoplastic materials and retroreflective elements packages.

Protection of Pavement Markings

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause.

Deficiencies

As determined by the Engineer, remove, and replace any unsatisfactory raised or inverted profiled thermoplastic pavement markings. The removal and replacement of the unsatisfactory pavement marking material shall be at no additional cost to the Department.

Method of Measurement

The Department will measure by the linear mile, complete in place and accepted, Wet Retroreflective Pavement Marking in accordance with **716.08.**

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
716-09.03	WET REFLECTIVE PAVEMENT MARKING (6IN)	LINEAR MILE
716-09.--	WET REFLECTIVE PAVEMENT MARKING(---)	--------

Such payments will be full compensation for all work specified, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment may be withheld until all deficiencies are corrected.

STATE OF TENNESSEE

(Rev. 10-19-2015)
(Rev. 10-5-2021)
(Rev. 7-15-2024)

January 1, 2021

SPECIAL PROVISION

REGARDING

ROADWAY SWEEPING

General. The work shall consist of the removal by mechanical sweeping, or other approved means, of dirt and debris such as tire and metal fragments, hub caps, rocks, etc. accumulated on the roadway along curbs, gutters, median barriers, bridge curbs and gore areas and ramps at interchanges.

The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with these specifications and terms of the contract.

Control of Work. The Engineer, or his appointed representative, will decide all questions, which may arise as to the quality and acceptability of the work performed and his decision will be binding on the parties. If at any time the required equipment fails to meet acceptable standards, the Engineer shall notify the Contractor and suspend work immediately.

Equipment. The Contractor shall furnish all equipment necessary to perform the work within the specified time. The use of mechanized vacuum or broom sweepers is required for this contract. Air flow vacuum sweepers shall have a blower capacity of not less than 17,000 CFM and broom mechanical sweepers shall have a minimum 100 HP @ 2,500 RPM diesel engine. All sweepers shall have a minimum 26,000 GVD and 10 foot sweeper path. All sweeping equipment shall be designed and operated with a water spray system to ensure that dust does not create a traffic hazard. All sweepers shall be equipped with a centrifugal dirt separator at the air return outlet of the hopper. All of the Contractor's equipment shall clearly display the Contractor's name and phone number on each side of the vehicle.

All sweeping equipment shall conform to all Federal, State and Local laws, regulations and ordinances for noise, water and air pollution controls and all Occupational Safety and Health Administration (OSHA) regulations.

All equipment shall be inspected and approved by the Engineer prior to the work beginning.

Hand brooms and other small tools may be required to remove any dirt and debris not removed by the power sweepers.

Work Schedule. Work may be performed between the following hours:

Roadway Classification	Roadway AADT	Working Hours
Interstate and Access Controlled Highways*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	AADT < 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
Multi-lane Highways (# of lanes >2)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	10,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 10,000	No Working Restrictions
Two Lane Highways (One lane in each direction)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	5,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 5,000	No Working Restrictions
*Work requiring the use of shoulder closures (only) will be allowed between 9AM -3PM		

The weekday hours of operation may be extended to if working in the non-peak direction of traffic flow (except Friday PM) as directed by the Engineer. Weekend operations shall be restricted to daylight hours.

Weekdays are defined as beginning at 8:00 p.m. Sunday and ending at 3:00 p.m. Friday. The Engineer may temporarily suspend work activities during periods of inclement weather, during special events or in Maintenance and Construction work zones.

Traffic Safety. Traffic flow around the work in progress shall be maintained. All work shall be performed in the direction of traffic instead of opposing traffic. All traffic control work zones shall be established by the Contractor in accordance with the requirements of the State's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD). The Contractor shall furnish shadow vehicles as recommended in Chapter 6 (Fig. 6H-4, 6H-17, and 6H-35) of the MUTCD for shoulder, two-lane, and multi-lane mobile traffic control work zones. All optional truck or trailer mounted attenuators for the shadow vehicle(s) in Figures 6H-4, 6H-17, and 6H-35 of the MUTCD are required for the sweeping operation**. All shadow vehicles in a sweeping operation shall be equipped with truck or trailer mounted attenuators.** A work vehicle (sweeper) cannot be utilized as a shadow vehicle.

The sweeping unit and the shadow vehicle(s) shall be equipped with flashing amber lights. Shadow vehicles shall be equipped with a Type C, 48" x 96" flashing arrow panel in accordance with Standard Drawing T-WZ-FAB1. Traffic control will be considered incidental to the work being performed and the cost thereof will be included in the price bid for linear mile of sweeping.

Dump Sites. All accumulated debris and rock materials swept or picked up by the Contractor will be removed from right-of-way to a Class IV dump site facility with the Contractor being responsible for all fees where applicable. The Contractor shall supply the Engineer with copies of dump tickets for each cycle prior to any payments being made.

Method of Measurement. Sweeping will be measured by the number of linear miles swept and cleaned free of all accumulated debris and foreign objects from the area between the edge of the traveled lanes and the face of the curb, barrier wall, bridge, guardrail, or outside edge of the paved shoulder. Sweeping of the described areas for a distance of one mile, measured along the centerline of said roadway, shall be deemed as one linear mile of sweeping.

Basis of Payment. The accepted quantities of linear miles swept will be paid for at the contract unit price per linear mile.

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-08-2015)
(Rev. 09-06-2016)
(Rev. 09-11-2018)
(Rev. 10-02-2019)
(Rev. 10-09-2020)
(Rev. 09-30-2021)
(Rev. 09-25-2024)

January 1, 2021

SPECIAL PROVISION

REGARDING

REMOVAL AND DISPOSAL OF LITTER

Description. This work shall consist of removal and disposal of litter from the entire highway rights-of-way where accessible (fence to fence where applicable), including shoulders and excluding the travel lanes on designated interstate and state routes.

Definitions.

Litter. Any object or group of objects foreign to the right-of-way that has been discarded or abandoned and is or may become visible from the edge of the roadway or shoulder as a result of mowing, vegetation management, maintenance operations, or traffic. Examples under this definition include but are not limited to paper, plastic, bottles, cans, wood, tires, portions of tires, and metal products.

Continuous Operation. The uninterrupted performance of work on successive working days until the completion of all of the items of work specific to litter removal in the contract are approved by the Engineer.

Working Day. A calendar day, exclusive of State recognized holidays, which weather or other conditions not under the control of the Contractor, will permit litter operations to proceed for at least five (5) hours of the day with the normal working force engaged in performing the controlling item or items of work which are normal to progress at the time, as determined by the Engineer.

Equipment. The contractor shall furnish all necessary equipment for the satisfactory performance of the work. All vehicles used on the project will be equipped with at least two 6" diameter flashing amber lights, visible in both directions and with a covering device to prevent the litter from being blown from the vehicle.

Work Schedule. The litter removal for each section of road shall be accomplished on a schedule that will ensure that the spacing between the beginnings of each cycle is constant

throughout the entire life of the contract. For example, if there are twenty-six (26) cycles to be accomplished, they are to be started and completed every two weeks. The maximum cycle time allowed for sections with fewer than twelve (12) cycles shall be thirty (30) calendar days. For contracts which require fewer than twelve (12) cycles the Engineer will notify the Contractor in writing at least five (5) working days prior to the beginning of each litter cycle. Work shall begin on the date specified by the Engineer and shall be a continuous operation. Each litter cycle shall begin at the same location and proceed as established in the preconstruction conference or as directed by the Engineer (see Section 105.06 of the January 1, 2021 Standard Specifications). The contractor shall supply sufficient resources to accomplish the work during the allotted cycle time.

Time and Frequency Litter. The number of litter cycles will be indicated in the General Notes and will correspond to the mowing schedule. One litter cycle will be reserved for winter pick-up (if needed) and scheduled at the discretion of the Engineer. In addition, the Engineer may eliminate an entire cycle or require a partial litter cycle at certain locations. A litter cycle will be considered complete when litter has been removed from the right-of-way specified in the General Notes and all quantities associated with litter removal have been accepted as complete by the Engineer.

Litter removal operations on controlled access roads in Davidson, Hamilton, Knox, and Shelby shall not be performed during rush hour traffic from 6:00 A.M to 9:00 A.M and 3:00 P.M to 6:00 P.M. However, the contractor shall be allowed to work in the direction opposite to rush hour traffic during these times.

Litter removal shall be performed only during daylight hours Monday through Friday or as directed by the Engineer. If work is performed on Saturday and/or Sunday, the Contractor will be charged a Working Day.

Litter Removal and Disposal. All litter shall be bagged and removed daily from the right-of- way. All litter accumulated each cycle by the Contractor will be removed from the right-of-way to a Class I dumpsite facility. All fees associated with disposal of litter removed from the state right-of way shall be included in the unit price bid for the Removal and Disposal of Litter, Item No. 719-02. The Contractor shall supply the Engineer with copies of dump tickets for each load deposited at the qualified dumpsite facility.

Acceptance of Work. The Department may accept a portion of the project before the entire project is completed. Such portion(s) shall be of reasonable length as determined by the Engineer and shall be clean and free of litter when the inspection is made.

Additional Work. The Contractor may be required to remove litter in areas not specifically detailed in the General Notes under the direction of the Engineer. Additional work shall be limited to the counties and systems which are designated in the Special Notes. Payment will be made at the contract unit price for the Removal and Disposal of Litter, Item No. 719-02.

Traffic Control. The Contractor shall maintain work zone traffic control and all traffic control devices for litter removal operations according to the requirements contained herein, the State of Tennessee's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD) defined under the Rules of Tennessee Department of Transportation Chapter 1680-3-1, and the Standard Specifications. Although Traffic Control may be included in the cost of other items, the contractor will be responsible for submitting certifications per Materials & Tests Division Standard Operating Procedures.

Warning Signs. The Contractor shall furnish portable signs in accordance with the "Manual on Uniform Traffic Control Devices" to notify the traveling public of litter operations. The Contractor shall place these signs along the highway during litter operations and remove them immediately after the operation ceases. Signs at the beginning point shall be forty-eight inches (48") by forty-eight inches (48") in size; diamond-shaped with black letters on an orange background with a black border with eight- inch high letters. These signs shall be dual-mounted, one on each shoulder, for both directions of travel.

Safety Requirements. T he Contractor shall comply with OSHA standards, including the use of Class 3 reflective shirts or vests at all times.

Notification to the Engineer shall be made immediately of any personal injury, accidents involving the contractor's equipment, or accidents involving the motoring public.

While equipment is not in use, it shall be parked or stored off the pavement or shoulder of the highway in an inconspicuous place more than thirty (30) feet from edge of pavement or as directed by the Engineer.

The Contractor shall be required to have the company name and phone number on a11 work zone support vehicles on the left and right sides in a location that is visible to the public. The lettering for the company name and phone number shall consist of a reflectorized material with a minimum height of three inches (3") or five inches (5") in height if non-reflectorized.

Method of Measurement. Litter pickup and disposal will be measured by the centerline mile. Measurement will be made longitudinally along the centerline of the project, including bridges, and such single measurement shall include removal and disposal of all litter on interchanges, State maintained crossroads, and service roads within the lateral limits of the rights-of-way excluding the travel lanes.

Basis of Payment. Removal and disposal of litter will be paid for at the contract unit price per centerline linear mile which shall be full compensation for mobilization and performance of the work in accordance with the stipulations, provisions and requirements contained herein.

All costs for traffic control as defined above shall be included in the unit bid price for litter removal, Item No. 719-02.

Special Provision 725 (SP725)

Regarding

Intelligent Transportation Systems (ITS)

Updated version to remove sections not used on the Design Build project by NSI.

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
3.0	Periodic Update and Addressed Comments from Version 2.2	Z. Domingue	8/21/24	M. Davis	8/28/24	W. Munshaw	8/29/24
3.1	Removed unused sections from version 3.0	S. El Said	9/12/2025				

0 Table of Contents

1 INTRODUCTION 1-1
2 GENERAL REQUIREMENTS 2-1
2.1 Scope of Work Requirements 2-1
2.2 Design Summary 2-5
2.3 General System Requirements 2-6
2.4 Training 2-7
2.5 Project Testing Plan Requirements 2-7
2.6 Warranties 2-15
2.7 Project Submittal Program Requirements 2-15
2.8 System Documentation 2-19
2.9 Payment Terms For 725 Item Numbers 2-19
3 CONDUIT 3-1
3.1 Description 3-1
3.2 Materials 3-1
3.3 Installation Requirements 3-8
3.4 Testing Requirements 3-13
3.5 Warranty 3-13
3.6 Method of Measurement 3-14
3.7 Payment 3-19
4 PULL BOXES 4-1
4.1 Description 4-1
4.2 Materials 4-1
4.3 Installation Requirements 4-3
4.4 Testing Requirements 4-3
4.5 Warranty 4-4
4.6 Method of Measurement 4-4
4.7 Payment 4-5
5 FIBER OPTIC INFRASTRUCTURE 5-1
5.1 Description 5-1
5.2 Materials 5-1
5.3 Installation Requirements 5-10
5.4 Testing Requirements 5-15
5.5 Warranty 5-19

5.6 Method of Measurement 5-19
5.7 Payment 5-21
6 WIRELESS ETHERNET RADIO COMMUNICATIONS 6-1
6.1 Description 6-1
6.2 Materials 6-1
6.3 Installation Requirements 6-4
6.4 Testing Requirements 6-5
6.5 Warranty 6-7
6.6 Method of Measurement 6-7
6.7 Payment 6-8
7 ELECTRICAL EQUIPMENT 7-1
7.1 Description 7-1
7.2 Materials 7-1
7.3 Installation Requirements 7-5
7.4 Testing Requirements 7-9
7.5 Warranty 7-10
7.6 Method of Measurement 7-10
7.7 Payment 7-12
8 EQUIPMENT CABINETS 8-1
8.1 Description 8-1
8.2 Materials 8-1
8.3 Installation Requirements 8-13
8.4 Testing Requirements 8-14
8.5 Warranty 8-16
8.6 Method of Measurement 8-17
8.7 Payment 8-17
9 POLES AND STRUCTURES 9-1
9.1 Description 9-1
9.2 Materials 9-1
9.3 Installation Requirements 9-8
9.4 Testing Requirements 9-10
9.5 Warranty 9-11
9.6 Method of Measurement 9-11
9.7 Payment 9-12
10 CCTV CAMERA SYSTEM 10-1

10.1 Description 10-1
10.2 Materials 10-1
10.3 Installation Requirements 10-6
10.4 Testing Requirements 10-7
10.5 Warranty 10-8
10.6 Method of Measurement 10-8
10.7 Payment 10-9
~~11 DYNAMIC MESSAGE SIGN~~ 11-1
SECTION NOT USED 11-1
12 RADAR DETECTION EQUIPMENT 12-1
12.1 Description 12-1
12.2 Materials 12-1
12.3 Installation Requirements 12-5
12.4 Testing Requirements 12-9
12.5 Warranty 12-11
12.6 Method of Measurement 12-11
12.7 Payment 12-11
~~13 ENVIRONMENTAL SENSOR SYSTEM (ESS)~~ 13-1
SECTION NOT USED 13-1
~~14 ROAD SIDE UNIT (RSU)~~ 14-1
SECTION NOT USED 14-1
~~15 OVERHEIGHT VEHICLE DETECTION SYSTEMS~~ 15-1
SECTION NOT USED 15-1
~~16 HIGHWAY ADVISORY RADIO (HAR)~~ 16-1
SECTION NOT USED 16-1
~~17 WEIGH IN MOTION (WIM) SYSTEM~~ 17-1
SECTION NOT USED 17-1
~~18 PERMANENT SPEED FEEDBACK SIGN~~ 18-1
SECTION NOT USED 18-1
19 NETWORK SWITCH 19-1
19.1 Description 19-1
19.2 Materials 19-2
19.3 Installation Requirements 19-5
19.4 Testing Requirements 19-6
19.5 Warranty 19-6

19.6 Method of Measurement 19-7
19.7 Payment 19-8
~~20 ITS COMMUNICATIONS HUB BUILDING~~ 20-1
SECTION NOT USED 20-1
21 PORTABLE SMART WORK ZONE SYSTEM (PSWZS) 21-1
21.1 Description 21-1
21.2 Materials 21-1
21.3 Portable Smart Work Zone System (PSWZS) Operational Requirements 21-6
21.4 Testing 21-9
21.5 Training 21-10
21.6 Warranty 21-10
21.7 Method of Measurement 21-11
21.8 Payment 21-11
22 SYSTEMS INTEGRATION 22-1
22.1 Description 22-1
22.2 Materials 22-2
22.3 Installation Requirements 22-8
22.4 Testing Requirements 22-9
22.5 Warranty 22-10
22.6 Method of Measurement 22-10
22.7 Payment 22-13
23 SPARE PARTS INVENTORY 23-1
23.1 Description 23-1
23.2 Materials 23-1
23.3 Storage 23-1
23.4 Testing Requirements 23-2
23.5 Warranties 23-2
23.6 Method of Measurement 23-2
23.7 Payment 23-2
24 SYSTEM MAINTENANCE REQUIREMENTS 24-1
24.1 Description 24-1
24.2 Schedule Of Work 24-3
24.3 Equipment To Be Maintained 24-4
24.4 Maintenance Procedures 24-4
24.5 Record Keeping Procedures 24-4

24.6 Equipment Control 24-5
24.7 Bar Code System 24-6
24.8 Staffing / Management Plan 24-6
24.9 Staffing Qualifications 24-6
24.10 Safety Plan 24-7
24.11 Contractor's Responsibility for Utility, Property, and Service 24-7
24.12 Performance Of the Contractor 24-7
24.13 Method of Measurement 24-8
24.14 Payment 24-9
25 PROJECT ACCEPTANCE 25-1
25.1 Description 25-1
25.2 Task Requirements 25-1
25.3 Testing Requirements 25-3
25.4 Warranty 25-4
25.5 Method of Measurement 25-4
25.6 Payment 25-5
APPENDIX A ABBREVIATIONS AND ACRONYMS 1
APPENDIX B PREVENTIVE MAINTENANCE PROCEDURES 1
APPENDIX C SPARE PARTS 1
APPENDIX D LATEST DEVICE FIRMWARE 1
APPENDIX E INSTRUCTIONS FOR ADDING SECTIONS/DOCUMENT MAINTENANCE 1
Tips and Tricks 1
APPENDIX F UNUSED/OUTDATED SPECIFICATIONS 1
~~26 FORWARD LOOKING INFRARED CAMERA SYSTEM~~ 26-1
SECTION NOT USED 26-1
~~27 FIELD VIDEO ENCODER UNIT~~ 27-1
SECTION NOT USED 27-1
28 TERMINAL SERVERS 28-1
28.1 Description 28-1
28.2 Materials 28-1
28.3 Installation Requirements 28-3
28.4 Testing Requirements 28-3
28.5 Warranty 28-4
28.6 Measurement 28-4
28.7 Payment 28-4

~~29 FORWARD FIRING RADAR DETECTION~~ 29-1
SECTION NOT USED 29-1

1 INTRODUCTION

The contents of this SP725 supersede all project Plans and other TDOT Standard Specifications.

This document is organized in several parts, starting with Section 2, GENERAL REQUIREMENTS, then moving into device-specific requirements and ending with system-wide requirements that lead to Final Acceptance in Section 25. ABBREVIATIONS AND ACRONYMS are included in APPENDIX A and PREVENTIVE MAINTENANCE PROCEDURES are included in APPENDIX B. APPENDIX C includes the list of Spare Parts required to be Furnished and Stored by the Contractor under this contract. Please refer to the Table of Contents for a full listing of document Sections and Subsections.

TDOT reserves the right to amend this SP725 after project award; any compensable costs incurred by the contractor as a result of changes to this SP725 will warrant change order considerations.

Item numbers used in this SP725 are for reference only. The actual item numbers to be used are those shown in the estimated quantity sheet of the Plans.

If reviewing the editable, electronic version of this document, please note that additional appendices beyond APPENDIX C are intended for use when preparing new project specifications and should be deleted, along with this statement, prior to finalizing the document. If reviewing the PDF version of this document, please note that appendices beyond APPENDIX C are not intended to be included in this SP725 and they should be disregarded within the context of this project.

2 GENERAL REQUIREMENTS

1. All commands and references in, or in connection with, the text in this Special Provision (SP725) document are written to direct Contractor responsibility for action unless otherwise specified.
2. This section specifies the minimum general requirements for this contract. These Section 2 requirements apply to all aspects of the contract including but not limited to the materials, installation, measurement, and payment requirements for all contract items.
3. The Contractor is responsible for all work required in this Section 2. All costs associated with the work in this Section 2 shall be included in the contract price for the items included in the project and no separate payment shall be made by TDOT.

2.1 Scope of Work Requirements

For specific information about the project, see the Scope of Work on the Plans. The Contractor shall be fully responsible for complete construction and testing of the Project as shown in the contract documents. Contract documents include but are not limited to Plans, TDOT Standard Specifications, this SP725, any supplemental specifications, and circular letters. This contract includes work on segments of roadways where proposed ITS devices, electrical infrastructure, and system communications shall be installed as detailed in the contract documents.

The system includes but is not limited to the furnishing and installation of devices, poles, sign structures, cabinets, foundations, guardrail, conduit, hub buildings, fiber optic cable network, wireless communication network, electrical power service, other required vendor software/hardware, and TDOT ATMS software integration necessary to complete a fully functioning system as required by the contract documents.

All the equipment provided shall comply with the applicable industry approved standards for the subsystems and communications network. Contractor shall follow approved industry standards and utilize the National Transportation Communications for ITS Protocols (NTCIP) for the DMS, CCTV Camera, RDS, ESS, RSU, OVDS, WIM, HAR, and other devices.

Field adjustments may be needed for conduit, cabinet, and device locations shown throughout the project. These adjustments shall be coordinated with and approved by the Engineer.

2.1.1 ITS and Network Communications Devices

Quantitative and performance requirements for each type of equipment provided in this SP725 are mandatory minimum requirements. Functional equivalents proposed by the Contractor that fully meet or exceed this SP725 will be considered, provided the functional equivalent is compatible with the communications, hardware, and software included in the project, and provided that the functional equivalent meets all design and operational objectives of TDOT. Experimental devices that are not proven in existing field installations at the time they are proposed for this project shall not be considered. All equipment and component parts that are furnished shall be new, with original manufacturer's warranty and not used or refurbished, shall meet all requirements of this SP725, and shall be in an operable condition at the time of delivery. All parts shall be of high-quality workmanship and no part or attachment shall be applied contrary to the manufacturer's recommendations or standard practices. All materials and installation of all devices shall be in accordance with this SP725 and Plans and with the manufacturer's recommendations for the exact intended application. The entire quantity of any particular added item shall be the exact same manufacturer, model, revision, firmware, etc. In addition, each major component must

be provided, successfully integrated into the existing TDOT ATMS system by the contractor and warranted by a single vendor/manufacturer.

Manufacturers of ITS and Network Communications active electronic equipment and other critical system components shall be required to establish minimal qualifications prior to approval of equipment submittals, by submitting for consideration the following years of experience supplying the general type of device indicated:

- Network Switches, RDS, ESS, OVDS, WIM, HAR, CCTV Camera, and DMS: 5 years
- RSU: 3 years

The experience statements shall include but not be limited to 3 owner references and documentation of operational equipment installations. The statement of experience shall identify the number of years of experience as well as the references listed above and shall be provided during the submittal program as outlined in Section 2.7 of this SP725.

2.1.2 Applicable Standards

All materials and installation procedures shall conform to the Plans, Special Provisions, the latest adopted edition of the TDOT Standard Specifications for Road and Bridge Construction, the latest adopted edition of the TDOT Standard Drawings, the latest adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD), and the supplemental Specifications, as included in the Specifications package.

1. Electrical Standards

    a. All electrical materials and work shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories Inc. (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association (NETA), Institute of Electrical and Electronics Engineers (IEEE), and the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the approved shop drawings to be prepared by the Contractor, and this Special Provision, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC), National Electrical Safety Code (NESC) and applicable codes of governing jurisdictions. Unless specified, all standards used for this project shall be the latest edition available.

2. Video Standards and Protocols

    a. One of the major system components to be furnished, installed, and tested under this project is IP addressable Closed-Circuit Television (CCTV) video equipment. Digitization of the video signals for transmission shall utilize the H.264 standard, MPEG4, Part 10 Standard as defined by the International Telecommunication Union (ITU), Motion Picture Experts Group (MPEG) and as required by the device specifications within this SP725.

3. NTCIP Standard Protocols

    a. The Dynamic Message Signs (DMS) shall be compatible with the latest approved version of the National Transportation Communications for ITS Protocol (NTCIP) as applicable. The Contractor shall provide documentation from an independent testing entity, which may be in the vendor’s possession, to identify NTCIP objects successfully incorporated and tested. The Contractor shall provide the Management Information Base (MIB) for all objects from the sign vendor during the submittal process. Additional NTCIP testing may

also be required as part of the Factory Acceptance Test. Deviation from NTCIP compliance shall require advance written approval by the Engineer prior to installation of the non-compliant device. The Engineer may withhold this approval at their discretion.

b. CCTV control protocol for pan, tilt, and zoom in addition to other camera controls shall meet NTCIP and Open Network Video Interface Forum (ONVIF) requirements.

4. Ethernet and IP Standards and Protocols

a. The Ethernet communications system and all connected devices shall, as an entire interconnected system, completely implement and be compatible with IEEE 802.3 industry standards for Ethernet and NTCIP standards supporting Ethernet as applicable and required. Ethernet switching equipment is used to transport the digital IP-based video and control data from field devices to hub cabinets. Network equipment at the field master hub switches routes the video and data to the TDOT Regional TMC, other facilities and end users as needed.

2.1.3 Device Control Protocols

For all active electronic devices controllable through any type of communications interface, the Contractor shall be required to voluntarily, and without seeking additional fees, restrictions, licenses or compensation from TDOT, coordinate with each respective system representative for each piece of equipment supplied, to support direct communication with and control of devices by the TDOT ATMS software identified. If the Software Integration Pay Item is included in this project for interfacing of device types new to TDOT, the Software Integration Pay Item shall be utilized to pay for development and coordination required to support direct communication with and control of devices by the TDOT ATMS software.

A list of all pertinent device makes and models that are already supported by each system will be provided at the project pre-bid meeting. If a supported make and model is provided under this contract, no further coordination with the operating system vendors will be required. However, if a new make and/or model is provided, the Contractor shall be responsible for coordinating with the system vendors to ensure sufficient drivers are developed to support the new devices without additional compensation. Complete documentation of the interface protocol and/or MIB shall be provided during the submittal program as outlined in Section 2.7 of this SP725.

2.1.4 Contractor and Subcontractor Qualifications

The Contractor or Subcontractor selected to perform the ITS portion of the project certifies to be qualified as an expert in the trade, capable of understanding the intent of this SP725 and constructing the project in accordance with the prevailing standard practice of the trade. Firms qualifying as Contractor and or Subcontractors to perform ITS work must demonstrate at least 5 years of experience and at least 2 projects within the last 5 years in the type of work they plan to perform on this project:

1. Fiber-Optic Communications
2. Wireless Communications
3. CCTV camera surveillance
4. RDS
5. ESS

6. RSU
7. DMS
8. OVDS
9. WIM
10. HAR
11. Electrical Power Distribution
12. Hardware and Software used for Transportation Management Centers

2.1.5 Complete, Compatible Installations

This SP725 is for materials and equipment necessary to construct the proposed Project; however, every fitting, minor detail, or feature may not be described. Any component not explicitly stated in this SP725, but necessary for the ITS sites to function, shall be considered incidental and shall be furnished and installed by the Contractor at the sole discretion of the Engineer. The Contractor is responsible for providing all miscellaneous, associated, and incidental materials to provide fully operational and complete ITS Equipment Sites as specified in this SP725, on the Plans, and in the contract documents. The fully operational and complete ITS shall be readily compatible with the communications technologies utilized, and compatible with the hardware, software, and communications equipment installed at the TDOT Regional TMC, and such miscellaneous materials required to achieve fully operational and complete status shall be considered incidental to the project.

2.1.6 Complete Operational Systems

The Contractor shall furnish and install all necessary equipment for completely operational ITS Equipment Sites which are of high quality, high reliability, and operational stability. Compliance with minimum requirements for individual items identified in this SP725 does not, in and of itself, constitute compliance with the reliability and operational stability requirements necessary to provide for the integration of the sites into a complete, integrated system. It is the Contractor's responsibility to ensure that the components provided will work together to form a complete working system as specified in this SP725, on the Plans, and in the contract documents. It is the Contractor's responsibility to notify the Engineer in writing of any components outlined in the Specifications or Plans that would prohibit the Contractor from being able to install a completed working system. The completed system shall be fully integrated with TDOT ATMS software already in use and be able to be fully monitored and controlled from the TDOT Regional TMC.

2.1.7 Communications System/Equipment Software Compatibility

The Contractor is responsible for ensuring that all equipment and software versions provided for this project is compatible with the existing communications system, TDOT ATMS software, and all other equipment provided for this project, as installed, configured, and programmed by the Contractor and while complying with all system functionality and performance requirements. This compatibility includes but is not limited to all field devices and their respective controllers, all wired and wireless communications links, all control center hardware, and all software applications and control systems including but not limited to the CCTV, DMS, RDS, ESS, RSU, OVDS, WIM, HAR, network switches, video communications equipment, and the network management system. The Contractor shall ensure that the delay in equipment response times throughout the entire system is compatible with the existing

software. Any modifications to the vendor software, firmware, and hardware to account for system latency and compliance with the total video response delay performance requirements shall be the responsibility of the Contractor.

2.1.8 Equipment and Materials

1. All equipment and materials furnished and installed on this project shall be new and unused.
2. All equipment and materials of a similar type and nature shall be of the same manufacturer, model, revision, firmware, etc.
3. All bolts, nuts, and fastening hardware less than 5/8" diameter shall be stainless steel. All bolts, nuts, and fastening hardware 5/8" in diameter and greater shall be hot-dipped galvanized. Refer to Subsection 908.04 of the Standard Specifications for High Strength Structural Bolts.
4. All components, materials, and incidentals shall be recommended by the manufacturer as suitable for the intended application, including any material exposed to the weather.
5. All equipment and associated materials shall be installed and configured in accordance with the manufacturer's recommendations and standard practices.
6. All equipment and materials furnished and installed on this project shall comply with the current requirements of the Build America Buy America (BABA) Act.

2.1.9 Coordination with Various TDOT Highway and Bridge Construction Contractors

The Contractor shall coordinate their activities with any other Contractors, which may be in the same work area. There are areas within the project limits where roadway construction activities may be occurring during the same timeframe as this project. Conflicts will be handled at the discretion of the Engineer. The Contractor shall notify TDOT promptly in writing if there are any conflicts which may impact the Contractor's schedule or construction activities. The mere presence of these roadway construction activities alone will not be a sufficient reason for schedule delays. The ITS Contractor is expected to coordinate with these other Contractors to the extent possible.

2.1.10 Project Completion and Liquidated Damages

The project shall be completed in accordance with the requirements set forth in SP108B.

2.2 Design Summary

For specific information about the project, see the Scope of Work on the Plans.

2.2.1 Phasing

All work in this project will be completed in a single phase. However, proper sequencing of the work is still critical to ensure that the existing devices are taken off-line for as short a time as possible.

This project sequencing is intended to establish a general workflow for the Contractor's various discrete crew types. For example, the Contractor's underground crew should complete 75% or more of the work in a specific geographic location before moving into a new location. However, crews that have completed work in a given area can move to the next area prior to the completion of work performed by different crew types within the earlier area. For example, the Contractor may move the conduit crews to secondary locations after completing the initial location even though other crews such as cable crews and cabinet

crews have not completed their efforts in the initial area. However, the actual physical cutover of the existing devices to the new network cannot occur until all efforts are complete.

The Contractor shall ensure continuous operation of the fiber optic communication lines and ITS devices affected by the work activities unless otherwise authorized by the Engineer. Prior to temporary disconnect of the fiber optic communication network or ITS network devices, Contractor shall notify the Engineer and coordinate with the TDOT Regional TMC at least 2 weeks in advance of a planned outage. Any outage must avoid peak roadway traffic periods. ITS network devices include but are not limited to CCTV cameras, Radar Detection Systems (RDS), and Dynamic Message Signs (DMS) within the project limits or those devices outside project limits that may be affected by communication failures caused by this project. Failure to restore communication and ITS devices beyond the specified time frame shall result in liquidated damages in accordance with rates established in Special Provision 108B until communication and/or ITS devices are restored.

Upon Conditional System Acceptance, TDOT will assume operations of those devices where practical. This use by TDOT does not constitute Final Acceptance or waive any other requirements in this Contract. Also, the Burn-In Period described in this SP725 does not begin until Conditional System Acceptance of all Phases has been achieved.

2.2.2 Electrical Power

The local electrical service provider within the limits of this contract is indicated on the Plans. For new devices, the provider shall provide power drops at proposed demarcation points, as appropriate. The Contractor shall include the initial install cost from the utility as well as the cost of coordinating with the utilities in the bid price for electrical connections. The Contractor is required to coordinate with the utility company for the installation of the service. The addresses recorded in the power company records are included on the Plans. The Contractor shall pay for all monthly service charges until after Conditional System Acceptance. Within the interstate right-of-way, any physical facilities, such as conduit runs, needed by the service provider shall be the responsibility of the Contractor to install as shown on the Plans. The electrical demarcation points within the existing device project limits will remain in place.

2.3 General System Requirements

2.3.1 CCTV and Control Data Latency

Control commands shall be generated from the off-the-shelf video control software provided by the Contractor and shall pass through the Ethernet network to the field equipment, such as CCTV cameras. Operation of the pan, tilt, zoom, presets, focus, iris, and any other available functions of the CCTV cameras shall be provided. Status data generated by the camera shall be transmitted to the camera control unit and to the TDOT Regional TMC. The total video response delay between the operator issuing a command to move a camera (through a mouse through the TDOT ATMS software), movement of that camera, and the resulting display on the operator's monitor of that camera's viewing image as it is moving, shall be minimized to avoid over steering and operator difficulty in positioning the camera. The maximum allowable total video response delay anywhere in the project shall not exceed an average of 1.0 second for any 10 cameras sequentially randomly sampled and shall not exceed 1.5 seconds for any single camera sampled.

2.3.2 DMS Control Latency

The total delay in sending a message to a DMS or receiving a polling response from a DMS shall not exceed 5 seconds from the time the operator commands the message at the TDOT Regional TMC until the message is displayed on the DMS.

2.3.3 Existing System

Details on the location of the existing devices are included on the Plans. If any additional information regarding the existing system is needed for bidding purposes, it is the Contractor's responsibility to request in writing the specific information desired in accordance with the question submittal deadlines in the pre-bid instructions. Questions shall be addressed to the Engineer.

2.4 Training

Prior to Conditional System Acceptance, the Contractor shall provide a 6-hour training session covering the operation and maintenance of all devices included in the project such as CCTV camera and camera lowering device, DMS, RDS, ESS, OVDS, HAR, WIM, and RSU as well as configuration and operation of all electronic equipment including network switches, wireless ethernet radios, video communications equipment, communications hubs and associated equipment, electrical power services, and fiber optic cable network. A second, redundant 6-hour training session shall be provided on a different day of the week for a total of 2, 6-hour training sessions.

The training shall be provided at the TDOT Regional TMC for at least 10 personnel with individual printed and electronic copies of all training materials and manuals provided to each participant. The training must include a complete demonstration of the configuration, operation, and capabilities of each component in the system. The training should also consist of a hands-on demonstration of all software configuration and functionality where applicable.

Each training session shall include a mixture of classroom style training in equipment operation, hands-on operator training, and question and answer sessions. The Contractor shall submit the trainers' qualifications to the Engineer for approval prior to scheduling the training. The qualifications of the trainers must meet, at a minimum, the recommended qualifications of the equipment manufacturer. If qualified personnel are not on the Contractor's staff, a representative of the manufacturer shall provide the training.

The Contractor shall submit to the Engineer for approval a detailed Training Plan including course agendas, detailed description of functions to be demonstrated, deviations in training location, and a schedule. The Contractor shall also provide all training material in electronic format to the Engineer.

2.5 Project Testing Plan Requirements

The Contractor shall submit for review and approval a Project Testing Plan as required below in addition to all other project testing and acceptance procedures required elsewhere in this SP725 and Plans. The Project Testing Plan shall include a series of tests on all project materials occurring at various stages in the project. The Project Testing Plan includes all testing in the Standard Specifications including all modifications and supplemental procedures contained in this SP725. All costs associated with the Project Testing Plan shall be included in the associated bid price for each item; no separate payment will be made for any testing.

Separate FAT, BTC, BTS, and SAT documents shall be provided for each ITS component as required for the project and specified in this SP725. See the Testing Subsections within this SP725 for specific testing requirements. A CSAT document shall be provided for the overall system.

2.5.1 General Requirements

The Contractor is responsible for planning, coordinating, conducting, and documenting all aspects of the Project Testing Plan and providing all required equipment for the tests. The Engineer is responsible only for attending and observing each test and reviewing and approving the Contractor's test results documentation. The Engineer reserves the right to attend and observe all tests.

Each test shall be an individual and separate event for each type of test and for each type of equipment as defined in this SP725. The Contractor shall follow the testing sequence as described in this SP725 and shall perform the required tests on all applicable devices and infrastructure.

Each test shall fully demonstrate that the material under test is clearly and definitively in full compliance with all project requirements.

Test procedures shall be submitted and approved for each test as part of the project submittal program requirements in Section 2.7. Test procedures shall include every action necessary to fully demonstrate that the material under test is clearly and definitively in full compliance with all project requirements. Test procedure actions shall cross-reference to this SP725 or Plans requirement that is the subject of the test action. Test procedure actions shall cross-reference the applicable sections of the final approved Project Submittal Compliance Form and the submittal materials for the subject of the test action. Test procedures shall contain test setup and block/wiring diagrams showing all materials being tested and all test and measurement equipment, with calibration documentation, and shall contain documentation regarding the equipment configurations and programming. Test procedures shall include check off blanks for each project requirement included in that test and shall include forms for the documentation of all measured test results. Test procedures shall include all qualifications required for the personnel conducting the tests.

No testing shall be scheduled until approval of all project submittals is granted by the Engineer for all materials covered under a given test and approval of the test procedures for the given test.

Unless otherwise required herein, the Contractor shall request in writing the Engineer's approval for each test occurrence a minimum of 60 calendar days prior to the requested test date. Test requests shall include the test to be performed and the material to be tested. The Engineer reserves the right to reschedule test requests if needed.

For any series of tests on different installations of a given material (e.g., different sections of cable), the Contractor shall request in writing the Engineer's approval for the first test occurrence of the series a minimum of 60 calendar days prior to the requested test date, regardless of the notification requirements for subsequent test occurrences.

The Contractor shall provide all appropriate personnel, ancillary equipment, and materials as required in the approved test procedures. Appropriate personnel may be a qualified employee of the Prime Contractor, their Subcontractors, or a vendor representative capable of conducting test procedures.

The Contractor shall document all test results, including all raw data necessary to validate the test results, in writing in accordance with the test procedure and submit to the Engineer within 7 calendar days of the test. Any given test session is considered incomplete until the Engineer has approved the documentation for that test session.

The Contractor shall repeat all tests if results are deemed by the Engineer to be unsatisfactory, following all test requirements as given here. In the written request for each test occurrence that is a repeat of a previous test, the Contractor shall summarize the diagnosis and correction of each aspect of the previous test that was deemed unsatisfactory. Any revisions to the test procedures for a repeated test occurrence shall meet all requirements for the original test procedures, including review and approval by the Engineer.

The satisfactory completion of any test shall not relieve the Contractor of their responsibility to provide a completely acceptable and operating system that meets all requirements of this project as specified in this SP725, on the Plans, and in the contract documents.

The tests for the Conditional System Acceptance may be completed in Phases as described in Section 2.2.1. However, the overall Conditional System Acceptance which starts the Burn-In Period shall not be granted until all elements in this contract have passed the Conditional System Acceptance Test. The phased acceptance testing is only to allow the Contractor to receive milestone payment for work completed.

2.5.2 Factory Acceptance Test (FAT)

FATs shall be conducted at the Manufacturer or Contractor's facility or at a facility acceptable to all parties. All equipment to be utilized for this project shall be subject to tests that demonstrate the suitability of the design and manufacturing procedures and compliance with the contract requirements unless an exception for a specific equipment item is granted by the Engineer. The tests shall be performed on production units identified to be delivered under this Contract. As a minimum, a FAT is required for each of the following project materials:

1. Dynamic Message Sign and Controller
2. Diesel Engine Standby Generator
3. Hub Building

The FAT procedure shall demonstrate all requirements defined in this Special Provision are met including but not limited to functional/system performance requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, environmental requirements, and interface requirements with other components of the system including the DMS control software, the Ethernet switches, etc.

The FAT procedure for Hub Buildings shall be a visual inspection prior to leaving the factory. Photos and/or videos of the finished building shall be provided to TDOT to verify that there are no manufacturing issues prior to leaving the factory site.

The Engineer reserves the right to witness all FATs. At a minimum, the Engineer will attend the FAT for the first new DMS, Diesel Engine Standby Generator, and/or Hub Building (if the project contains these items). Attendance at the FAT can be in-person or through a virtual meeting with the manufacturer at the discretion of the Engineer. The FAT for the first 2 units of each item type shall be conducted during the same time period and shall be completed before additional units of that item type are produced.

The Engineer shall be notified a minimum of 60 calendar days in advance of such tests. Salary and travel expenses of the Engineer and their representatives will be the responsibility of TDOT. In case of equipment or other failures that make a retest necessary, travel expenses of the Engineer and their representatives shall be the responsibility of the Contractor. This shall include all costs associated with

having 2 of the Engineer's representatives on site including but not limited to airfare, automobile rental, lodging, and per diem. These costs, excluding airfare, shall not exceed $500.00, per representative, per day. These costs shall be deducted from the payments due or charged to the withholding account of the Contractor when the project is terminated.

The vendor must complete the FAT on all remaining signs on their own and submit documentation to the Engineer that the FATs were completed. The Engineer reserves the right to randomly attend those FATs.

No equipment for which a FAT is required shall be shipped to the project site without successful completion of a FAT as approved by the Engineer and the Engineer's approval to ship.

2.5.3 Bench Test Component (BTC)

The Contractor shall perform a complete BTC on all equipment and materials as specified in this Subsection below. The Contractor shall provide the testing location and facility, which shall be in Tennessee and within a 25-mile radius of the project limits or as directed by the Engineer. The test location must be approved by the Engineer as part of the BTC test procedure submittal. The full contract quantity of all materials shall be tested, unless a different quantity for the purposes of the BTC is given in this Subsection below. The quantity listed in the Subsection below is a "minimum" quantity and the Engineer reserves the right to require testing of additional quantities if the initial testing is not deemed adequate.

The BTC shall demonstrate that all equipment and materials are in full compliance with all project requirements and works "out of the box," by visual inspection, setup and operation "on the bench", functional testing of the component including manufacturer's recommended startup diagnostics, and testing prior to any field installation of that equipment or material. Test results documentation shall be provided for each equipment item and material in the full contract quantity; test results documentation shall include the manufacturer's serial number and the project location ID for each item.

As part of the BTC, the Contractor shall install bar code labels on all equipment prior to installation as described in Section 24.7 of this SP725. The cost of the bar code installation shall be considered incidental and included in the cost of the item being labeled.

Contractor shall also configure all devices as if they're operating in the field during the BTC phase. The devices must be configured in preparation for Bench Test System and subsequent integration into the TDOT ATMS software.

As a minimum, a BTC is required for each of the following project materials:

1. Fiber Optic Drop Panel
2. Fiber Optic Cable (3 fibers from each buffer tube)
3. Wireless Ethernet Radio
4. Equipment Cabinet (Type A)
5. Equipment Cabinet (Type B)
6. Equipment Cabinet (Type C)
7. Equipment Cabinet (ITS Communications Hub)
8. Closed Circuit Television Equipment

9. Dynamic Message Sign and Sign Controller
10. Radar Detection System
11. Environmental Sensor System
12. Road Side Unit
13. Overheight Vehicle Detection System
14. Highway Advisory Radio
15. Weight in Motion
16. Permanent Speed Feedback Sign
17. Network Switch (Type A)
18. Network Switch (Type B)
19. Portable Smart Work Zone System
20. Off-the-Shelf and Vendor Software
21. TMC System Compatibility

2.5.4 Bench Test System (BTS)

The Contractor shall perform a complete BTS on all equipment and materials as specified below. The Contractor shall provide the testing location and facility, which shall be in Tennessee and within a 25-mile radius of the project limits or as directed by the Engineer. The test location must be approved by the Engineer as part of the BTS test procedure submittal. The Contractor shall not request any BTS until the BTCs have been satisfactorily completed for all equipment and materials to be included in the BTS.

The BTS shall demonstrate that all equipment and materials are in full compliance with all project requirements and that a fully set up and configured sample of the project is completely integrated and interoperable in accordance with the project requirements. The BTS shall include all manufacturer's recommended startup diagnostics, configuration, and testing procedures. Equipment items and materials included in the BTS shall be setup in temporary configurations (e.g., cameras, DMS and antenna on mounting stands). At least 1 camera shall be located a minimum of 20 feet above ground and shall have a clear one-mile viewing area in at least 1 direction. Equipment located in cabinets or equipment racks shall be mounted as if in its final installation. Test results documentation shall include the manufacturer's serial number and the project location ID for each item. All temporary permits, wiring and cabling, equipment mounting, electrical service, and permitting necessary for the BTS shall be the responsibility of the Contractor. The Contractor shall arrange, at no additional expense to the State, the attendance of qualified technical representatives of all of the equipment manufacturers to attend the BTS.

No field installation of any equipment and materials included in the BTCs shall occur until after the BTS has been satisfactorily completed, and the Engineer has approved test results.

2.5.5 Stand Alone Site Tests (SAT)

The Contractor shall perform a complete SAT on all equipment and materials associated with the field device site including but not limited to electrical service, conduit, pull boxes, fiber optic infrastructure,

cable, poles, camera lowering devices, RDS cable, etc. A SAT shall be conducted at every field device site including communications hubs and all fiber optic infrastructure.

The SAT shall demonstrate that all equipment and materials are in full compliance with all project requirements and fully functional as installed and in final configuration. The SAT shall demonstrate full compliance with all operational and performance requirements of the project including but not limited to measurement accuracy for RDS and ESS. All SATs also include a visual inspection of the cabinet and all construction elements at the site to ensure they are compliant with the Plans, TDOT Standard Specifications and this SP725.

The Contractor shall request in writing the Engineer's approval for each test occurrence a minimum of 60 calendar days prior to the requested test date. No more than 2 SATs shall be scheduled simultaneously at any given time unless otherwise approved by the Engineer. The Contractor shall arrange, at no additional expense to the State, the attendance of a qualified technical representative of the equipment manufacturers to attend each test until a minimum of 2 sites of that particular type are approved.

2.5.6 Conditional System Acceptance Test (CSAT)

The Contractor shall perform a complete Conditional System Acceptance Test on all equipment, materials, and systems in the project. A Conditional System Acceptance Test can be requested and performed on a phased approach as described in Section 2.2.1 as the phases are completed. The Contractor shall not request the Conditional System Acceptance Test until the SATs have been satisfactorily completed, all as-built documentation has been submitted and approved, and all other project work has been completed to the satisfaction of the Engineer. Prior to a Conditional System Acceptance Test, the Contractor shall provide advance notice of and written test results documentation that the Contractor has performed a Dry-Run of the Conditional System Acceptance Test, and the Engineer reserves the right to require attendance of a Dry-Run Test session. A Dry-Run Test shall consist of the test requirements for the Conditional System Acceptance Test.

The Contractor shall test all project systems simultaneously from the TDOT Regional TMC in a manner equivalent to the normal day-to-day operation of the systems installed as part of this project. The Conditional System Acceptance Test shall demonstrate that all equipment and materials in the network are in full compliance with all project requirements and vendor recommendations and that they are fully functional as installed and in final configuration, communicating with and being controlled through the TDOT ATMS software at the TDOT Regional TMC.

The Engineer reserves the right to require, at no additional expense to the State, the attendance of a qualified technical representative of the equipment and/or software manufacturers to attend any given Conditional System Acceptance Test.

Upon completion and full approval of the Conditional System Acceptance Test for all equipment in all phases, Conditional System Acceptance will be given, and the Burn-In Period will begin.

2.5.7 Burn-In Period

1. Burn-In Period

    a. Following the Engineer's written notice of successful completion of the Conditional System Acceptance Test, the entire newly installed system must operate successfully for a 90-calendar-day Burn-In Period. The Contractor shall be responsible for the full maintenance of the newly installed equipment as required in Section 24.3 of this SP725 during the Burn-In Period. However, no separate payment will be made beyond the

contract unit bid price for the Burn-In Period. Successful completion of the Burn-In Period will occur at the end of 90 complete calendar days of operation without a system failure attributable to hardware, software, or communications components. Each system failure during the Burn-In Period will require an additional 30 calendar days of successful operation prior to being eligible for Final Acceptance. (i.e., if there are 2 system failures during the initial 90-calendar-day period, the Burn-In Period may be increased to 150 calendar days at the discretion of the Engineer.) Successful completion of the Final System Acceptance is required to complete the Burn-In Period. Unsuccessful completion of the Final System Acceptance shall cause an automatic extension of the Burn-In Period beyond the contract duration for a duration to be determined by the Engineer.

2. Burn-In General Requirements

    a. Determination of a system failure shall be at the sole discretion of the Engineer.

    b. System failure is defined as a condition under which the system is unable to function as a whole or in significant part to provide the services as designed. While a single component failure will not constitute a system failure, chronic failure of that component or component type may be sufficient to be considered a system failure.

    c. Components are defined as contract items or major material elements in a contract item. For electrical and electronic contract items, components are defined as the complete assembly of materials that makes up the contract item.

    d. Chronic failure of a component or component type is defined as 3 or more failures (lasting more than 15 minutes) for components with a contract quantity of 50 units or less. For components or component types that have a contract quantity greater than 50 units, chronic failure will be defined as having a failure of that component type more times than a number equal to 5% of the total contract quantity of that unit.

    e. Multiple (more than 1) communication outages or failures (lasting more than 15 minutes) will be considered a system failure in any case. Communication failure due to a minor component may not be a system failure. A single path/link failure (e.g., CCTV or DMS link) is not considered a system failure.

    f. Specifically exempted as system failures are failures caused by an accident, acts of God, or other external forces that are beyond the control of the Contractor. However, failure of the Contractor to respond to the repair request for that failure within 24 hours may be considered a system failure.

    g. The existing devices and equipment are not part of the Burn-In Period; therefore, any hardware failures of the existing equipment will not affect the Burn-In Period.

    h. TDOT will advise the Contractor in writing when it considers that a system failure has occurred, or chronic failure exists.

    i. If multiple system and/or chronic failures continue to occur throughout the Burn-In Period due to a single component type, the Contractor may be required to replace all units of that component type with a different model or manufacturer.

    j. The Contractor shall document all failures and subsequent diagnosis and repair. The repair documentation shall include as a minimum:

        i. Description of the problem

        ii. Troubleshooting and diagnosis steps

iii. Repairs made

iv. List of all equipment and materials changed including serial numbers

v. Update of the equipment inventory where needed

k. The Contractor shall provide the repair documentation to the Engineer within 2 calendar days of completing the repair; failure to provide acceptable documentation as required shall be reason to not approve the repair as complete. The Engineer will provide acceptance or rejection of the repair and documentation within 7 calendar days.

l. The Engineer reserves the right to require, at no additional expense to the State, the presence of a qualified technical representative of the equipment and/or software manufacturers as related to the diagnosis and/or repair of any system failure.

m. During the Burn-In Period the Contractor shall perform incidental work such as touching up, cleaning of exposed surfaces, leveling and repair of sites, sodding/grassing, and other maintenance work as may be deemed necessary by the Engineer to ensure the effectiveness and neat appearance of the work sites.

n. During the Burn-In Period the Engineer shall maintain a "Burn-In Period punch list" that contains required Contractor actions but that the Engineer does not define as a system failure. Each Burn-In Period punch list action item shall be completed by the Contractor to the Engineer's satisfaction within 7 calendar days of Contractor notification of the action item.

o. During the Burn-In Period the Contractor shall maintain the system as specified in Section 24.3 of this SP725. No separate payment will be made beyond the contract unit prices for the Burn-In Period pay item.

p. The overall Burn-In Period will be considered complete upon the successful completion of all of the following items: Burn-In time periods, the Engineer's acceptance of all repairs and repair documentation, completion of all Burn-In Period punch list actions and a successful Final Systems Acceptance Testing and Inspection as described below.

2.5.8 Final System Acceptance Testing and Inspection

The Contractor shall perform a Final System Acceptance Test and Inspection on all equipment and materials in the project. Upon successful completion of the Burn-In Period, the entire project shall be eligible for Final System Acceptance Testing and Inspection. The Final System Acceptance Testing and Inspection will be conducted provided the Burn-In Period has demonstrated the entire system is operating successfully. The Final Systems Acceptance Testing and Inspection shall include:

1. Demonstration that all equipment and materials in the network are in full compliance with all project requirements and fully functional as installed and in final configuration, communicating with and being controlled through the control center at the TDOT Regional TMC. This will be performed in accordance with the submitted and approved CSAT procedures.

2. Verification that all Burn-In punch list items have been completed.

3. Verification that all final cleanup requirements have been completed.

4. Approval of final as-built documentation.

Prior to conducting the Final Systems Acceptance Testing and Inspection, the Burn-In Period shall demonstrate that all requirements defined in this SP725 have been met including but not limited to

functional/system performance requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, environmental requirements, and interface requirements with other components of the system.

The Contractor shall request in writing the Engineer's approval to start the Final Systems Acceptance Testing and Inspection a minimum of 60 calendar days prior to the requested start date. The Engineer reserves the right to reschedule the start date if needed. The start date for the Final Systems Acceptance Testing and Inspection cannot be prior to the successful completion of the overall Burn-In Period.

An unsuccessful or incomplete Final Systems Acceptance Testing and Inspection shall require a new Final Systems Acceptance Testing and Inspection after the Contractor has made the necessary corrections. Up to 14 calendar days' notice shall be given to the Engineer prior to the Contractor conducting a subsequent Final Systems Acceptance Testing and Inspection.

The Engineer reserves the right to require, at no additional expense to the State, the attendance of a qualified technical representative of the equipment and/or software manufacturers to attend a portion of a Final Systems Acceptance Testing and Inspection.

The Contractor shall be responsible for the full maintenance of all project equipment and materials as described in Section 24 of this SP725 during the entire time period from the beginning of the Burn-In Period until Final System Acceptance is granted, which will complete the Burn-In Period.

2.5.9 Final System Acceptance

Upon successful completion of the Final Systems Acceptance Testing and Inspection, the Engineer will grant a signed letter of Final System Acceptance. Upon Final System Acceptance, the Contractor is relieved of any further maintenance responsibilities and has TDOT's concurrence that all construction activities are complete and accepted. Final System Acceptance does not relieve the Contractor of project documentation completion as it relates to administrative final records.

2.6 Warranties

Each component of the Project shall be warranted against manufacturing defects and workmanship for a period of at least 1 year from the date of Final System Acceptance. These warranties shall cover complete replacement at no charge for the equipment. The Contractor shall be responsible for all labor, shipping, insurance, and other charges until Final System Acceptance. Equipment covered by the manufacturers' warranties shall have the registration of that component placed in TDOT's name prior to Final Systems Acceptance Testing and Inspection. Even though the warranties will be in TDOT's name, the Contractor is still responsible for executing the warranties during Annual Maintenance. The Contractor is responsible for ensuring that the vendors or manufacturers supplying the components and providing the equipment warranties recognize TDOT as the original purchaser and owner/end user of the components from new. See the Warranty Subsections within this SP725 for specific warranty terms for the components in this project.

2.7 Project Submittal Program Requirements

The Contractor shall develop and conduct a submittal management program that shall meet the following minimum requirements, supplemented by any additional requirements regarding submittals that may appear in subsequent sections of this SP725 or any other contract documents. All materials used on this project will require a submittal and approval prior to purchase and use regardless of whether they are called out specifically in this SP725.

With each submittal package, the Contractor shall complete a Project Submittal Compliance Form, which shall be provided by TDOT within 14 calendar days of the Pre-Construction Meeting. The compliance form will list each SP725 Subsection and will require the Contractor to verify and check that it meets the requirements of this SP725. At contract Notice to Proceed (NTP), the Engineer shall provide blank copies of the contract item specific compliance form. Submittal packages without these completed forms will be considered unallowable and returned to the Contractor without review or consideration.

The Project Submittal Compliance Form shall include but not be limited to the following data:

1. Contract pay item number
2. Submittal package identification
3. Submittal description with make/model/part number information
4. Reference to SP725 requirement
5. Compliance or non-compliance statement for each SP725 requirement
6. Cross-reference to attached documentation for each SP725 requirement
7. Authorized Contractor signature

The Contractor shall at minimum provide the following submittals for review and approval by the Engineer. All submittals must be submitted electronically. The table below is meant as a guide and is not all-inclusive. Items not listed below may also be required during the submittal stage.

Item	Catalog Cutsheets and Technical Specifications	Test Procedure	Installation Procedures	Maintenance Manuals	Operational Manuals	Manufacturer's Statement of Experience	Final Documentation	Interface Protocols
CCTV Equipment	X	X	X	X	X	X	X	X
Camera Lowering Device with Tool	X	X	X	X	X	X	X	
Dynamic Message Signs	X	X	X	X	X	X	X	X
Travel Time Message Sign	X	X	X	X	X	X	X	X
Radar Detection System	X	X	X	X	X	X	X	X
Environmental Sensor Station	X	X	X	X	X	X	X	X
Road Side Unit	X	X	X	X	X	X	X	X
Overheight Vehicle Detection	X	X	X	X	X	X	X	X
Highway Advisory Radio	X	X	X	X	X	X	X	X
Weigh in Motion System	X	X	X	X	X	X	X	X
Speed Feedback Sign	X	X	X	X	X	X	X	
Cabinets	X	X	X	X	X		X	

Item	Catalog Cutsheets and Technical Specifications	Test Procedure	Installation Procedures	Maintenance Manuals	Operational Manuals	Manufacturer's Statement of Experience	Final Documentation	Interface Protocols
Network Switches (all types)	X	X	X	X	X	X	X	X
Portable Smart Work Zone System	X	X	X	X	X	X	X	X
All Software	X	X	X	X	X		X	
TMC Hardware	X	X	X	X	X		X	
System Console	X					X	X	
Demarcation Point Riser Assembly	X							
Ground Mounted Demarcation	X							
Systems Design Report							X	
Traffic Maintenance Plans	X							
Training Plan							X	
Conduit and Pull Boxes	X							
Fiber Optic Infrastructure	X	X	X	X	X	X	X	
Wireless Comm. Infrastructure	X	X	X	X	X	X	X	
Diesel Engine Generator	X	X		X	X		X	X
Electrical Power Equipment	X							

2.7.1 Fifteen (15) Day Submittals

Within 15 calendar days of Notice to Proceed, the Contractor shall submit a written description of their proposed submittal program, including a comprehensive list of all intended submittals and schedule of the submittals for the remainder of the project. The Contractor shall develop an appropriate schedule based on the schedule of work, with the exception of the items identified below that have specific due dates. At a minimum, the submittals listed in the table above shall be included in the submittal program. Note that the 15-day submittal is only a schedule of the submittal program. The 15-day submittal does not include any actual equipment submittals.

The Contractor shall submit to the Engineer for approval an electronic copy of the program including a complete list and initial schedule of all of those materials, components, and structures to be incorporated in the work for which submittals are required. This list shall form the basis for a log of submittals that will be used by the Contractor and Engineer to manage the submittal process. The list shall be submitted as an Excel spreadsheet. In addition, the 15-day submittal shall also contain a letter from the Contractor certifying that all required interface protocols will be submitted from all vendors as requested.

2.7.2 Forty-Five (45) Day Submittals

Within 45 calendar days of Notice to Proceed, the Contractor shall submit the following:

1. **Catalog Cut Sheets and Technical Specifications**: Within 45 Days of Notice to Proceed, the Contractor shall submit to the Engineer for approval equipment catalog cut sheets and technical specifications for all items listed in the above table and any related items. The catalog cut sheets and technical specifications shall include all necessary information to clearly demonstrate that the proposed equipment meets the requirements of this SP725 and the Plans. In addition, the equipment cut sheets shall include manufacturer's name, model number, and any other descriptive data as necessary to clearly evaluate the item. Interface Protocols for all devices and equipment should also be submitted. All materials included within a specific Section of this SP725 shall be submitted at the same time as a submittal package. The equipment cut sheet submittal shall also include BABA compliance documentation for each device and material that is provided on the project.

   Specific submittal requirements contained herein shall be supplemented by any requirements shown in the various Special Provisions such as the Traffic Maintenance Plans and Project Schedules as described in Section 108.03 of the TDOT Standard Specifications shall not be ordered or released for fabrication without the approval of submittals by the Engineer.

   The review and approval of submittals by the Engineer is based on the information provided in the submittal and the conformance with the design concept of the project. Submittal reviews do not relieve the Contractor of the responsibility for making the overall system conform to the requirements of the contract. Approvals at the submittal stage are always conditional upon demonstration that the equipment is fully compliant with the contract including compatibility with all other equipment in the system.

2. **Installation Procedures**: Within 45 Days after Notice to Proceed the Contractor shall submit to the Engineer the Installation Procedures for approval by the Engineer. The installation submittal shall include step-by-step installation directions as developed by the equipment manufacturer. The Contractor shall be required to follow these installation procedures during construction.

2.7.3 Ninety (90) Day Submittals

Within 90 Calendar Days of Notice to Proceed the Contractor shall submit the following:

1. **Shop Drawings and Design Calculations:** Within 90 calendar days of Notice to Proceed the Contractor shall submit to the Engineer shop drawings and design calculations for all structural elements and attachments including but not limited to all sign structures, support poles, structure attachments and foundations. Shop drawings and design calculations shall be sealed and signed by a Professional Engineer licensed with the State of Tennessee.

2.7.4 Other Submittal Timeframes

1. **Test Procedures**: Unless noted otherwise, a minimum of 60 calendar days prior to each desired test date, the Contractor shall submit to the Engineer all test procedures for approval by the Engineer. The test procedure submittal shall include all the test forms for each of the required tests as required in this SP725. The actual test cannot be scheduled until the test procedures are approved.

2. **Operational Manuals**: A minimum of 60 calendar days prior to Bench Test Component, the Contractor shall submit to the Engineer Operational Manuals for approval by the Engineer. The Operational Manual submittal shall include step by step directions for the operators to execute all the functions as required in this Special Provision. The Operational Manuals shall be functionally organized and identify available (built-in) options to operational characteristics. The Engineer reserves the right to request Operational Manuals during the cut sheet submittal stage if the

Engineer deems it necessary to adequately check the operational characteristics of the equipment. Operational Manuals shall be provided in a word-searchable electronic copy.

3. **Maintenance Manuals**: A minimum of 60 calendar days prior to bench testing, the Contractor shall submit to Engineer Maintenance Manuals for approval by the Engineer. The Maintenance Manual submittal shall include all the necessary steps to maintain the equipment in good working condition, and as indicated by the manufacturer to maintain the warranty. The Engineer reserves the right to request Maintenance Manuals during the cut sheet submittal stage if the Engineer deems it necessary to adequately check the required features of the equipment. Maintenance Manuals shall be provided in a word-searchable electronic copy.
4. **Final Documentation**: Prior to the start of the Burn-In Period, the Contractor shall submit a word-searchable electronic copy of final documentation for review and approval by the Engineer. Burn-In Period will not start until final documentation is approved by the Engineer. In addition to any specific final documentation requirements outlined in the individual sections of this SP725, final documentation shall include a single binder containing all of the equipment warranties and other manufacturer produced documentation. In addition, final documentation shall include an inventory list of all the furnished and installed equipment. This list shall include equipment description, manufacturer's part number, model number, serial number, warranty start and end date, and equipment location in decimal degrees of latitude and longitude. The final documentation shall also include a troubleshooting matrix which can be utilized by the system operators to determine the most appropriate action for various problems that may occur in the system.

2.7.5 Review Process

1. The Engineer will review and return submittals to the Contractor within 21 calendar days of receipt.
2. If additional information is requested or if a re-submittal is required, the Contractor is required to re-submit within 21 calendar days of receipt of the Engineer's comments.
3. The Engineer will review and return the re-submittals to the Contractor within 21 calendar days of receipt.
4. Any additional re-submittals must also meet this 21-calendar-day timeline.
5. The Contractor shall maintain a file of approved submittals, shop drawings, and operating data for reference purposes and shall provide an electronic copy of that file to the Engineer upon completion of construction.

2.8 System Documentation

The Contractor shall maintain a formal procedure to document the configuration of the As-Built system as described in Section 25 of this SP725. That program will include maintenance of record drawings and other documentation of the actual location and arrangement of all hardware installed on the project. In addition, the program will include maintenance of records of the system integration procedures. Provisions will be made to accommodate changes to the system both during and after construction.

2.9 Payment Terms For 725 Item Numbers

Stockpile, also known as "Stored Materials", Payment will be made for all 725 Item Numbers per TDOT Standard Specifications. For 725 items that describe payment terms based on completing certain testing or installation requirements, those payment terms will apply only to the unit price amount that is more than

the stored materials payment. For example, if an item says that 50% of the contract unit price will be paid upon approval of Bench Test Component results, this payment will only be applicable if the stored materials payment was not already more than 50% of contract unit price. If the percentage associated with a testing requirement exceeds the amount previously paid for stored materials, the additional amount will be paid to the Contractor at the time of that particular test completion. See the Payment Subsections in this SP725 for specific payment terms.

3 CONDUIT

3.1 Description

This section specifies the minimum requirements for conduit furnished and installed on this project as shown on the Plans or as directed by the Engineer.

3.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be constructed using new and commercially available components in accordance with manufacturers' recommendations. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

3.2.1 General Requirements

1. All Continuous Flexible Conduit products and structure mounted multi-cell conduit shall meet the requirements specified herein.
2. All Continuous Flexible Conduit products and structure mounted multi-cell conduit shall have been manufactured and labeled no earlier than in the sixth calendar month preceding the TDOT letting date of the Contract.

3.2.2 Continuous Flexible Conduit (Conduit Duct Bank)

Continuous Flexible Conduit shall meet specifications for ASTM F2160 and ASTM D3350 (Cell Classification 334480C or E) Slow crack growth minimum requirement is F10>96 h per ASTM D1693, condition B, IGEPAL® CA-630 MegaPure™ Detergent,10% Solution.

1. Conduit shall be extruded from colored material for uniform full-thickness coloring.
2. All Continuous Flexible Conduit shall be labeled with durable identification giving the name of the manufacturer, ASTM F-2160, conduit size (inner diameter trade size and wall thickness/rating), manufacturer/date codes, the legend "TDOT ITS", and sequential foot marking. Labeling shall occur a maximum of every 2'.
3. Conduit to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE.
4. The conduit manufacturer shall have a documented Quality Control/Assurance System.
5. All buried conduit used on this project shall conform to the color scheme and use described below:
    a. Conduit Bank Type 1
        - Green Drop Fiber and/or RDS Cable

b. Conduit Bank Type 2

- Green Drop Fiber and/or RDS Cable
- White RDS Cable, Second Drop Fiber or Spare

c. Conduit Bank Type 3

- Green Drop Fiber and/or RDS Cable
- Blue RDS Cable or Second Drop Fiber
- White Second RDS Cable or Spare

d. Conduit Bank Type 4

- Orange Trunk Fiber Cable
- Blue RDS Cable or Drop Fiber
- White Spare or Second RDS Cable
- Brown Spare

e. Conduit Bank Micro-Conduit

- Orange Trunk Fiber Cable
- Blue Spare or Second Trunk Fiber Cable
- Green Spare or Drop Fiber
- Brown Spare

f. 2" and 3" Electrical Conduit

- Gray Electrical wire

g. DMS Conduit Bank

- Gray Electrical wire
- Green Drop Fiber
- Blue RDS Cable
- Brown Spare

6. 1¼" conduit shall conform to ASTM F2160 and meet the following requirements:
   a. SDR 9 for all Bored conduits
   b. SDR 11 for all other conduits
7. 2" conduit shall conform to ASTM F2160 and meet the following requirements:
   a. SDR 9 for all Bored conduits
   b. SDR 11 for all other conduits
8. Micro-conduit shall be sized per manufacture recommendations for the proposed micro-fiber installation to facilitate blowing the fiber through the conduit. A minimum fill ratio of 50% and

maximum fill ratio of 80% shall be achieved in accordance with the requirements in Section 5.2.4. Micro-conduit shall have a minimum 2mm wall thickness and shall include an over sheath.

9. If micro-conduit is to be installed within the paved shoulder, the micro-conduit shall be heat-rated or utilize backfill material and construction methods to ensure that the micro-conduit is not affected by the maximum temperature produced by the grouting material used to restore the pavement.

10. Coupling

    a. Contractor shall make every effort to minimize coupling. Couplings are permitted only with the Engineer's prior approval.

    b. Approved couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer's recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.

    c. Couplings shall be accomplished only by hydraulic press-on, electro-fusion, or push-to-connect press-on coupling methods.

        i. Hydraulic press-on couplings of seamless tool-grade tubular aluminum with sealing ring barbs and center stop may be used. Use hydraulic compression duct coupling tools and follow all manufacturer's installation procedures, fully inserting both conduit sections to the coupling center stop.

        ii. Prefabricated electro-fusion couplings that are field installed using the coupling manufacturer's recommended automatic self-monitoring fusing machine and installation procedures may be used.

        iii. Push-to-connect press-on couplings that are field installed using the coupling manufacturer's recommended methods may be used. Press-on couplings shall lock onto conduits and contractor shall ensure to insert conduit to stop point.

3.2.3 Multi-Cell "Bullet Resistant" Fiberglass Conduit System (Structure Conduit Bank)

1. The multi-cell conduit system shall consist of a minimum round 4" inner diameter outer duct containing four, round 1-1/4" innerducts. System may be assembled in the field by Contractor. All conduits shall be rated for their use, with the outer duct meeting requirements for use outdoors where subject to UV and physical damage as further described below.

    a. The innerducts shall be held together in a square (four conduit system) configuration by a system of spacers or equivalent mechanism.

    b. The coupling system shall be resistant to water infiltration, air loss during cable installation and shall be capable of locking the system tightly together to avoid free twisting of the innerducts.

2. All conduit system manufacturers shall have a documented Quality Control/Assurance System.

3. Outer duct shall conform to the following requirements:

    a. All outer ducts shall be a minimum of 4" inner diameter trade size and shall have a nominal 20' lay length. Types to be used shall be designated on the Plans.

b. The spigot end of the duct shall have a circumferential insertion depth mark to ensure that proper insertion depth is achieved.

c. Bullet resistant fiberglass conduit shall have a minimum wall thickness of 0.250". The conduit shall prevent the penetration of a .45 caliber slug fired from 20' away. The conduit shall conform to the following requirements when tested in accordance with this SP725. All accessories and fittings, including outer duct couplings, expansion joints, anchor and stop rings, etc., shall meet all the same "bullet resistant" requirements as the conduit. All conduit and fittings shall be gray.

d. Outer duct shall be labeled with durable identification giving the name of the manufacturer, manufacturer/date codes and the legend "TDOT ITS." Labeling shall occur a maximum of every 2'.

e. Outer duct shall comply with and be tested according to the following Physical and Mechanical Properties and Test Methods

i.	Ultimate Tensile Strength – 11,000PSI Minimum	ASTM D-2105
ii.	Dielectric Strength - >=500V/Mil.	ASTM D-149
iii.	Water Absorption – 1% Maximum	ASTM D-570
iv.	Specific Gravity – 1.9 – 2.0	ASTM D-792
v.	Glass Content – 68 + - 2%	API Spec 15 LR
vi.	Barcol Hardness – 58-52	ASTM D-2583

f. Where Structure Conduit Bank Type 1 and 2" Structure Conduit w/bank is shown on the Plans, the conduit shall be 2" fiberglass conduit and shall meet the same applicable characteristics as the outer duct described above.

4. Innerduct shall conform to the following requirements:

a. Innerduct shall be manufactured from polyvinyl chloride (PVC) or high-density polyethylene (HDPE). Innerduct shall be factory treated with an atomized silicone or manufactured in a manner to reduce friction during pulling of fiber optic cable. Innerduct to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE, Issue 2, June 2009. The dimensions of innerduct shall meet the requirements of the manufacturer's catalog cuts approved by TDOT.

b. HDPE innerduct shall have a permanent dry lubricant extruded within the inner wall and shall incorporate longitudinal ribs within the inner wall.

c. Micro duct in accordance with the material requirements within this SP may be used as the innerduct. If micro duct is used, it shall be secured within outer duct to prevent movement.

d. HDPE innerduct shall have the following color and size:

i. Color of innerducts – four-way (orange, blue, brown, white)

ii. Nominal Inner Size – 1 ¼"

5. Coupling Bodies shall conform to the following requirements:

a. The coupling body shall be designed with 4 bores (conduit entries) and shall ensure that when the conduit is joined, the outer walls of the innerducts and the inner walls of the outer duct shall be sealed, providing an airtight seal from within the innerduct system and a watertight seal from the outside of the outer duct. The coupling body shall be tested for water tightness and air tightness. The coupling body shall conform to the following requirements:

   i. Water tightness – 6 PSI Minimum

   ii. Air tightness - no leakage at 100 PSI

6. Bends and Sweeps shall conform to the following requirements:

   a. Each multi-cell system shall offer a complete line of factory-made fixed bends and sweeps. No flexible bends or field-made bends will be permitted in multi-cell systems. Bullet resistant fiberglass bends and sweeps shall have compatible bell and spigot ends. In no case shall bends and sweeps exceed a 90-degree direction change.

   b. Fixed bends for bullet resistant fiberglass multicell conduit shall be available in radii no less than 3’ and provide the following bending radii:

      i. 4’ radius: 11 ¼ degrees

      ii. 6’ radius: 22 ½ degrees

      iii. 9’ radius: 45 and 90 degrees

3.2.4 Rigid Galvanized Steel (RGS) Conduit

All rigid galvanized steel conduit shall meet TDOT Standard Specifications.

3.2.5 PVC Schedule 40 Conduit

All PVC Schedule 40 conduit shall meet TDOT Standard Specifications.

3.2.6 Marking Tape

The Marking Tape shall meet the following requirements:

1. The color of the tape shall be orange with the legend “TDOT ITS FIBER OPTIC CABLE” printed at intervals no greater than 6’.
2. The tape shall be a dielectric, polyolefin film tape, 0.004”. thick, and 3”. wide. The tape shall be constructed using material and ink colors which will not change when exposed to the acids and other destructive substances commonly found in the most common soil types in Tennessee.
3. Marking Tape shall comply with and be tested according to the following Physical and Mechanical Properties and Test Methods:

   a. Standard Weight – 0.02 lb./ft² ASTM D-2103

   b. Thickness-Overall – 0.004” ASTM D-2103

   c. 3” Tensile Break-MD – 35 lbf ASTM D-882

   d. 3” Tensile Strength-MD – 2900 PSI ASTM D-882

   e. 3” Tensile Break-TD – 38 lbf ASTM D-882

f. 3” Tensile Strength-TD – 3160 PSI ASTM D-882

g. Elongation-MD – 530% ASTM D-882

h. Elongation-TD – 660% ASTM D-882

i. PPT Resistance-MD – 12 lbf ASTM D-2582

j. PPT Resistance-TD – 14 lbf ASTM D-2582

k. Tear Strength – 3” x 8” – MD – 24 lbf ASTM D-2261

l. Tear Strength – 3” x 8” – TD – 32 lbf ASTM D-2261

m. The following acronyms are referenced in the section above:

i. **PPT** – Puncture Propagation Tear

ii. **MD / TD –** Machine Direction / Transverse Direction

3.2.7 Conduit Detection Wire

The conduit detection wire shall meet the following requirements:

Conduit detection wire shall be #10 AWG stranded copper orange-insulated THHN-THWN conductor. #20 AWG stranded copper orange insulated THHN-THWN conductor shall be allowed for micro-conduit installations.

3.2.8 Cable Markers

The Cable Markers shall meet the following requirements:

1. Shall be a six-foot post with an 18” Cable Marker as shown on the Plans.
2. Shall be a cylindrical polymeric marker mounted on a 3.5” outside diameter post and may be used for the identification of buried utility services. These markers may be used in road rights-of-way and installations requiring 360-degree visibility, good outdoor durability, and impact resistance.
3. The marker shall be comprised of polymer materials, which are resistant to impact (high MTBF), ultraviolet light, ozone, or hydrocarbon damage. The post and marker shall remain impact resistant in temperatures of -28°C to 60°C.
4. Shall incorporate a cylindrical tube construction.
5. The marker shall be capable of permanent installation on a 3.5” O.D. tube and may utilize an anchor barb below ground level to prevent rotation and marker removal.
6. The marker shall have an outside diameter of 3.5” – 4.0”. The wall thickness shall be 0.12” – 0.15” and the overall length shall be 18.00”.
7. The marker shall be orange in color and be pigmented throughout its entire cross section.
8. The graphics shall consist of a solvent-based ink that is abrasive and UV resistant and include the text, “TDOT ITS Fiber Optic Cable” “Call XXX-XXX-XXXX Before Digging in this Area.” (Phone number will be provided upon approval of cable marker cut sheets)
9. The marker shall have a minimum tensile strength of 2700 pounds per square inch, as measured by ASTM D-638 (specimen type I with separation rate of 2 inches per minute.) Tensile strength

shall not deviate more than 10% from the standard room temperature result when tested at both 60°C and -6°C after a minimum of 2 hours conditioning at the respective temperature.

10. A “Distance to Conduit” sticker or label shall also be provided. This label shall meet the following minimum requirements:

    a. Lettering shall be a minimum of 1” in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. The Label shall have the words “Distance to Conduit XX Feet” pre-printed on the label. The distance numerals shall be added in the field and shall be manufactured from the same type of reflective sheeting. (See Plans for layout of label).

3.2.9 Pull Tape

The Pull Tape for cable installation shall meet the following requirements:

1. 1250 lb. tensile strength
2. Flat, not round, construction
3. Printed sequential foot markings
4. Pre-lubricated for reduced pulling tension at start of cable pull
5. Low susceptibility to absorption of moisture

3.2.10 Duct Plugs

Duct plugs shall meet the following requirements:

1. Duct plugs intended for underground telecommunications infrastructure shall be installed on underground conduits.
2. Duct plugs shall be sized to fit the conduits and cables with which they are used.
3. Duct plugs shall provide watertight and airtight gasketed seals by use of mechanical expansion of the duct plug body and gasket. No sealants or caulks shall be used to install duct plugs.
4. All metallic components of duct plugs shall be stainless steel.
5. Blank duct plugs shall be used to seal spare conduits and shall have inner rings to which pull tape can be tied.
6. Cable duct plugs shall be used to seal conduits that contain 1 or more cables. The plug shall be sized to fit the conduit and cable(s) with which it is used and shall be a split plug with a bushing assembly for sealing around the cable(s) by mechanical compression.

3.2.11 Grouting Compound

Grouting compound shall meet or exceed the following requirements.

1. Grouting compound shall be a 3-component epoxy resin design for installation for grouting of micro-conduit in road bituminous, asphalt, or concrete surfaces.

2. Grouting compound shall have rapid shrink free curing, site ready use packaging, high tensile strength, chemical resistance, and rapid strength agents.

3. Grouting compound shall allow installation without heating equipment with pavement temperature and air temperature between 20°C and 50°C. Heating equipment may be utilized for lower temperatures but must adhere to manufacturers requirements.

3.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections.

3.3.1 General Requirements

1. Use blank duct plugs to seal the ends of all conduits within twenty-four hours of conduit placement. This includes intermediate/incomplete sections of conduit placed twenty-four hours prior to conduit splicing or termination in pull boxes and empty conduits installed in pull boxes twenty-four hours prior to cable installation.

2. Conduit shall be installed in a straight-line horizontal path between pull boxes except where shown otherwise on the Plans.

3.3.2 Continuous Flexible Conduit (Conduit Duct Bank)

1. Install Conduit Duct Banks by configuring individual continuous flexible conduits into a continuous duct bank from termination point to termination point as shown in the Standard Details and other contract documents. The following general requirements apply to all conduit installations:

    a. Continuous flexible conduit installation in earth, rock, or shoulder shall be trenched, horizontal directional bored or drilled, or plowed at the Contractor's discretion, unless otherwise noted on the Plans, at a minimum depth of 24" from the top of the conduit.

    b. Contractor shall make every effort to minimize coupling. Couplings are permitted only with the Engineer's prior approval and will typically be approved where conduit types change or at locations where conduit reels end. Other locations will be on a case-by-case basis. Couplings are not permitted on micro-conduit systems. Micro-conduit systems shall be continuous from pull box to pull box.

    c. There shall not be more than 360 degrees of total bend between pull points in accordance with NEC 358.26.

2. All horizontal directional bored or drilled conduit shall meet the following requirements:

    a. Bore Logs will be required for each bore location.

    b. The Contractor shall submit a proposed bore log format to the Engineer for review and obtain approval prior to performing any boring activity.

    c. Contractor to document GPS location for entry and exit points as well as every 20 feet for every bore and include this information in the As-Built deliverables. See Section 25.2.7 for more information on Conduit As-Buit Documentation Requirements.

3. All trenched conduit shall meet the following requirements:

    a. Conduit shall be placed in the straightest orientation possible, reducing bends, twists, rises, and waves. Conduits shall be held in place during backfilling when necessary to

keep straight and at the proper depth. Where field conditions require the trench to change direction and bends are necessary, the bends shall be formed in the trench and should be smooth and even and shall not have less than a 4-foot radius (as measured to the inside surface of the conduit).

b. Contractor to document GPS location for pull box entry and exit points as well as every 20 feet of trenched conduit between pull boxes and include this information in the As-Built deliverables. See Section 25.2.7 for more information on Conduit As-Buit Documentation Requirements.

4. All micro-conduit installed within the paved shoulder shall meet the following requirements:

   a. Installation of micro-conduit systems in pavement shall be in accordance with the manufacturer's specifications and recommendation to avoid damage to conduit during installation, during backfilling, or during operation once traffic has returned to the paved surface.

   b. The top edge of the micro-conduit systems shall be installed at a minimum depth of 6 inches into the pavement by saw cutting and sealing with grouting compound. All sharp edges within the saw cut shall be removed and corners shall be rounded. Saw cuts shall be blown out with compressed air or vacuumed to remove loose materials. Slot must be dry, clean, and free from dust, oil, or grease prior to micro-conduit installation.

   c. Once the micro-conduit is installed in the slot, grouting compound shall be prepared, placed, and finished in accordance with manufacture's requirements. Backfill shall meet TDOT Standard Specifications for a paved shoulder.

   d. All areas in the paved shoulder shall be completely restored daily according to the time frames set under the approved Traffic Control Plan.

   e. Unless otherwise approved by the Engineer, the conduit shall only be placed within the paved shoulder in the areas identified on the Plans.

   f. Contractor to document GPS location for pull box entry and exit points as well as every 20 feet of micro-conduit between pull boxes and include this information in the As-Built deliverables. See Section 25.2.7 for more information on Conduit As-Buit Documentation Requirements.

5. All continuous flexible conduit routes installed perpendicular to the roadway underneath asphalt or concrete roadways or other travel ways shall meet the following requirements:

   a. Conduit shall be horizontal directional bored or drilled at a minimum depth of 5' from the top of the conduit under roadways. No open trenching will be allowed in asphalt or concrete unless specified on Plan sheets.

   b. Separate encasement is not required for borings unless needed for proper installation due to poor soil conditions as directed by the Engineer.

6. All conduit underneath railroad tracks shall meet the following requirements:

   a. Conduit shall be horizontal directional bored or drilled at a minimum of 10' below the railroad bed.

   b. It is the Contractor's responsibility to determine any additional requirements from the railroad owner and shall meet those requirements in addition to those included on the Plans and this SP725.

c. Any required steel casings or other materials needed to meet the railroad authority requirements shall be included in the cost of the conduit.

7. All conduit to be installed under streams, drainage canals, wetlands, or other waterways shall be horizontal directional bored or drilled. No open trenching through an area deemed to be a current or wet weather stream will be allowed. All conduit bored under streams shall be a minimum depth of 5' below the streambed.

8. If a drainage or utility conflict arises, the Contractor shall submit a plan for resolving the conflict to the Engineer for review and approval.

9. Separate encasement for borings is not required unless necessary for proper installation due to poor soil conditions as directed by the Engineer or the inability to meet the required installation depth.

10. Continuous flexible conduit may be required to be installed in rock. As called out on the Plans and where encountered by the Contractor, trenching and boring conduit in rock may require additional tools and machinery to install. If trenching in rock is performed, the following is required:

    a. A minimum depth of 24" of cover from the top of the conduit must be maintained.

    b. A minimum of 3" of sand must sit below the conduit in the bottom of the trench.

    c. A minimum 3" sand cover over the conduit must be maintained directly on top of the conduit layered with 9" back fill of soil free of rocks or other foreign matter layered on top of the sand. The remainder of the trench may be backfilled with existing material removed from the trench provided that no material is larger than #2 stone.

3.3.3 Multi-Cell "Bullet Resistant" Fiberglass Conduit System (Structure Conduit Bank)

1. Contractor shall attach conduit to bridge decks by either clamps or hanger systems as indicated on the Plans.

2. If conduit is to be hung by a bridge hanger system attached to the bridge decking, Contractor shall design the system and obtain approval from TDOT Division of Structures prior to ordering the components of the system. Hangers shall be spaced no more than 10' apart.

3. For all bridge installed conduit, it is the Contractor's responsibility to obtain the bridge design drawings from TDOT Structures Division to show the exact location and design of the attachment.

4. Contractor shall obtain from the manufacturer or supplier of the multi-cell system complete and comprehensive written installation manuals for the complete system and provide to the Engineer. At the start of the multi-cell installation, Contractor shall engage the manufacturer or supplier to provide technical assistance, as needed. At any time during the construction process, Contractor shall ensure that the manufacturer or supplier provides technical assistance to the Contractor and/or TDOT as needed to install a functional and warrantied system.

5. Contractor shall install expansion and deflection joints, anchors, stop rings, etc. according to the multi-cell conduit system and support hanger manufacturers' recommendations. Fiberglass couplings shall be epoxied unless otherwise recommended by the manufacturer. Contractor shall ensure that during the construction process and at the request of the Engineer, the multi-cell

conduit system or support hanger manufacturer is available to provide on-site technical assistance at no additional cost to TDOT.

6. All holes in concrete for conduit passes shall be core drilled.
7. All conduit passing through abutment walls shall be sealed around, using a sealant approved by the TDOT Division of Structures.
8. Damage to paved end fills shall be repaired to the satisfaction of the Engineer at the expense of the Contractor.

3.3.4 Rigid Galvanized Steel (RGS) Conduit

1. All exposed conduit runs shall be 2" rigid galvanized steel unless otherwise required on the Plans.
2. Contractor shall properly terminate all conduit runs on structures and poles into the respective device or install a weather head so as to seal the conduit from moisture, insects, rodents and other foreign material. The cost of the galvanized steel conduit, weather heads and all associated fittings shall be included in the cost of other items.
3. Contractor shall install bushings in conduit at all exposed conduit terminations for protection of the conductors.
4. All RGS conduit shall be grounded per NEC.

3.3.5 PVC Schedule 40 Conduit

1. Shall meet the specifications of Section 3.3.2.

3.3.6 Marking Tape

1. As shown on the Plans Typical Details, Contractor shall install marking tape above all underground conduit installed by trenching or plowing.
2. Marking tape shall be installed in continuous manufactured lengths. No splicing or overlap shall be permitted.
3. Marking tape is not required when conduit is bored.

3.3.7 Conduit Detection Wire

1. Contractor shall install 1 conduit detection wire with all conduits directly below or at the same level as the conduit. Conduit detection wire is required with all conduits installed by any underground installation method, including trenching, directional boring, or plowing.
2. Only 1 conduit detection wire is required per installed conduit segment regardless of the number of conduits installed in that segment.
3. Contractor shall install conduit detection wire outside of the conduit, except when boring conduit, then the detection wire shall be placed in a spare conduit. Alternatively, conduit with an integrated detection wire may be utilized.
4. The conduit detection wire shall be continuous and unspliced between pull boxes and shall enter the pull boxes at the same location as the conduit with which it is installed, entering under the lower edge of the pull box.
5. Coil and secure 4' of conduit detection wire in each pull box or vault.

3.3.8 Cable Markers

1. Contractor shall install cable markers at the following locations:
    a. At the back side of the right-of-way (or tree line) laterally even with each pull box, or adjacent pull boxes, on conduit runs parallel to the roadway. If distance between pull boxes is greater than 650', 1 additional cable marker shall be placed at the midpoint between the adjacent pull boxes, at the back of the right-of-way (or tree line). Additional cable markers shall be placed such that no distance between cable markers shall be greater than 650'.
    b. Directly beside any pull box that is on the interior of an interchange.
    c. At each end of any bore under a roadway, directly beside the pull boxes.
    d. Any additional locations directed by the Engineer.
2. All cable marker locations shall be approved by the Engineer prior to installation. The proposed schedule for installing the cable markers shall also be approved by the Engineer prior to installation.
3. After the cable markers are installed, Contractor shall apply the distance to conduit labels.

3.3.9 Pull Tape

1. Contractor shall install pull tape into each empty conduit and empty cell within a multi-cell conduit. Pull tape shall not be installed in Micro-Conduit as the intent is for Micro-Cable to be blown in place.
2. Contractor shall install the pull tape after conduit testing has been completed.
3. Contractor shall install and secure 5' of slacked pull tape in each empty conduit or cell at each pull box.
4. Contractor shall secure the pull tape by tying it to the blank duct plug for the conduit in which it is installed.

3.3.10 Duct Plugs

1. Contractor shall install blank duct plugs in each empty conduit that enters a pull box, ground-mounted cabinet, pole foundation, hub, or building entrance.
2. Contractor shall install duct plugs within twenty-four hours of the associated duct installation.
3. Contractor shall install cable duct plugs in each conduit containing fiber optic or RDS communications cable that enters a pull box, ground-mounted cabinet, hub, or building entrance.
4. Contractor shall not install cable duct plugs on conduits containing power service conductors.
5. Contractor shall install cable duct plugs within twenty-four hours of installing cables in the associated duct.

3.3.11 Spare Conduits in Foundations

1. A minimum of 1-2" spare conduit shall be installed in all pole foundations and a minimum of 2-2" conduits shall be installed in the base of all ground mounted cabinets.
2. Spare conduits shall be sealed with blank duct plugs.

3.4 Testing Requirements

3.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the Conduit.

3.4.2 Factory Acceptance Test

FAT is not required for Conduit.

3.4.3 Bench Test Component (BTC)

BTC is not required for Conduit.

3.4.4 Bench Test System (BTS)

BTS is not required for Conduit.

3.4.5 Stand Alone Site Test

SAT shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and any applicable structures.
3. Verify the Conduit has no internal or external damage.
4. Contractor shall test every conduit for airtightness after installation and before cable or pull tape is installed. Contractor shall perform testing on all conduit types in this SP725 including but not limited to each cell of multi-cell conduits, each conduit in duct banks, and each individual conduit.
5. Contractor shall perform a continuity or tone test after installation of conduit detection wire to confirm that a continuous run of wire was installed between pull boxes.

3.5 Warranty

All materials specified in this section (individually and as a system) shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

3.6 Method of Measurement

1. All conduit material shall be measured following the guidelines in the following sections.
2. All conduit types shall be measured in linear feet per type to the nearest foot. All conduit types will be measured along the conduit by the following:
    a. From center of pull box to center of pull box.
    b. No additional measurement will be made for vertical conduit inside the pull box or structure.
    c. No additional measurement will be made for conduit between a pull box and the nearby pole or structure, within 5'or less.
3. Unless otherwise specified on the Plans, all costs for materials, trenching, installing, backfilling trench, plowing, directional boring, restoration, repaving of shoulders, marking tape, pull tape, duct plugs, fittings, conduit detection wire, testing, bore logs, and other accessories and hardware necessary for installation of the conduit system shall be included in the overall cost of the conduit or conduit duct bank.
4. Separate encasement for borings is not required unless necessary for proper installation due to poor soil conditions or the inability to meet the required installation depth. If encasement is needed in those situations the cost of the encasement shall be included in the cost of the conduit.

3.6.1 Conduit (2IN, 3IN, and 4IN)

Conduit will be measured by the linear foot for each type of conduit indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. 2" Conduit: 1 – 2" Continuous Flexible Conduit or PVC Schedule 40 Conduit installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching or plowing is physically possible using typical trenching equipment.
2. 3" Conduit: 1 – 3" Continuous Flexible Conduit or PVC Schedule 40 Conduit installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching or plowing is physically possible using typical trenching equipment.
3. 4" Conduit: 1 – 4" Continuous Flexible Conduit or PVC Schedule 40 Conduit installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching or plowing is physically possible using typical trenching equipment.

3.6.2 Conduit Bored (2IN, 3IN, and 4IN)

Bored Conduit will be measured by the linear foot for each type of conduit indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. 2" Conduit (Bored): 1 – 2" Continuous Flexible Conduit installed via jacking or boring the conduit in soil or areas with intermittent (non-solid) rock.
2. 3" Conduit (Bored): 1 – 3" Continuous Flexible Conduit installed via jacking or boring the conduit in soil or areas with intermittent (non-solid) rock.
3. 4" Conduit (Bored): 1 – 4" Continuous Flexible Conduit installed via jacking or boring the conduit in soil or areas with intermittent (non-solid) rock.

3.6.3 Conduit In Rock (2IN, 3IN, and 4IN)

Conduit In Rock will be measured by the linear foot for each type of conduit indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. 2" Conduit (In Rock): 1 – 2" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of trenching as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
2. 3" Conduit (In Rock): 1 – 3" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of trenching as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
3. 4" Conduit (In Rock): 1 – 4" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of trenching as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

3.6.4 Conduit Bored In Rock (2IN, 3IN, and 4IN)

Conduit In Rock will be measured by the linear foot for each type of conduit indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. 2" Conduit (In Rock): 1 – 2" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of boring as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
2. 3" Conduit (In Rock): 1 – 3" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of boring as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
3. 4" Conduit (In Rock): 1 – 4" Continuous Flexible Conduit installed in solid rock or solid shot rock fill by means of boring as called out in the Plans or determined in the field by the Engineer. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

3.6.5 Conduit Bank (All Types)

Conduit Bank will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. Conduit Bank (Type 1): 1 – 1 ¼" Continuous Flexible Conduit installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.
2. Conduit Bank (Type 2): 2 – 1 ¼" Continuous Flexible Conduits installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.

3. Conduit Bank (Type 3): 3 – 1 ¼" Continuous Flexible Conduits installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.
4. Conduit Bank (Type 4): 4 – 1 ¼" Continuous Flexible Conduits installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.
5. Conduit Bank (Micro-conduit): Micro-conduit Continuous Flexible Conduits installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.

3.6.6 Conduit Bank Bored (All Types)

Conduit Bank Bored will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. Conduit Bank (Type 1–Bored): 1 – 1 ¼" Continuous Flexible Conduits installed via jacking or boring the conduit bank.
2. Conduit Bank (Type 2–Bored): 2 – 1 ¼" Continuous Flexible Conduits installed via jacking or boring the conduit bank.
3. Conduit Bank (Type 3–Bored): 3 – 1 ¼" Continuous Flexible Conduits installed via jacking or boring the conduit bank.
4. Conduit Bank (Type 4–Bored): 4 – 1 ¼" Continuous Flexible Conduits installed via jacking or boring the conduit bank.
5. Conduit Bank (Micro-conduit–Bored): Micro-conduit Continuous Flexible Conduits installed via jacking or boring the conduit bank.

3.6.7 Conduit Bank In Rock (All Types)

Conduit Bank In Rock will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. Conduit Bank (Type 1–In Rock) 1 – 1 ¼" Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
2. Conduit Bank (Type 2–In Rock) 2 – 1 ¼" Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
3. Conduit Bank (Type 3–In Rock) 3 – 1 ¼" Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
4. Conduit Bank (Type 4–In Rock) 4 – 1 ¼" Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

5. Conduit Bank (Micro-conduit–In Rock) Micro-conduit Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

3.6.8 Conduit Bank Bored In Rock (All Types)

Conduit Bank Bored In Rock will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. Conduit Bank (Type 1–Bored In Rock) 1 – 1 ¼" Continuous Flexible Conduits installed via boring the conduit bank in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
2. Conduit Bank (Type 2–Bored In Rock) 2 – 1 ¼" Continuous Flexible Conduits installed via boring the conduit bank in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
3. Conduit Bank (Type 3–Bored In Rock) 3 – 1 ¼" Continuous Flexible Conduits installed via boring the conduit bank in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
4. Conduit Bank (Type 4–Bored In Rock) 4 – 1 ¼" Continuous Flexible Conduits installed via boring the conduit bank in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.
5. Conduit Bank (Micro-conduit–Bored In Rock) Micro-conduit Continuous Flexible Conduits installed via boring the conduit bank in solid rock or solid shot rock fill. The locations for this pay item are identified on the Plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

3.6.9 Micro-Conduit Bank In Pavement

Micro-Conduit Bank In Pavement will be measured by the linear foot for the micro-conduit bank and shall include the items identified in Section 3.2.2. This item will also include the cost to sawcut the pavement and restore the pavement with grouting compound as identified in Section 3.2.11.

3.6.10 DMS Conduit Bank

DMS Conduit Bank will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. DMS Conduit Bank: 4 – 2" Continuous Flexible Conduits installed in the same trench.

3.6.11 Structure Conduit Bank (All types)

Unless otherwise specified on the Plans, all costs for materials, cutting asphalt or concrete, trenching, installing, backfilling trench, restoring asphalt or concrete, drilling existing concrete shoulder, replacement of existing transverse joint material, directional boring, bridge hanger materials and

assemblies, testing of conduit, pull tape, duct plugs, and bridge attachment design shall be included in the overall cost of structure conduit or structure conduit bank.

Conduit will be measured by the linear foot for each type of conduit bank indicated after installation.

1. Structure Conduit Bank Type 1: 1-4" Fiberglass Conduit outer duct with 1-1 ¼" innerducts
2. Structure Conduit Bank Type 2: 1-4" Fiberglass Conduit outer duct with 2-1 ¼" innerducts
3. Structure Conduit Bank Type 3: 1-4" Fiberglass Conduit outer duct with 3-1 ¼" innerducts
4. Structure Conduit Bank Type 4: 1-4" Fiberglass Conduit outer duct with 4-1 ¼" innerducts
5. 4" Structure Conduit: 1-4" Fiberglass Conduit
6. 4" Structure Conduit with Bank: 1-4" Fiberglass Conduit installed in the same Hanger assembly as the related Conduit Bank type as specified on the Plans.

3.6.12 Conduit with Bank (2IN, 3IN, and 4IN)

Conduit with Bank will be measured by the linear foot for each conduit indicated after installation and shall include the items identified in Section 3.2.2.

1. 2" Conduit with Bank: 1 – 2" Continuous Flexible Conduit installed in the same trench as the related Conduit Bank Type as specified in the Plan Sheet.
2. 3" Conduit with Bank: 1 – 3" Continuous Flexible Conduit installed in the same trench as the related Conduit Bank Type as specified in the Plan Sheet.
3. 4" Conduit with Bank: 1 – 4" Continuous Flexible Conduit installed in the same trench as the related Conduit Bank Type as specified in the Plan Sheet.

3.6.13 Conduit with Bank Bored (2IN, 3IN, and 4IN)

Conduit and Conduit with Bank will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 3.2.2, as well as the type and number of conduits indicated below.

1. 2" Conduit with Bank (Bored): 1 – 2" Continuous Flexible Conduit installed in the same bore as the related Conduit Bank Type as specified on the Plans.
2. 3" Conduit with Bank (Bored): 1 – 3" Continuous Flexible Conduit installed in the same bore as the related Conduit Bank Type as specified on the Plans.
3. 4" Conduit with Bank (Bored): 1 – 4" Continuous Flexible Conduit installed in the same bore as the related Conduit Bank Type as specified on the Plans.

3.6.14 Structural ITS

Unless otherwise specified on the Plans, all costs for materials, cutting asphalt or concrete, trenching, installing, backfilling trench, restoring asphalt or concrete, drilling existing concrete shoulder, replacement of existing transverse joint material, directional boring, underground conduit, conduit transitions from barrier wall or retaining wall to underground, conduit within barrier wall or retaining wall, conduit hanger materials within barrier wall or retaining wall reinforcement, pull boxes in accordance with Section 4 of this SP, pull box attachment brackets, testing of conduit, pull tape, and duct plugs shall be included in the overall cost of Structural ITS. This item is to be measured on a lump sum

basis based on the specified linear feet of conduit and specified number of pull boxes specified on the Plans.

3.6.15 ITS Cable Marker

Cable Markers will be measured per each and paid for at the contract price per each. The bid price shall include furnishing and installing the complete cable marker, and distance sticker/label. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

3.6.16 Rigid Galvanized Steel (RGS) Conduit

Rigid Galvanized Steel Conduit, and all related materials including but not limited to weather heads, bushings, couplings, mounting straps, bonding to ground, etc., that is installed on sign structures, poles, or between the pull boxes and equipment cabinets is included in the cost of other items and will not be measured separately.

3.6.17 PVC Schedule 40 Conduit

PVC Conduit is included in the cost of other items and will not be measured separately.

3.6.18 Marking Tape

Marking Tape is included in the cost of the conduit and will not be measured separately.

3.6.19 Conduit Detection Wire

Conduit Detection Wire is included in the cost of the conduit and will not be measured separately.

3.6.20 Pull Tape

Pull Tape is included in the cost of the conduit and will not be measured separately.

3.6.21 Duct Plugs

Duct Plugs are included in the cost of the conduit and will not be measured separately.

3.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-01	STRUCTURAL ITS	LS
725-01.01	STRUCTURAL ITS (BRIDGE NO.)	LS
725-01.02	STRUCTURAL ITS (BRIDGE NO.)	LS
725-01.03	STRUCTURAL ITS (BRIDGE NO.)	LS
725-01.04	STRUCTURAL ITS (BRIDGE NO.)	LS
725-01.20	STRUCTURAL ITS (RET. WALL NO.)	LS

Item No.	Description	Unit
725-01.21	STRUCTURAL ITS (RET. WALL NO.)	LS
725-01.22	STRUCTURAL ITS (RET. WALL NO.)	LS
725-01.23	STRUCTURAL ITS (RET. WALL NO.)	LS
725-10.86	2 IN CONDUIT IN ROCK	LF
725-21.20	DMS CONDUIT BANK STRUCTURE	LF
725-22.21	CONDUIT BANK (TYPE 1)	LF
725-22.22	CONDUIT BANK (TYPE 2)	LF
725-22.23	CONDUIT BANK (TYPE 3)	LF
725-22.24	CONDUIT BANK (TYPE 4)	LF
725-22.26	CONDUIT BANK (MICRO-CONDUIT)	LF
725-22.31	CONDUIT BANK BORED (TYPE 1)	LF
725-22.32	CONDUIT BANK BORED (TYPE 2)	LF
725-22.33	CONDUIT BANK BORED (TYPE 3)	LF
725-22.34	CONDUIT BANK BORED (TYPE 4)	LF
725-22.36	CONDUIT BANK BORED (MICRO-CONDUIT)	LF
725-22.41	CONDUIT BANK IN ROCK (TYPE 1)	LF
725-22.42	CONDUIT BANK IN ROCK (TYPE 2)	LF
725-22.43	CONDUIT BANK IN ROCK (TYPE 3)	LF
725-22.44	CONDUIT BANK IN ROCK (TYPE 4)	LF
725-22.47	CONDUIT BANK IN ROCK (MICRO-CONDUIT)	LF
725-22.50	DMS CONDUIT BANK	LF
725-22.51	DMS CONDUIT BANK IN ROCK	LF
725-22.61	STRUCTURE CONDUIT BANK (TYPE 1)	LF
725-22.62	STRUCTURE CONDUIT BANK (TYPE 2)	LF
725-22.63	STRUCTURE CONDUIT BANK (TYPE 3)	LF
725-22.64	STRUCTURE CONDUIT BANK (TYPE 4)	LF

Item No.	Description	Unit
725-22.71	2 IN CONDUIT	LF
725-22.72	2 IN CONDUIT BORED	LF
725-22.74	2 IN CONDUIT W/BANK	LF
725-22.75	2 IN CONDUIT BORED W/ BANK	LF
725-22.78	3 IN CONDUIT	LF
725-22.79	3 IN CONDUIT BORED	LF
725-22.80	3 IN CONDUIT W/ BANK	LF
725-22.81	3 IN CONDUIT BORED W/ BANK	LF
725-22.82	3 IN CONDUIT IN ROCK	LF
725-22.83	4 IN CONDUIT	LF
725-22.84	4 IN CONDUIT W/BANK	LF
725-22.85	4 IN CONDUIT BORED W/ BANK	LF
725-22.86	4 IN CONDUIT BORED	LF
725-22.87	4IN CONDUIT IN ROCK	LF
725-22.88	4IN CONDUIT STRUCTURE	LF
725-22.89	4IN CONDUIT STRUCTURE W/BANK	LF
725-22.90	CONDUIT BANK BORED IN ROCK (TYPE 1)	LF
725-22.91	CONDUIT BANK BORED IN ROCK (TYPE 2)	LF
725-22.92	CONDUIT BANK BORED IN ROCK (TYPE 3)	LF
725-22.93	CONDUIT BANK BORED IN ROCK (TYPE 4)	LF
725-22.95	CONDUIT BANK BORED IN ROCK (MICRO-CONDUIT)	LF
725-22.96	2 IN CONDUIT BORED IN ROCK	LF
725-22.97	3 IN CONDUIT BORED IN ROCK	LF
725-22.98	4IN CONDUIT BORED IN ROCK	LF
725-22.99	MICRO-CONDUIT BANK IN PAVEMENT	LF
725-23.01	ITS CABLE MARKER	EA

All Conduit will be paid per linear foot, as applicable, as follows:

1. Stored Materials will be paid per TDOT Standard Specifications.
2. Final Payment will be made after complete installation and satisfactory completion of Stand Alone Site Test of all items for which it is specified.

Cable Markers will be paid per each, as applicable, as follows:

1. Stored Materials will be paid per TDOT Standard Specifications.
2. Final Payment will be made after complete installation and satisfactory completion of Stand Alone Site Test of the Conduits.

Structural ITS will be paid at the lump sum price as follows:

1. Stored Materials will be paid per TDOT Standard Specifications.
2. Final Payment will be made after complete installation and satisfactory completion of Stand Alone Site Test of all items for which it is specified.

4 PULL BOXES

4.1 Description

This section specifies the minimum requirements for furnishing and installing pull boxes and covers as indicated on the Plans.

The Contractor shall install standard pull boxes at the locations shown on the Plans. The Plans will indicate pull box locations relative to the cabinet and other installation details, final location of pull boxes shall be determined in the field.

4.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

4.2.1 Pull Box (Type C)

Type C pull boxes shall meet the following requirements:

1. Minimum dimensions: 25”W x 16”L x 18”D exterior, 24”W x 13”L x 16”D interior.
2. Pull Box cover shall be precast composite polymer concrete product and shall be secured with stainless steel tamper resistant (e.g. pentahead) bolts. The Contractor shall furnish a total of 5 adapter/tools for removal of each type of tamper resistant bolt as part of this project.
3. Pull Boxes and covers shall be single-stack, open-bottom assemblies configured as shown in the standard drawings.
4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.
5. Pull Box shall meet current NEC standards for handhole enclosures.
6. Pull Box cover shall be labeled (TDOT ITS ELECTRICAL).
7. Type C pull boxes shall only be used for electrical power conduit/wiring.

4.2.2 Pull Box (Type D)

Type D Pull Boxes shall meet the following requirements:

1. Minimum dimensions: 24”W x 36”L x 36”D exterior.
2. Pull Box cover shall be precast composite polymer concrete product and shall be secured with stainless steel tamper resistant(e.g. pentahead) bolts. The Contractor shall furnish a total of 5 adapter/tools for removal of each type of tamper resistant bolt as part of this project.
3. Pull Boxes and covers shall be single-stack open-bottom assemblies configured as shown on the Plans.
4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.

5. Pull Box shall meet current NEC standards for handhole enclosures.
6. Pull Box cover shall be labeled (TDOT ITS COMMUNICATIONS).
7. Each Pull Box shall come equipped with 4 Cable Racks and 12 Rack Hooks. The Cable Racks shall be a minimum of 24”and Rack Hooks shall be a minimum of 7” in length. The cable Racks and Rack Hooks shall be Hot-Dipped Galvanized Steel.
8. Type D pull boxes shall only be used for communications conduit/cabling.

4.2.3 Pull Box (Type E)

Type E Pull Boxes shall meet the following requirements:

1. Minimum dimensions: 30” W x 48” L x 36” D exterior.
2. Pull Box cover shall be precast composite polymer product and shall be secured with stainless steel tamper resistant (e.g. pentahead) bolts. The Contractor shall furnish a total of 5 adapter/tools for removal of each type of tamper resistant bolt as part of this project.
3. Pull Boxes and covers shall be single-stack open-bottom assemblies configured as shown on the Plans.
4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.
5. Pull Box shall meet current NEC standards for handhole enclosures.
6. Pull Box cover shall be labeled (TDOT ITS COMMUNICATIONS).
7. Each Pull Box shall come equipped with 4 Cable Racks and 12 Rack Hooks. The Cable Racks shall be a minimum of 24” and Rack Hooks shall be a minimum of 7”in length. The cable Racks and Rack Hooks shall be Hot-Dipped Galvanized Steel.
8. Type E pull boxes shall only be used for communications conduit/cabling.

4.2.4 Pull Box (Structure Mounted)

Structure Mounted Pull Boxes shall meet the following requirements:

1. Minimum dimensions: 36” L x 12” D x 24” H exterior.
2. All components of pull box shall be 316 stainless steel except conduit adapter, O-rings and gasket.
3. Pull Box shall be NEMA 4X rated, 16-gauge, 316 stainless steel with gasketed, hinged door and tamper-resistant bolts.
4. Pull Boxes and cover assembly shall be configured as shown on the Plans.
5. Pull Box shall meet current NEC standards for handhole enclosures.
6. Pull Box cover shall be labeled (TDOT ITS COMMUNICATIONS). Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

4.2.5 Terminator Ring

The Terminator Ring shall meet the following requirements:

1. Shall accommodate the number of ducts penetrating the side of the Pull Box or Manhole.
2. The Terminator shall mount securely to the side of the box or cast into the side of the Manhole. The Terminator shall be a minimum of 1" thick and allow adequate spacing of the ducts.
3. The Terminator shall be manufactured from a composite material that will not deteriorate in any type of weather conditions.

4.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections. This section shall be as per guidelines of the TDOT Standard Specifications. Pull Boxes and covers shall be installed per the design details.

1. All items paid under this spec shall be installed per the manufacturer's recommendations.
2. A ground rod shall be installed in each Pull box. Bond all equipment ground conductors to the ground rod.

4.3.1 Pull Box (Type C)

1. Ducts shall enter the bottom of the Pull Box and shall extend into the box no more than 4"and no less than 2".

4.3.2 Pull Box (Type D)

1. Cable Racks and Rack Hooks shall be installed per the manufacturer's recommendations.
2. Ducts shall enter the side of the Pull Box using a Terminator and shall extend into the box no more than 4" and no less than 2".

4.3.3 Pull Box (Type E)

1. Cable Racks and Rack Hooks shall be installed per the manufacturer's recommendations.
2. Ducts shall enter the side of the Pull Box using a Terminator and shall extend into the box no more than 4"and no less than 2".

4.3.4 Pull Box (Structure Mounted)

1. Pull Box Support Hangers shall be installed per the manufacturer's recommendations.
2. Pull Box shall include a conduit box adapter with O-ring on both sides (inside and out) for connection to conduit system where required on the Plans. Ducts shall extend into the box no more than 4" and no less than 2".

4.4 Testing Requirements

4.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.

3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the Pull Box.

4.4.2 Factory Acceptance Test

FAT is not required for Pull Boxes.

4.4.3 Bench Test Component

BTC is not required for Pull Boxes.

4.4.4 Bench Test System

BTS is not required for Pull Boxes.

4.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to any applicable structures.
3. Verify the Pull Boxes have no internal or external damage.
4. Verify that security bolts are in place and properly fastened to covers.

4.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

4.6 Method of Measurement

4.6.1 Pull Box (Type C)

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The bid price shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, tamper-resistant bolt removal adapter/tool, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.6.2 Pull Box (Type D)

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The bid price shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, cable rack rails and hooks, terminator rings, tamper-resistant bolt removal adapter/tool, and miscellaneous materials necessary for a complete and accepted installation. This price

shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.6.3 Pull Box (Type E)

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The bid price shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, cable rack rails and hooks, terminator rings, tamper-resistant bolt removal adapter/tool, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.6.4 Pull Box (Structure Mounted)

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The bid price shall include furnishing and installing the pull box and cover including support hangers, conduit box adapters with O-ring, tamper-resistant bolt removal adapter/tool, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.7 Payment

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

Item No.	Description	Unit
725-20.43	PULL BOX (TYPE C)	EA
725-20.44	PULL BOX (TYPE D)	EA
725-20.45	PULL BOX (TYPE E)	EA
725-20.46	PULL BOX (STRUCTURE MOUNTED)	EA

Pull Boxes will be paid per each as follows:

1. Stored materials will be paid per TDOT Standard Specifications.
2. Final Payment will be made after complete installation and satisfactory completion of Stand Alone Site Test of all items for which it is specified.

5 FIBER OPTIC INFRASTRUCTURE

5.1 Description

This section specifies the minimum requirements for fiber optic infrastructure furnished and installed on this project. This work includes cable, splicing, termination, connectors, closures, panels, installation, and testing.

The fiber optic infrastructure will serve as the backbone for the communications systems (wireline) and will be used to transport data and video signals to/from field device locations using an Ethernet protocol.

5.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

5.2.1 General

1. Furnish fiber optic infrastructure materials that meet applicable industry standards for links less than 100 km including but not limited to:
    a. Manufacturer of optical fiber, fiber optic cable, fiber optic drop cable, integrated fiber optic termination unit, optical termination and connectorization materials and all ancillary and incidental materials shall comply with RUS Bulletin 1753F-601a where applicable and be currently ISO 9001 certified.
    b. Provide and install optical fiber, fiber optic cable, fiber optic drop cable, integrated fiber optic termination unit, optical termination and connectorization materials in accordance with contract drawings, specifications, IEEE C2 (NESC(R)), NFPA 70 (NEC), ICEA S-83-596, UL 1666, EIA/TIA-568-B.3, EIA/TIA-598-D, EIA/TIA-758-B, ITU-T G.652D, Fiber Optic Connector Intermateability Standard (FOCIS), and Telcordia GR-20 CORE requirements where applicable.
    c. EIA/TIA-455 Testing procedures
    d. Applicable Telcordia (Bellcore) Testing Standards
    e. Fiber optic cable physical requirements and cable construction shall be in accordance with ICEA S-87-640, ASTM D 4976
    f. Fiber optic cables shall be tested in accordance with Telcordia GR-20-CORE
2. Upon request of the Engineer, provide certification from a nationally recognized, independent testing laboratory that certifies that the cable conforms to industry standards.
3. Furnish fiber optic infrastructure materials recommended by the manufacturer for outside plant use and the intended application.

4. Furnish all optical fiber, fiber optic cable, fiber optic drop cable, integrated fiber optic termination unit, optical termination and connectorization materials, and all ancillary and incidental materials that are single-mode and/or compatible. All materials shall meet the following requirements:

    a. All cables and termination infrastructure shall be factory installed and fusion spliced to an approved equivalent single-mode optical fiber.

    b. All fibers and buffer tubes shall follow EIA/TIA-598B identification using colors. Do not use printed legends.

    c. All cables shall have been manufactured and labeled no earlier than 3 calendar months preceding the TDOT letting date of the contract.

5.2.2 Fiber Optic Cable (144 F)

1. Provide fiber optic cable that meets the following requirements:

    a. All-dielectric outside plant loose tube cable shall have central strength/anti-buckling member or outer aramid yarn strength member.

    b. Dry, water blocking materials and construction.

    c. Reverse oscillating "SZ" stranded buffer tube construction

    d. Medium density polyethylene outer jacket shall be a consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Outer jacket polyethylene shall contain carbon black for ultraviolet light protection and does not promote the growth of fungus.

    e. 144 fiber cable with 12 active buffer tubes and 12 individual stranded fibers per buffer tube

    f. Cable construction design that allows no more than 12 buffer tube positions

    g. Maximum diameter 0.7"

    h. Maximum weight 0.2 pounds per foot

    i. Rated for conduit installations

    j. Rated attenuation: 0.4dB/km and 0.3dB/km at 1310nm and 1550nm, respectively

2. Designate this cable as a trunk cable.

3. Ensure that the cable can withstand a maximum pulling tension of 600 lbf during installation and 180 lbf installed long term (at rest).

4. Provide cable with shipping, storage, and operating temperature range of -30°C to +70°C.

5. Provide cable with a minimum installation temperature range of -10°C to +40°C.

6. Provide cable with outer jacket marking using the following template:

    a. Manufacturer's Name – "Optical Cable" – Month/Year of Manufacture – Telephone Handset Symbol – "TDOT ITS" – "144F SM"

7. Contractor shall include in the outer jacket marking the cable sequential length in accordance with the following:

a. In English units every 2’

b. Within -1%/+1% of the actual length of the cable

c. In contrasting color to the cable jacket

d. Marking font height no less than 0.10”

e. On any single length of cable on a reel, the sequential length markings do not run through “00000”

5.2.3 Fiber Optic Drop Cable (12 F)

1. Provide fiber optic drop cable that meets the following requirements:

    a. All-dielectric outside plant loose tube cable shall have central strength/anti-buckling member or outer aramid yarn strength member.

    b. Dry water blocking materials and construction

    c. Reverse oscillating “SZ” stranded buffer tube construction

    d. Medium density polyethylene outer jacket shall be a consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Outer jacket polyethylene shall contain carbon black for ultraviolet light protection and does not promote the growth of fungus.

    e. 12-fiber cable with 1 active buffer tube and 12 individual stranded fibers

    f. Maximum diameter 0.48”

    g. Maximum weight 0.07 pounds per foot

    h. Rated for conduit installations

    i. Rated attenuation: 0.4dB/km and 0.3dB/km at 1310nm and 1550nm, respectively

2. Designate this cable as a drop cable.

3. Ensure that the cable can withstand a maximum pulling tension of 600 lbf during installation and 180 lbf installed long term (at rest).

4. Provide cable with shipping, storage, and operating temperature range of -30°C to +70°C.

5. Provide cable with an installation temperature range of -30°C to +60°C.

6. Provide cable with outer jacket marking using the following template:

    a. Manufacturer’s Name – “Optical Cable” – Month/Year of Manufacture – Telephone Handset Symbol – “TDOT ITS” – “12F SM”

7. Include in the outer jacket marking the cable sequential length in accordance with the following:

    a. In English units every 2’

    b. Within -1%/+1% of the actual length of the cable

    c. In contrasting color to the cable jacket

    d. Marking font height no less than 0.10”

e. On any single length of cable on a reel, the sequential length markings do not run through "00000"

5.2.4 Fiber Optic Micro-Cable (144 F)

1. Provide fiber optic micro-cable that meets the following requirements:
    a. All-dielectric outside plant loose tube cable shall have central strength/anti-buckling member or outer aramid yarn strength member.
    b. Dry, water blocking materials and construction
    c. Reverse oscillating "SZ" stranded buffer tube construction
    d. Medium density polyethylene outer jacket shall be a consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Outer jacket polyethylene shall contain carbon black for ultraviolet light protection and does not promote the growth of fungus.
    e. 144 fiber cable with 12 active buffer tubes and 12 individual stranded fibers per buffer tube
    f. Cable construction design that allows no more than 12 buffer tube positions
    g. Maximum outside diameter 0.32"
    h. Maximum weight 0.04 pounds per foot
    i. Rated for micro-conduit installations
    j. Rated attenuation: 0.35 dB/km and 0.25 dB/km at 1310nm and 1550nm, respectively
2. Designate this cable as a trunk cable.
3. Install only within micro-conduit to a minimum fill ratio of 50% and a maximum fill ratio of 80%.
4. Ensure that the cable can withstand a maximum air assisted install speed of at least 490 ft/min during installation.
5. Provide cable with minimum shipping, storage, and operating temperature range of -30°C to +70°C.
6. Provide cable with a minimum installation temperature range of -10°C to +60°C.
7. Provide cable with outer jacket marking using the following template:
    a. Manufacturer's Name – "Optical Cable" – Month/Year of Manufacture – Telephone Handset Symbol – "TDOT ITS" – "144F SM"
8. Contractor shall include in the outer jacket marking the cable sequential length in accordance with the following:
    a. In English units every 2'
    b. Within -1%/+1% of the actual length of the cable
    c. In contrasting color to the cable jacket

d. Marking font height no less than 0.10”

e. On any single length of cable on a reel, the sequential length markings do not run through “00000”

5.2.5 Fiber Optic Splice Fusion

1. Provide fusion splices for splicing of all fibers on the project. Do not provide any other type of fiber splicing.

2. Perform fusion splicing with a fully automatic portable fusion splicer that provides consistent low loss (maximum 0.10db) splices. Splicer shall provide three-axis fiber core alignment using light injection and loss measurement techniques or the splicer shall utilize an active alignment Profile Alignment System. The fusing process shall be automatically controlled. The splicer shall provide splice loss measurements on an integral display, as well as a magnified image of the fiber alignment. The Contractor shall retain ownership of the fusion splicer.

5.2.6 Fiber Optic Connectors

1. Provide fiber optic connectors compliant with this SP725 for all fiber optic infrastructure including but not limited to fiber optic termination cabinets, fiber optic drop panels, and fiber optic patch cords.

2. Provide only factory-installed keyed LC compatible connectors for all fiber optic infrastructure.

3. Provide only factory-installed connectors of a type other than LC when required by the Network Switches. Do not use field-installed mechanical connectors. Do not use adapter couplers to change connector types.

4. Use ceramic ferule connectors factory-installed with a thermal-set heat-cured epoxy and machine polished mating face. Install connectors as per manufacturer application and recommendations, including proper termination to the outer-tubing (900-micron tubing, 3 mm fanout tubing, etc.) required for the application.

5. Use connectors rated for an operating temperature of -40°C to +75°C.

6. Provide connectors that have an installed insertion loss of less than 0.50db, a typical loss of 0.20db, and an optical return loss less than or equal to -45db.

7. Use simplex connectors for all male LC connectors. Provide latching cover for 2 male connectors being used in a duplex configuration. Female couplers may be duplex but must allow simplex mating connectors.

8. Label each fiber position on panels and termination cabinets containing duplex couplers with the port/position ID as shown on the Plans.

9. Provide dust caps for all exposed male connectors and female couplers at all times until permanent connector installation.

10. LC connectors shall comply with TIA/EIA-4750000-C and TIA/EIA-604-10A.

5.2.7 Fiber Optic Termination Cabinet (144 F)

1. Provide fiber optic termination cabinet in communications hubs, field junctions, and the TDOT Regional TMC as shown and quantified on the Plans for full termination of 144 fiber outside plant (OSP) cables.

2. Use termination panels that are fully compatible with all components of the fiber optic infrastructure as specified including but not limited to fiber optic cable, fiber optic fusion splices, and fiber optic connectors.

3. Use rack-mount termination panels designed to fit standard 19" EIA equipment racks.

4. Provide all mounting hardware and supports to mount the termination panels in the locations shown on the Plans.

5. Use termination panels providing 144 fiber connectors and capable of storing 144 fusion splices in splice trays.

6. Use termination panels that integrate the splice trays and connector modules into 1 compartment within 1 panel or house the splice trays and connector modules in separate compartments integrated into 1 panel.

7. Maximum dimensions of a complete termination panel shall be 7 rack units high (12.25") by 17" deep.

8. Use termination panels with fully enclosed metallic construction and with a protective hinged front cover for the connector ports.

9. Provide cable access on all sides of the enclosed area behind the connector port panel.

10. Provide a unique serial number permanently attached on the enclosure body of each fiber optic termination panel.

11. Provide an outer non-metallic cable strain-relief boot where the fiber optic cable enters the fiber optic termination panel and that secures the cable to the fiber optic termination panel; the strain-relief boot shall fully encircle the cable for a minimum of 2" from the panel's outer surface.

12. Provide sufficient splice trays for storing 144 fusion splices in 12 splice increments.

13. Provide termination panels with fiber optic connector modules in a 12-fiber configuration of 6 rows of 1 duplex LC connector couplers.

14. Connector modules shall mount vertically in the fiber optic termination front panel.

15. Connector modules shall include clearly legible and permanent labeling of each of the 12-fiber connector couplers and shall be labeled and identified as shown on the Plans.

16. Provide factory-assembled 12-fiber termination interconnect cables (pigtail cables) to be fusion spliced to the outside plant cable and connected to the rear of the connector modules.

    a. Termination interconnect cables shall be all-dielectric single jacketed cable with high tensile strength yarn surrounding 12 individual single mode fibers following EIA/TIA-598B color identification with factory-installed connectors.

17. Provide all incidental and ancillary materials including but not limited to grommets, cable strain relief and routing hardware, blank connector panels, and labeling materials.

5.2.8 Fiber Optic Closure

1. Provide fiber optic closures designed for underground outside plant use for splicing cables in pull boxes.

2. Use fiber optic closures that are impact and corrosion resistant and waterproof when immersed in 20'of water. GR-771 documentation shall be provided for the enclosure.

3. Use fiber optic closures that are fully compatible with all components of the fiber optic infrastructure as specified including but not limited to fiber optic trunk cable, fiber optic drop cable, integrated fiber optic termination unit, and fiber optic fusion splices.

4. Use a cylindrical dome-type splice closure with cable entry at one end only and a sealed single-molded piece dome body of high-density polyethylene or equivalent non-metallic material.

    a. The cable entry end shall be manufactured of a similar material as the dome body and shall seal the closure with flexible thermoplastic rubber or polymer gasket seals.

    b. The cable entry end shall include cable entrance ports that shall seal the cable and port opening with flexible thermoplastic rubber or polymer gasket seals with mechanical compression.

    c. Closures shall be re-enterable and re-sealed without the need for specialized tools or equipment, or the use of any additional parts.

    d. Do not use any heat shrink or caulk/encapsulate materials for sealing the assembled closure or terminated cables.

5. Provide splice closures with maximum outer dimensions of 12” diameter and 24” length.

    a. Splice closures shall provide cable entrance ports for at least 5 fiber optic cables.

    b. At least 2 cable entrance ports shall accommodate cables of at least 0.7” outer diameter.

    c. The closure shall allow for the storage and express of at least 6 unopened buffer tubes.

6. Provide a splice closure with a cable entry end with pre-template cable ports and a split-plate design permitting installation of the closure in mid-span cable segments.

7. The splice closure size shown on the Plans specifies the minimum number of fusion splices to be accommodated by the closure. With the splice closure, provide all materials to accommodate the number of splices specified by the closure size, including splice tray, storage, and organizing materials.

5.2.9 Fiber Optic Drop Panel (12 F)

1. Provide fiber optic drop panels designed for outside plant use for terminating drop cables in equipment cabinets.

2. Use fiber optic drop panels that are fully compatible with all components of the fiber optic infrastructure as specified including but not limited to fiber optic trunk cable, fiber optic splice closures, integrated fiber optic termination unit, fiber optic fusion splices, and fiber optic connectors.

3. Use fiber optic drop panels that are factory manufactured assemblies of fiber optic drop 12-fiber termination interconnect cables (pigtail cables) with factory-installed fiber connectors and integral ruggedized fiber connector enclosures. Pigtail cables to be fusion spliced to the outside plant cable and connected to the rear of the connector modules.

    a. Termination interconnect cables shall be all-dielectric single jacketed cable with high tensile strength yarn surrounding 12 individual single mode fibers following EIA/TIA-598B color identification with factory-installed connectors.

4. Use drop panels with 12 duplex LC fiber connectors.

5. Use ruggedized fiber connector enclosures of thermally stable rigid plastic housings fully potted with a thermally stable epoxy filling that encapsulates the drop cable fanout, fibers, and connector bodies or enclosures made of metal with smooth black powder coat finish.
6. Use permanent labels on the enclosure with contrasting color to identify each connector body by its associated fiber number.
7. Fiber connectors shall be arranged in rows of 1 duplex connector couplers. All fiber connectors shall be arranged on one of the long (vertical) faces of the enclosure.
8. Provide a unique serial number permanently attached on the enclosure body of each drop panel.
9. Provide an outer non-metallic cable strain-relief boot where the drop cable enters the fiber connector enclosure and that secures the cable to the enclosure; the strain-relief boot shall fully encircle the cable for a minimum of 2" from the enclosure's outer surface.
10. Use fiber connector enclosures that are no more than 2" wide and 2" deep and no more than 11" long.
11. Provide a mounting plate that has at least 4 mounting holes near the enclosure's corners that permit horizontal or vertical mounting flush to a panel and are spaced appropriately for vertical mounting to an EIA equipment rack rail using 2 of the mounting holes.

5.2.10 Pre-Terminated Fiber Optic Drop Cable

1. The pre-terminated fiber optic drop cable shall provide the connectivity between the fiber optic splice enclosure and the end of line termination at field cabinets.
2. The pre-terminated fiber optic drop cable shall conform to the following:
    a. The cable shall be of a pre-terminated, rugged, and modular design.
    b. The termination component shall include 12-port, single mode duplex LC connectors.
    c. The termination component shall be constructed out of a rugged molded unit of ABS plastic to ensure that the component is not vulnerable to the elements.
    d. The installed insertion loss shall be less than 0.50db, a typical loss of 0.20db, and have an optical return less than or equal to -45db.
    e. The fiber cable should be a maximum length of 275' including 100' of coiled cable in the adjacent Type E pull box.
    f. The components must be pretested by manufacturer to ensure quality and safety.
    g. The pre-terminated fiber optic drop cable shall be provided with factory testing results.

5.2.11 Cable Labels

1. Provide cable labels that meet the following requirements:
    a. Self-coiling wrap-around type.
    b. PVC or equivalent plastic material with UV and fungus inhibitors.
    c. Base materials and graphics/printing inks/materials designed for underground outside plant use including solvent resistance, abrasion resistance, and water absorption.
    d. Minimum size of 2.5" wide by 2.5" long.

e. Minimum thickness of 0.010”.

f. Orange label body with pre-printed text in bold black block-style font with minimum text height of 0.375”.

2. Pre-print the following text legibly on labels used for all fiber optic trunk cables (FO Cable):

TDOT ITS OPTICAL CABLE

3. On all cable labels, print the text specified above twice on the label with the text of the second image inverted. The result shall be text which “reads correctly” when the label is coiled onto a cable.

5.2.12 Fiber Optic Patch Cords

1. Provide fiber optic patch cords consisting of a length of fiber optic cable terminated on both ends.
2. All patch cords shall be factory preconnectorized assemblies adhering to all applicable cable and fiber specifications stated in this SP725.
3. The length of all patch cords shall be of a specific length for each necessary connection, maintaining minimum bend radius, and with no residual strain at the connector or anywhere on the patch cord itself beyond self-support.
4. All patch cords shall be duplex zip-cord fiber cable with simplex LC connectors, except as otherwise allowed in Section 5.2.6.
    a. The 2 connectors of each end of the patch cord shall be differentiated by distinct colors or have markings on each connector identifying each fiber.
    b. Contractor shall provide sufficient flexibility at each end to disconnect 1 connector without disturbing the other, or to allow swapping of the 2 connectors within the same duplex coupler without disturbing the remainder of the patch cord.
    c. Contractor shall provide strain relief and reinforcement at the point where the duplex cable separates for the individual simplex connectors.
5. Fiber cable shall be 2mm jacketed cable with high tensile strength yarn protecting the inner fiber manufactured into a duplex zip-cord configuration. All Inside Plant patch cords shall meet NEC jacketing requirements.
6. Connector strain relief boots to the outer jacket and strength yarn of fiber patch cords.
7. Use yellow outer jackets for single mode fiber.
8. No splices of any type are allowed within a patch cord assembly.

5.2.13 Fiber Optic Attenuators

1. Fiber optic attenuators shall be fixed in-line.
2. Provide fiber optic attenuator that meet all requirements of Section 5.2.12 for fiber optic patch cords.
3. The fiber in the attenuator shall contain a passive optical attenuator with the following performance characteristics:
    a. Dual-wavelength capability (1310 and 1550nm)

b. Fixed attenuation value of 6dB +/- 15%.

c. Minimum optical return loss 40db

d. Operating temperature range no less than -30ºC to +65ºC

5.2.14 Project Submittal Program Requirements

1. General Requirements

    a. The Contractor shall provide project submittals for all fiber optic infrastructure as required in Section 2.7 of this SP725, including scheduling requirements. The project submittals for fiber optic infrastructure shall include but are not limited to the additional specific requirements in this Subsection.

2. Fiber Optic Installation and Testing Tools

    a. Provide project submittals including manufacturer-recommended operations, maintenance, and calibration procedures for the following equipment:

        i. Fusion splicers

        ii. Cable pulling strain dynamometers and breakaway links

        iii. Cable air jetting/blowing systems

        iv. OTDRs

        v. Optical attenuation testers (light sources and power meters)

    b. Submit documentation and proof of manufacturer-recommended operator training and certification for the following equipment:

        i. Fusion splicers

        ii. Cable air jetting/blowing systems

        iii. OTDRs

        iv. Optical attenuation testers (light sources and power meters)

5.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections.

5.3.1 General

1. Install all fiber optic infrastructure according to the manufacturer's recommended procedures and specifications.

2. Fiber optic installation tools shall be maintained and calibrated in accordance with the tool manufacturer's recommendations. Tool manufacturer certified calibration documentation shall be provided upon Engineer's request. Installation tools include:

    a. Fusion splicers

    b. Cable pulling strain dynamometers and breakaway links

    c. Cable air jetting/blowing systems

3. Fiber optic installation tools shall be operated only by Contractor personnel who have been trained and certified by the tool manufacturer. Installation tools requiring certified operators include:
    a. Fusion splicers
    b. Cable air jetting/blowing systems
    c. Cable tension dynamometers

5.3.2 Fiber Optic Cable

5.3.2.1 Cable Shipping and Delivery

1. Cable Manufacturer shall package the cable for shipment on factory reels. Each package shall contain only one continuous length of cable. Radius of the reel drum shall not be smaller than the minimum bend radius recommended by the manufacturer for the media. Manufacturer shall construct the packaging to prevent damage to the cable during shipping and handling.
2. Cable Manufacturer shall seal both ends of the cable to prevent the ingress of moisture.
3. Cable Manufacturer shall include with each reel a weatherproof reel tag attached identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber. Include with each cable a cable data sheet containing the following information:
    a. Cable Manufacturer name
    b. Cable part number
    c. Factory order number
    d. Cable length
    e. Factory measured attenuation of each fiber
4. Cable Manufacturer shall cover the cable with a protective and thermal wrap.
5. Cable Manufacturer shall securely fasten the outer end of the cable to the reel head to prevent the cable from becoming loose in transit.
6. Cable Manufacturer shall project the inner end of the cable a minimum of 6.5’ into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing.
7. Cable Manufacturer shall plainly mark each reel to indicate the direction in which it is to be rolled to prevent loosening of the cable on the reel.

5.3.2.2 Cable Handling and Installation

1. See Section 5.3.2.3 for Micro-Cable Handling and Installation Requirements.
2. Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer.
3. Continuously monitor pulling tensions with calibrated measuring devices, such as a strain dynamometer.
4. Protect all pulled installations with calibrated breakaway links.

5. Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:

    a. 20 X Cable Diameter Short Term – During Installation

    b. 10 X Cable Diameter Long Term – Installed

6. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.

7. Take all necessary precautions to protect reeled cable from vandals or other sources of damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section at Contractor's expense.

8. Whenever unreeled cable is placed on the pavement or surface above a pull box, Contractor shall provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.

9. Keep the cable continuous throughout the pull. Cable breaks and reel end splices are permitted only as shown on the Plans.

10. Where a cable ends in an underground fiber optic splice closure, Contractor shall secure and store all unused fibers and buffer tubes in splice trays in preparation for future reel end splicing and continuation.

5.3.2.3 Micro-Cable Handling and Installation

1. Micro-Cable shall only be installed within Micro-Conduit.

2. Micro-Cable shall be installed by blowing into the Micro-Conduit. Do not exceed the maximum air assisted install speed during installation as specified by the cable manufacturer.

3. Continuously monitor air assisted install speed with calibrated measuring devices.

4. Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:

    a. 20 X Cable Diameter Short Term – During Installation

    b. 15 X Cable Diameter Long Term – Installed for Micro-Cable

5. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.

6. Take all necessary precautions to protect reeled cable from vandals or other sources of damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section at Contractor's expense.

7. Whenever unreeled cable is placed on the pavement or surface above a pull box, Contractor shall provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.

8. Keep the cable continuous throughout the pull. Cable breaks and reel end splices are permitted only as shown on the Plans.

9. Where a cable ends in an underground fiber optic splice closure, Contractor shall secure and store all unused fibers and buffer tubes in splice trays in preparation for future reel end splicing and continuation.

5.3.2.4 Cable Storage

1. Safely store all cable to minimize susceptibility to damage.
    a. Maintain proper bend radius, both short and long term, during cable storage.
    b. Storage coils shall be neat in even length coils, with no cross over or tangling.
    c. Storage coils of different cables shall be kept separate except when the cables terminate in the same splice closure.
    d. Storage coils shall be secured to cable racking hardware with tie wraps, Velcro straps, or non-metallic cable straps with locking/buckling mechanism.
    e. Do not use adhesive or self-adhering tapes, metal wires and straps, or rope/cord.
2. Unless otherwise noted on the Plans, the following are the requirements for cable slack storage:
    a. Trunk fiber optic cable in Type “D” Pull Box – 50’
    b. Trunk fiber optic cable in Type “E” Pull Box – 200’
    c. Trunk fiber optic cable in Structure Mounted Pull Box – 10’
    d. Trunk fiber optic cable in pad-mounted cabinet – 25’
    e. Trunk fiber optic cable in pole-mounted cabinet – 25’
    f. Drop fiber optic cable in Type “D” Pull Box – 25’
    g. Drop fiber optic cable in Type “E” Pull Box – 100’
    h. Drop fiber optic cable in Structure Mounted Pull Box – 10’
    i. Drop fiber optic cable in pad-mounted cabinet – 25’
    j. Drop fiber optic cable in pole-mounted cabinet – 25’

5.3.3 Pre-Terminated Fiber Optic Drop Cable

1. Follow installation procedures detailed in Section 5.3.2 of this SP725.
2. Secure pre-terminated fiber optic drop cable to inner wall of equipment cabinet in an accessible location.
3. Install dust covers on all connector terminations.
4. Coil 100’ of cable in the adjacent Type E pull box.

5.3.4 Fiber Optic Closure

1. Install fiber optic closures where, and of the size, shown on the Plans. Install splice closures in the center ± 3’ of the entire length of stored cable coils or install at the end of cables that terminate in the pull box.

2. Store FO closures and cable coils on the pull box cable rack hooks. Keep all closures and cable coils off the bottom of the pull box. Secure closures and/or cable coils as needed to hold them in place.

5.3.5 Fiber Optic Splice Fusion

1. Perform fusion splicing of all fiber optic splices as shown on the Plans in the locations shown.
2. Perform fusion splicing only in enclosed spaces such as splice trailers or tents specifically intended for this operation.
3. Completed fusion splices shall have no more than 0.10dB optical loss as measured in accordance with Section 5.2.5.
4. Adequately protect all fusion splices in splice trays in a splice closure or termination cabinet. Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the fiber and the splice tray manufacturers.
5. Use fusion splice protectors of a heat shrink tubing that protects the splice and extends over the fiber coating. Splice protectors shall be compatible with and as recommended by the fiber and the splice tray manufacturers.
6. No bare fiber may be exposed.

5.3.6 Fiber Optic Termination Cabinet (144 F)

1. Install only 1 cable per termination panel, including within the separate splice tray storage compartment if so equipped. Contractor shall install the connector modules for fibers 1 through 144 as shown on the Plans. Equip any remaining unused connector module slots with blank panels.
2. Install all fibers, buffer tubes, and cables following minimum internal and external bend radius, proper management, routing, fastening and protection, and with no residual strain on any connector, fiber, buffer tube or cable.
3. Install 1 cable buffer tube to 1 termination panel interconnect cable, matching fiber to fiber. Keep all fibers of the outside plant cable buffer tube and their corresponding termination-interconnect cables complete within the same splice tray.
4. Label the front and rear of the termination panels with the trunk cable segment ID of the cable terminated within; use permanent clearly legible labels with minimum 0.5” text height.
5. Label each end of termination panel interconnect cables to identify the 12 trunk cable fibers/buffer tube connected; use permanent overlapping cable labels with clearly legible text.
6. Install dust covers on all connector terminations.

5.3.7 Fiber Optic Drop Panel (12 F)

1. Prior to factory manufacturing of fiber optic drop panels, Contractor shall verify the final installed location of all portions of each drop cable route from the splice closure to the equipment cabinet (including the cabinet location, all conduit and pull boxes, and the splice closure location) to determine the required length of drop cable, including all splice closure and storage coils, to be factory manufactured with each drop panel. Do not use the Plans quantity for determining the drop cable length to be factory manufactured.
2. If using factory installed connectorized fanout kit, splice all 12 fibers into the drop cable.

3. Using the drop panel mounting plate, Contractor shall install drop panels on the side panel or equipment cabinets. Mount the fiber optic drop panel with the connectors horizontal or facing downward and route the drop cable up or down as necessary. Route and secure the drop cable such that it is fully strain-relieved, does not violate the manufacturer's recommended bending radius, and does not interfere with the operation of or access to any cabinet equipment or electrical components.

4. Contractor shall place 1 copy of the manufacturer test documentation in the equipment cabinet, where the drop panel is installed and submit an electronic copy to the Engineer.

5.3.8 Cable Labels

1. Install cable labels on all trunk cables. Clean the installed cable of all dirt and grease before applying any label.

2. Label all cables in or at every location where the cable is exposed outside of a conduit, innerduct or pole, using the cable IDs for trunk cables. As a minimum, install cable labels in the following locations:

    a. Within 12" of every cable entry to a pull box, equipment cabinet, communications hub, or the TDOT Regional TMC.

    b. Within 12" of the exterior entry point of every fiber optic splice closure, termination cabinet, and drop panel.

    c. Every 30' for the entire length of cable in any storage coil in pull boxes.

5.3.9 Fiber Optic Patch Cords

1. Install fiber optic patch cords to connect all electronic equipment with the fiber optic infrastructure. Follow port assignments as shown on the Plans.

2. Install fiber optic patch cords to connect all active optical paths between fiber optic termination cabinets in communications hubs as shown on the Plans.

3. Neatly route and dress all patch cords to the connected devices and within cable management facilities.

5.3.10 Fiber Optic Attenuators

1. Provide fiber optic attenuators in accordance with Section 5.2.13.

5.4 Testing Requirements

5.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.

2. All test results shall confirm physical and performance compliance with this SP725.

3. All test results shall confirm physical and performance compliance with this SP725 including optical fibers and fusion splices. The total loss in each test segment shall not exceed the calculated allowable loss based on the formulas listed below.

    a. 1310 nm wavelength

i. (X * 0.35) + (Y * 0.1) + (Z * 0.5) = calculated loss (dB)

1. X = span length (km)
2. Y = number of fusion splices within the span (ea)
3. Z = number of connectors within the span (ea)

b. 1550 nm wavelength

i. (X * 0.25) + (Y * 0.1) + (Z * 0.5) = calculated loss (dB)

1. Same variables as above

If the Contractor is unable to achieve the calculated allowable loss after at least 2 attempts of correction, alternative resolution can be discussed with the Engineer.

4. In addition to the notification requirements of Section 2.4, Contractor shall provide the tentative date, time, and location of fiber optic infrastructure testing no less than 7 days in advance of the test. Provide confirmed date, time, and location of fiber optic infrastructure testing no less than 48 hours before conducting the test.
5. Provide test results documentation in electronic format. Electronic format shall be readable in Microsoft Excel or other approved application.
6. Provide all test results in English units of measure of length.
7. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7. Test documentation shall include:

a. Cable & Fiber Identification

i. Cable & Fiber ID and Location – Physical location (device ID and station number of FO Termination Cabinet, FO Drop Panel, or cable end FO closure), fiber number, and trunk or drop cable ID for both the beginning and end point.

ii. Operator Name

iii. Engineer's Representative

iv. Date & Time

b. Setup and Test Conditions Parameters

i. Launch Cable Length

ii. Wavelength

iii. Pulse width Optical Time Domain Reflectometer (OTDR)

iv. Refractory index (OTDR)

v. Range (OTDR)

vi. Scale (OTDR)

vii. Ambient Temperature

c. Test Results for OTDR Test (each direction and averaged)

i. Total Fiber Trace (miles)

ii. Splice Loss/Gain (dB)

iii. Events > 0.05db

iv. Measured Length (Cable Marking)

v. Total Length (OTDR Measurement)

d. Test Results for Attenuation Test (each direction and averaged)

i. Measured Cable Length (Cable Marking)

ii. Total Length (OTDR Measurement from OTDR Test)

iii. Number of Splices (Determined from as-builts)

iv. Total Link Attenuation

8. Fiber optic testing tools shall be maintained and calibrated in accordance with the tool manufacturer's recommendations. Tool manufacturer certified calibration documentation shall be provided upon Engineer's request. Testing tools include:

    a. OTDRs

    b. Optical attenuation testers (light sources and power meters)

9. Fiber optic testing tools shall be operated only by Contractor personnel who have been trained and certified by the tool manufacturer. Testing tools requiring certified operators include:

    a. OTDRs

    b. Optical attenuation testers (light sources and power meters)

5.4.2 Factory Acceptance Test

FAT is not required for Fiber Optic Infrastructure.

5.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Contractor shall test each connectorized fiber in the fiber optic drop panel to demonstrate compliance with all requirements for cables and connectors as detailed in this SP725. Include in the test documentation the site number where the drop panel is to be installed, the serial number of the drop panel, the drop cable sequential length markings at each end of the drop cable, and the total drop cable distance.

2. Contractor shall test all fiber optic cables prior to any cable removal from the shipping reels. Each cable reel delivered to the job site shall be tested. The testing shall include:

    a. A visual inspection of each cable and reel

    b. An OTDR Test and documentation, as required in the SAT below, for 3 randomly selected fibers from each buffer tube.

c. An Optical Attenuation Test is not required. If the Contractor decides to perform one for their own protection, said test should be documented and provided to the Engineer.

5.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. BTS of fiber optic components will be performed in conjunction with other components in this SP725 that are reliant upon the Fiber Optic Infrastructure.

5.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify the Fiber Optic Infrastructure has no internal or external damage.
3. Test all Fiber Optic Infrastructure on this project after field installation is complete including but not limited to all splicing and terminations.
4. Test each fiber in each fiber optic cable including OTDR Tests and Optical Attenuation Tests. The testing shall consist of all fiber optic cables and drop cables from termination point to termination point including:
    a. Fibers from Fiber Optic Termination Cabinet to Fiber Optic Termination Cabinet.
    b. Fibers from Fiber Optic Termination Cabinet to Fiber Optic Drop Panel.
    c. Fibers from Fiber Optic Drop Panel to Fiber Optic Drop Panel.
    d. Fibers from Fiber Optic Termination Cabinet to the end of the cable run in the last Fiber Optic Closure. Fiber that is not terminated shall be temporarily terminated in order to perform testing.
5. The OTDR Testing shall conform to the following requirements:
    a. OTDR Test shall be conducted using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.
    b. A factory patch cord (“launch cable”) of a length equal to the “dead zone” of the OTDR to connect the OTDR and the fiber under test shall be used. The launch cable shall not be greater than 820 feet in length.
    c. Bi-directional OTDR Tests for each fiber shall be conducted with the bi-directional averages calculated and used as the result.
    d. All tests shall be conducted at 1310 nm and 1550 nm for single mode cable.
6. The Optical Attenuation Testing shall conform to the following requirements:
    a. Optical Attenuation Test shall be conducted using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.
    b. Bi-directional Optical Attenuation Tests for each fiber shall be conducted with the bi-directional averages calculated and used as the result.
    c. All tests shall be conducted at 1310 nm and 1550 nm for single mode cable.

5.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

5.6 Method of Measurement

5.6.1 Fiber Optic Testing

Payment for the testing of new fiber optic shall be included in the cost of the Fiber Optic Cable. Payment for the testing of any existing fiber optic shall be included in the cost of Network Integration.

5.6.2 Fiber Optic Cable (144 F)

Single Mode Fiber Optic Cable (144 F) will be measured in units of linear feet and paid for at the contract price per linear feet. The bid price shall include the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, mounting brackets, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP725 or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.3 Fiber Optic Micro-Cable (144 F)

Single Mode Fiber Optic Micro-Cable (144 F) will be measured in units of linear feet and paid for at the contract price per linear feet. The bid price shall include the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, mounting brackets, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP725 or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.4 Fiber Optic Drop Cable (12 F)

Single Mode Fiber Optic Drop Cable (12 F) will be measured in units of linear feet and paid for at the contract price per linear feet. The bid price shall include the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP725 or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.5 Fiber Optic Closure (12 F)

Fiber Optic Closure (12 F) will be measured in units of each and paid for at the contract price per each. The bid price shall include but not be limited to cable labels, 1 splice tray, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.6 Fiber Optic Closure (144 F)

Fiber Optic Closure (144 F) will be measured in units of each and paid for at the contract price per each. The bid price shall include but not be limited to cable labels, 12 splice trays, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.7 Fiber Optic Splice Fusion

Fiber Optic Splice Fusion will be measured in units of each splice and paid for at the contract price per each individual splice. The bid price shall include but not be limited to all ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.8 Fiber Optic Termination Cabinet (144 F)

Fiber Optic Termination Cabinet (144 F) will be measured in units of each and paid for at the contract price per each and shall include but not be limited to rack-mounted fiber optic cabinet, fiber optic connectors, cable labels, patch cords, splice tray, splices, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.9 Fiber Optic Drop Panel (12 F)

Fiber Optic Drop Panel (12 F) will be measured in units of each and paid for at the contract price per each. The bid price shall include but not be limited to fiber optic drop panel, fiber optic connectors, cable labels, patch cords, splicing of the fiber optic drop cable into the fiber optic drop panel, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.10 Pre-Terminated Fiber Optic Drop Cable

Pre-Terminated Fiber Optic Drop Cable will be measured in units of each and paid for under the Fiber Optic Drop Panel (12 F) pay item at the contract price per each. The bid price shall include but not limited to cable lengths up to 275', cable labels, factory terminations, integrated patch panel, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.6.11 Fiber Optic Connectors

Fiber Optic Connectors are incidental to other items and will not be measured separately for payment.

5.6.12 Cable Labels

Cable Labels are incidental to other items and will not be measured separately for payment.

5.6.13 Fiber Optic Patch Cords

Fiber Optic Patch Cords are incidental to other items and will not be measured separately for payment.

5.6.14 Fiber Optic Attenuators

Fiber Optic Attenuators are incidental to other items and will not be measured separately for payment.

5.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-23.02	FIBER OPTIC TESTING	LS
725-23.16	FIBER OPTIC CABLE (144 F)	LF
725-23.17	FIBER OPTIC MICRO-CABLE (144 F)	LF
725-23.21	FIBER OPTIC DROP CABLE (12 F)	LF
725-23.26	FIBER OPTIC CLOSURE (12 F)	EA
725-23.27	FIBER OPTIC CLOSURE (144 F)	EA
725-23.28	FIBER OPTIC SPLICE FUSION	EA
725-23.30	FIBER OPTIC TERMINATION CABINET (144 F)	EA
725-23.31	FIBER OPTIC DROP PANEL (12 F)	EA

Fiber Optic Infrastructure, except as specified below, will be paid per linear foot or per each, as applicable, as follows:

1. 25% of the contract unit price upon delivery and satisfactory completion of Bench Test Component test.
2. Additional 35% of the contract unit price for complete installation of cables.
3. Additional 30% of the contract unit price for satisfactory completion of Stand Alone Site Test testing and documenting of all fibers in any lineal foot and in each splice or termination/connectorization location, and submission of and acceptance of all test documentation.
4. Final 10% of the contract unit price upon Final System Acceptance

Fiber optic splices, fusion, will be paid per each as follows:

1. 60% of the contract unit price upon completion of the splice.
2. Additional 30% of the contract unit price for satisfactory completion of Stand Alone Site Test and documenting of all fibers in any lineal foot and in each splice or termination/connectorization location, and submission of and acceptance of all test documentation.
3. Final 10% of the contract unit price upon Final System Acceptance.

Fiber optic testing will be paid at the lump sum price upon completion of testing as approved by the Engineer.

6 WIRELESS ETHERNET RADIO COMMUNICATIONS

6.1 Description

This section specifies the minimum requirements for the wireless ethernet radio communications to be furnished and installed. The radio will provide one end of the wireless communications link for locations as shown on the Plans. The work includes complete Federal Communications Commission (FCC) licensing services, where required, and all documentation necessary to operate and maintain the equipment. The wireless system shall operate in the FCC unlicensed (license-exempt) ISM band of 2.4 GHz or 5 GHz. The wireless devices shall be FCC certified. The FCC identification number shall be displayed on an external label and all system devices shall operate within their FCC frequency allocation. The radio link shall transmit data and multicast video across the link with minimal latency in the data transmitted across the link.

The radio equipment in this contract includes the following type:

1. Radio & Antenna (Type A): This is a CFR47 Part 15 License Exempt Point-to-Point (PTP) Wireless Ethernet Link that is used to support video and data communications.

2. Radio & Antenna (Type B): This is a CFR47 Part 15 License Exempt Point-to-Multipoint (PMP) Wireless Ethernet Link that is used to support video and data communications.

6.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

The Contractor is responsible for the propagation study and assessment of the wireless link prior to submitting the product and desired frequency following the International Telecommunication Union (ITU) recommendation ITU-R P.530-17. The Contractor shall perform this study with industry approved test equipment and submit the study to the Engineer for review and approval. Propagation study shall confirm a wireless link path availability of 99.99% for each wireless link.

6.2.1 Point-to-Point and Point-to-Multipoint Wireless Ethernet Radio and Antenna

1. The radio shall directly interface with the field 10/100/1000 Ethernet Gigabit port at the radio field sites indicated on the Plans. Software to remotely control the radios will be provided and included in the price of the radios. No additional payment will be made for licensing (where required as indicated on the Plans), configuration and troubleshooting software.

2. The radios shall be a truly Time Division Duplex (TDD) or Frequency Division Duplexing (FDD) point to point microwave system that delivers the Full Duplex data rate link at a bandwidth and distance specified for each link as shown on the Plans. The link shall supply very low latency of less than 250µsec over long distances.

3. Security

    a. Tiered security layering
    b. Use of AES 256-bit Encryption
    c. Federal Information Processing Standard Publication 197 (FIPS 197) for symmetric encryption
    d. Other Security functions are preferred HTTPS, SNMPv3, SFTP
    e. Security Log

4. Network Features:

    a. Bridging-Q in Q IEEE 802.1ad
    b. Layer 1 Link Bonding IEEE 802.1AX
    c. Syslog
    d. SyncE or IEEE1588 Timing
    e. IPv6
    f. NPTV3 and V4

5. Network QoS:

    a. Packet Classification
    b. Scheduling
    c. MTU sizes >9200Bytes
    d. Y.1731 Ethernet OAM
    e. Y.1731 Ethernet Bandwidth Notification (ETH-BN)
    f. WRED

6. The radio shall adhere to the 802.1Q Management VLAN with Transparent, Access and Trunk mode.

7. Wired Ethernet Interface

    a. 2 ports (minimum)
        a. 1 Port RJ-45 - Electric Multi-Rate 1/2.5/10 Gbps traffic interface/PoE
        b. 1 Out of band management port
    b. Industrial Weatherproof Ethernet Connector
    c. Category 6 Industrial outdoor rated cable

8. Channel Size of 5 MHz-40 MHz, Based on the regulations defined in CFR47 Part15

9. Management

    a. Telnet
    b. SSH
    c. SNMPv3
    d. SSL
    e. Web GUI

10. Wireless Modulation shall utilize BPSK, up to 256 QAM , with support for Enhanced MIMO techniques where applicable.

11. Radio Transmit Power

    a. Up to 28 dBm

12. Antenna Configurations

    a. Wireless Ethernet Radio shall be capable of direct mounting to an external antenna up to 6FT in size. Integrated high-gain antennas are acceptable for Point-to-Point radios.

13. Electrical

    a. <30 Watts typical
    b. POE power injector with PoE Surge Arrestor and power cords to allow the radio to be powered from a minimum 24-volt power supply. Provide any required PoE or PoE+ devices that are 802.3af or 802.3at compliant, meeting the power requirements of the radio equipment.

14. Environmental

    a. Hardened
    b. Operating Temperature: -40°C to 60°C
    c. Operating Humidity: 0% to 100% relative humidity, non- condensing
    d. 125 MPH wind loading
    e. Meet or exceed IP67 requirements
    f. Mean Time Between Failure shall not be less than 80,000 hours.

6.2.2 Cabling

1. Provide outdoor-rated Category 6 cables for integrated radio/antenna sites.

2. Provide outdoor-rated, shielded Category 6 cabling from the PoE injector to the Wireless Ethernet Radio meeting the following minimum requirements:

    a. Comply with TIA-568-C.2 standard.

    b. Comply with ICEA S-56-434 standard or equivalent industry standard as approved by the Engineer for communications cables for outdoor use including weathertight, outdoor CMX UV-rated, abrasion-resistant jacket.

    c. Provide cable that is UL 444 sunlight resistant listed.

    d. Provide insulated No. 22 to 23 AWG, solid bare copper conductors with polyolefin insulation, arranged in four color-coded shielded twisted-pairs with drain wire incorporating a cross-web separator design.

    e. Provide modular IP67-rated shielded RJ-45 8P8C male push-pull connectors with eight-position non-keyed and eight gold anodized pins or other Ethernet-compatible locking weathertight connector.

6.2.3 Surge Protection

1. Category 6 Ethernet PoE Surge Protection

a. Provide SPD that is listed per UL 497B.

b. Comply with TIA-568-B.

c. Comply with IEEE 802.3af or IEEE 802.3at as required.

d. Support 10Base-T, 100Base-T, and 1000Base-T transmission speeds.

e. Provide a peak surge current rating (Imax) of a minimum of 10 kA (8/20 µs waveform).

f. Provide a clamping voltage of up to 90V ±20% for L-G and 20V ±20% for L-L

g. Provide surge protection for all connector pins.

h. Provide input and output connections with shielded RJ-45 connectors.

i. Provide an in-line, series-connected configuration.

j. Provide system capable of being either wall/panel or DIN-rail mounted.

k. Provide an SPD that is constructed of aluminum metal housing.

l. Provide hardware and materials to bond SPDs to the field cabinet ground bus bar.

6.2.4 Grounding

The contractor shall install a grounding system for the Wireless Ethernet Radio. The grounding system shall be designed to meet the following:

1. Provide a complete Wireless Ethernet Radio grounding and bonding system.
2. The grounding and bonding system materials and installation given in this SP are a minimum. Design and shall be installed to provide a maximum ground impedance of 5 ohms for the Wireless Ethernet Radio.

6.3 Installation Requirements

1. Before submitting shop drawings for poles or Wireless Ethernet Radio units and Antennas, the Contractor shall verify all wireless links for proper frequency, height and line of sight, based on the plan design, specifications, and accepted propagation study. Should the Contractor encounter interference in the path, or immoveable objects that interfere with the wireless path, the Contractor shall prepare and submit a solution for review and acceptance by the Engineer.

2. The Contractor shall furnish, install, configure, and integrate Wireless Ethernet Radio units between sites shown on the Plans. Antenna alignment shall be performed in accordance with the manufacturer's installation requirements. Testing of the link and attached Ethernet switches shall occur prior to the cut over of all existing devices to the radio link.

3. The Contractor shall furnish and install all supports, clamps, cables, connections and other materials to secure the Wireless Ethernet Radio and Antenna at the selected locations for a complete installation. All cables shall be permanently labeled at all access points. Each cable shall have a unique identifier. Label identification with unique identifier shall be stamped or

engraved on metal tags, or neatly and legibly lettered with permanent ink on nylon tags. Cables shall be labeled immediately upon installation.

4. The type of mounting poles to be supplied and the location of their installation shall be as depicted on the Plans unless otherwise approved by the Engineer.

5. If a steel or concrete monopole is used as the mounting pole, any cabling run between the top of the pole and base of pole or cabinet conduit shall be run within conduit inside the pole to avoid conflicts with lowering device equipment, where present.

6. Contractor shall obtain permission from TDOT Regional TMC IT in advance of any work being performed to access existing sites that call for new Wireless Ethernet Radio equipment on the Plans.

7. If any network or existing device downtime is anticipated due to the installation of or switchover to the wireless network, the Contractor shall coordinate the downtime at least 2 weeks in advance of the planned outage with TDOT Regional TMC IT.

8. The Contractor shall coordinate with the TDOT Network Administrator representative for all necessary configuration of the radio link. The radio link shall be configured to operate in the current network configuration and shall allow all new and existing video and data to transmit across the link with no degradation. After coordinating with the TDOT Network Administrator representative, the Contractor shall submit the network configuration to the TDOT Network Administrator representative and Engineer for approval.

9. Contractor shall connect the Wireless Ethernet Radio to the L2 or L3 ethernet switch in the equipment cabinet via a Category 6 cable.

10. Contractor shall connect the Wireless Ethernet Radio and/or PoE injector to the cabinet UPS to maintain continuous, conditioned power to the radio and antenna.

6.4 Testing Requirements

6.4.1 General Requirements

1. The Contractor shall conduct a project testing program for Wireless Communications equipment as required in Section 2.5 of this SP725.

2. All test results shall confirm physical and performance compliance with this SP725.

3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.

4. Payment for all testing is included in the cost of the Wireless Ethernet Radio Communications.

5. The Contractor shall provide all equipment, such as but not limited to volt/ohm meters and laptop, to test installed systems at their own expense.

6.4.2 Factory Acceptance Test

FAT is not required for Wireless Communications.

6.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the Radio and Antenna has no internal or external damage.

2. Test all Wireless Ethernet Radio functionality using manufacturer software.

6.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. BTS of Wireless Ethernet Radio Communications equipment will be performed in conjunction with other components in this SP725 that are reliant upon the Wireless Ethernet Radio equipment for communications. The test shall include demonstration of manufacturer's link speed and number of simultaneous links without signal degradation.

6.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify FCC approval and licensure has been obtained for the site link, where required as indicated on the Plans.

2. Verify all components have been installed per manufacturer requirements and this SP725.

3. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to any applicable structures.

4. Verify the Wireless Ethernet Radio equipment has no internal or external damage.

5. Verify that security bolts are in place and properly fastened to covers.

6. Verify the antenna is properly aligned with the target antenna with direct line of sight.

7. Verify the Wireless Ethernet Radio equipment has been properly connected to the UPS for continuous, conditioned power.

8. Verify all links' receive signal strength and bit error rate reflect the designed values from the RF engineering study.

9. Demonstrate that the manufacturer's link speed and number of simultaneous links is achieved without signal degradation.

10. Verify all grounding, lightning protection, and surge projection systems are in place and properly installed.

11. A ground resistance test shall be performed at each Wireless Ethernet Radio site. Ground resistance tests shall be conducted using a 3- or 4-Point Fall-of-Potential method defined by IEEE Standard #81 or other industry approved test method. Each grounding electrode shall be tested prior to connection to the ground system. Resistance-to-Ground of the ground system shall not exceed 5 ohms. Ground resistance measurements shall be conducted in normally dry conditions not less than 48 hours after the latest rainfall. All ground resistance tests shall be conducted in the

presence of the Engineer. The Contractor shall document all test recordings and provide a copy of all test reports to the Engineer upon completion in accordance with the Project Submittal Program Requirements in Section 2.7.

6.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

6.6 Method of Measurement

Wireless Communication will be measured in units of each and paid for at the contract price per each, but shall act as one seamless pair of point to point radios. The prices bid shall include furnishing, installing, and testing of the unit and shall include the radio transceiver/ modem unit, mounting hardware, RF coaxial cables, ethernet cables, power cables, connectors, power control unit, surge suppressors, antenna with mounting accessories, SWR/wattmeter test equipment and all work, equipment and appurtenances as required to provide a fully functioning radio and antenna. The price bid shall also include all configuration and system software and documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the unit. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

6.6.1 Radio and Antenna (Type A)

Radio & Antenna (Type A) will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All radio transceiver/ modem unit, mounting hardware, RF coaxial or Ethernet cables and connectors, power control unit or power injectors, surge suppressors, antenna with mounting accessories, configuration, system software, and testing or other equipment, labor or materials required to integrate the wireless radio and antenna will be considered incidental and not be paid for separately. The contract price shall also include all documentation including as-built drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the unit.

6.6.2 Radio and Antenna (Type B)

Radio & Antenna (Type B) will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All radio transceiver/ modem unit, mounting hardware, RF coaxial or Ethernet cables and connectors, power control unit or power injectors, surge suppressors, antenna with mounting accessories, configuration, system software, and testing or other equipment, labor or materials required to integrate the wireless radio and antenna will be considered incidental and not be paid for separately. The contract price shall also include all documentation including as-built drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the unit.

6.6.3 Radio and Antenna (Description)

Radio & Antenna (Description) will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All radio transceiver/ modem unit, mounting hardware, RF coaxial or Ethernet cables and connectors, power control unit or power injectors, surge suppressors, antenna with mounting accessories, configuration, system software, and testing or other equipment, labor

or materials required to integrate the wireless radio and antenna will be considered incidental and not be paid for separately. The contract price shall also include all documentation including as-built drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the unit.

6.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-20.81	RADIO AND ANTENNA (TYPE A)	EA
725-20.82	RADIO AND ANTENNA (TYPE B)	EA
725-20.84	RADIO AND ANTENNA (DESCRIPTION)	EA

Wireless Communication will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System, and Pre-installation test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

7 ELECTRICAL EQUIPMENT

7.1 Description

This section describes the minimum requirements for the electrical systems to be furnished and installed on this project. The work required includes all materials, labor, coordination, auxiliaries, and incidentals necessary to furnish, install, and test a complete electrical system as indicated on drawings and as specified in this section. The electrical systems will provide power to the ITS devices installed as part of this project including but not limited to communications hubs and field cabinets.

7.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

7.2.1 Electrical Cable

1. Electrical cable shall be stranded copper wire with XHHW (XLPE (cross-linked polyethylene) high heat-resistant, water-resistant) insulation, rated at 600V.

7.2.2 Demarcation Site (Overhead Power) for Electrical Service

1. Demarcation sites for overhead power service installations shall include a service power meter base, fusible disconnect switch with fuse(s) and/or power distribution breaker panel (Mini Load Center) and enclosure, wood pole, weather head, SPD, wire, conduit and appurtenances, wire splices, and all labor materials associated with the installation of these devices except as approved by the Engineer. Where multiple power circuits are originating from the same demarcation point, the demarcation point shall include all equipment needed for all circuits.
2. All demarcation site conduit shall be Rigid Galvanized Steel (RGS).
3. Conduit for the pole mounted electrical service pertains to the RGS riser assembly and any underground conduit connected to the riser and extending to the nearby pull box.

7.2.3 Demarcation Site (Underground Power) for Electrical Service

1. Demarcation sites for underground power service installations shall include a service power meter base, fusible disconnect switch with fuse(s) and/or power distribution breaker panel (Mini Load Center) and enclosure, Unistrut rack, incidental concrete paving, SPD, wire, conduit and appurtenances, wire splices, and all labor materials associated with the installation of these devices except as approved by the Engineer. Where multiple power circuits are originating from the same demarcation point, the demarcation point shall include all equipment needed for all circuits.
2. All demarcation site conduit shall be Rigid Galvanized Steel (RGS).
3. Conduit for the rack mounted electrical service pertains to the RGS riser assembly and any underground conduit connected to the riser and extending to the nearby pull box.

7.2.4 Transformers (Types A and B)

1. Provide transformer (Type A) – 10kVA step up or step down transformers as indicated on the Plans.
2. Provide transformer (Type B) – 5kVA step up or step down transformers as indicated on the Plans.
3. Each of the transformer Types shall conform to the following requirements:
    a. UL listing.
    b. Operate at 60 Hz.
    c. Built in accordance with ANSI short term overload capability.
    d. Meet or exceed NEMA ST-20 sound levels (37dB for 0-9KVA; 42dB for 10-30KVA).
    e. Tested in accordance with NEMA, ANSI, and IEEE Standards.
    f. Dry Type Transformers: ANSI/NEMA ST 20: factory-assembled, non-vented, dry type transformers; ratings as shown on the Plans.
    g. Voltage rating for transformers shall be as indicated on the Plans.
    h. The average temperature rise shall be 115°C.
    i. Shall comply with NEC standards for transformers and disconnects.
    j. Basic Impulse Level (BIL): 10 KV for transformers less than 300kVA.
    k. Coil Conductors shall be continuous copper windings with terminations brazed or welded.
    l. Enclosure: Non-Ventilated, NEMA 3R enclosure standard. Suitable for outdoors. Provide lifting lugs or brackets.
    m. Isolate core and coil from enclosure using vibration-absorbing mounts.
    n. Nameplate: Include transformer connection data and rating.
    o. Include lug kits which are compatible with the type and amperage of the windings.
    p. All cores to be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point.
    q. Terminations shall consist of wire leads with minimum insulation rating of 125ºC.
4. Pad Mounted Transformers shall conform to the following requirements:
    a. Include transformers capable of being pad mounted.
    b. Include a concrete pad for pad mounted transformers as indicated on the Plans.
    c. Pad shall be installed to allow safe working clearances per NEC or NESC and avoid obstructing access doors to any equipment.
5. Rack Mounted Transformers shall conform to the following requirements:

a. Include transformers mounted on a channel steel frame as indicated on the Plans.

b. Include a concrete pad as an extension of proposed cabinet foundation or stand alone as indicated on the Plans.

c. Include a galvanized steel stand constructed of 3" channel with welded construction.

d. Legs shall be bolted to or buried into concrete pad to depths indicated on the Plans.

e. Include knee bracing as required to prevent excess stand movement.

f. Stand shall be installed to allow safe working clearances per NEC or NESC and avoid obstructing access doors to any equipment.

g. Bond equipment grounding conductor to the steel frame.

7.2.5 Equipment Cabinet Uninterruptible Power Supply

The Uninterruptible Power Supply (UPS) shall be line interactive or on-line (double conversion) type with 120VAC single phase input and output. All components shall be UL 1778 listed. The UPS shall be designed to meet the following:

1. The UPS system must be sized to provide:
    a. 1 hour of run time for total load (minimum 200W) supported in cabinets with a Layer 2 Switch
    b. 2 hours of run time for total load (minimum 200W) supported in cabinets with a Layer 3 Switch
2. Loads supported include all devices controlled and energized from the equipment power terminal block in each ITS cabinet. The exception to this is a DMS housing, which shall not be connected to and supported by the UPS.
3. The UPS assembly including batteries must be compliant with the environmental testing specified in NEMA TS2, Sections 2.2.7, 2.2.8 and 2.2.9 and provide continuous power with specified wattage and operate per the requirements specified during and after subjected to the aforementioned environmental testing.
4. The UPS assembly shall support remote environmental sensing hardware and software integrated with SNMP, capable of monitoring temperature.
5. The unit and supplemental battery packs (if required) shall include mounting hardware for a 19" equipment rack.
6. 8 output receptacles, type NEMA5-15R.
7. The UPS and associated assembly, including batteries shall have an operating temperature range of -20°C to +55°C.
8. The UPS and associated assembly, including batteries shall have an operating relative humidity rating of 0 – 95%, noncondensing.
9. The UPS shall automatically return to utility power after an event.
10. The UPS shall include SNMP manageable hardware and software with 10Base-T connection (RJ-45).

11. The Contractor shall provide the cabinet vendor with a list of all the loads to be powered at each ITS cabinet.
12. The vendor shall provide for submittal approval, cabinet internal wiring, and load calculations, as well as cabinet layout showing the UPS unit physically sized adequately to fit within the cabinet spaces available.
13. All calculations and layouts, wiring, and overcurrent protection shall meet NEC.
14. Should there be any changes in the configuration of each cabinet, it shall be the responsibility of the Contractor to advise the cabinet vendor for any adjustments required to the sizes of the cabinets or the UPS as required to meet any new load demands.

7.2.6 Surge Protective Device (SPD)

1. All SPD shall be UL listed and bear the UL label.
2. All metal oxide varistors used for surge protection shall be rated in the appropriate voltages.
3. Surge suppressors operating temperature shall be between -40°C to +75°C.
4. Power Carrying Conductors shall conform to the following requirements:
    a. The SPD shall be installed on the load side of the main circuit breaker with leads as short and straight as possible. This shall be required for all voltage levels.
    b. The SPD shall have a clamping voltage response time of less than 5 nanoseconds.
    c. The SPD shall have a Voltage Protection Rating (VPR) of 700V or less for L-N, L-G, & N-G for 120V, 120/240V, 208Y/120V systems. The SPD shall have a Voltage Protection Rating (VPR) of 1200V or less for L-N, L-G, & N-G for 240/480V and 480Y/277V systems.
    d. The SPD shall have a Maximum Continuous Operating Voltage (MCOV) of 150V for 120, 120/240V, 208Y/120V systems. The SPD shall have a Maximum Continuous Operating Voltage (MCOV) of 320V for 240/480V and 480Y/277V systems.
    e. The SPD peak surge current shall be equipped with a minimum surge current rating of 70kA per phase.
    f. The SPD shall have Nominal Discharge Current Rating (I_n) of 20kA.
    g. The SPD shall be UL1449 listed.
    h. The SPD shall be located adjacent to the electrical power service and distribution panel.
    i. The SPD shall have a visual indicator of loss protection.
    j. The SPD shall include 1 set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

7.2.7 Power Distribution Breaker Panel

1. Power distribution breaker panels shall be rated as indicated on the Plans, 12 space maximum, 4 space minimum, and Main Circuit Breaker (MCB) panels. Shall be in a NEMA 3R enclosure for use in outdoor locations. Ampere rating of each power distribution breaker panel shall be as indicated on the Plans.

2. Panels shall be bottom fed and capable of being surface mounted inside a cabinet.
3. Power distribution breaker panel schedules shall be filled in with descriptions of each circuit in accordance with Article 110-22 of the National Electric Code and placed in a protective sleeve mounted securely inside the panel door.
4. Molded Case, bolt-on thermal magnetic trip circuit breakers, with common trip handle for all poles shall be provided factory installed in accordance with the power distribution breaker panel schedules on the Plans.

7.2.8 Disconnect Switches

1. Provide fused and non-fused disconnect switches, ampere rating, voltage rating, number of poles, and fuse size as indicated on the Plans.
2. Disconnect switches shall be in a NEMA 3R enclosure for use in outdoor locations and able to be locked in both the on and off positions.

7.2.9 Labeling

1. Provide labels for all electrical service equipment including Transformers, Power Distribution Panels, Disconnect Switches and device cabinets identifying the equipment being served and, when required, its function.
2. Labels shall be 4" x 6" (minimum) unless specified otherwise, self-adhesive, water and chemical resistant, flexible vinyl, outdoor rated, protected from UV radiation, moisture, oxidation, and other pollutants.
3. If any equipment is rated 240/480V, provide a 5” x 7” (minimum) label indicating “Danger 240/480V” on relevant equipment including disconnects and transformers.
4. Each panel board shall have a laminated, typed circuit schedule permanently mounted inside the panel board. The circuit schedule shall list which loads are controlled by each circuit breaker.

7.3 Installation Requirements

7.3.1 Electrical Cable

Contractor shall abide by the following installation requirements:

1. Conductors of the type, size, and specification shall be installed at the location shown on the Plans or as directed by Engineer.
2. Conductors in conduits shall be carefully pulled into place using methods in conformance with standard industry practice and the cable manufacturer’s recommendations.
3. When wire or cable is brought up into the base of a foundation, sufficient slack shall be left to enable the connections to be made outside the foundation.
4. Powdered soapstone, talc, or other approved inert, non-oily cable lubricant shall be used in placing conductors in conduit.
5. Conductors shall be handled and installed in such a manner as to prevent kinks, bends, or other distortion, which could cause damage to the conductor or outer covering.

6. All wires and cables within a single conduit shall be pulled at the same time. When cables are pulled through hand holes, in pole shafts, etc., a pad of firm rubber or other suitable material shall be placed between the cable and the edges of the opening to prevent cable damage.
7. Cable, entrances into panels, transformers, cabinets, and conduit outlets shall be sealed from moisture, insects, rodents, and foreign material with a sealing compound manufactured for this application.
8. Splices and taps for circuits rated below 600V shall be performed in accordance with the National Electrical Code and materials shall be used that will be compatible with the sheath and insulation of the cable and suitable for direct burial.
9. Straight splices shall be made with tubular copper compression type connectors, or bronze or copper split bolt connectors.
10. Tap splices shall be made with parallel tubular copper compression type connectors or parallel groove bolted connectors.
11. Compression connectors shall be crimped with the connector manufacturer's recommended compression tool and die.
12. The compression tool shall be of the type which will prevent removal of the tool until the crimp has been completely closed.
13. After a conductor splice is made, it shall be insulated with a rubber insulating tape and then covered with material suitable for direct burial.
14. The tape shall be applied half-lap with a minimum of 2 full laps of each tape to a point approximately 3” from the conductor splice.
15. All sharp points and edges of the connector shall be padded, and all voids filled with insulating putty.
16. The tape shall not be stretched in such a manner as to cause creeping. All spliced joints shall be watertight.
17. Splices and taps for circuits rated above 600V shall be made using a splice kit as supplied by the cable manufacturer suitable for direct burial and splices shall be made in accordance with manufacturer instructions and recommendations for the particular cable and voltage level.
18. Splices shall be completed the same day started and shall not be done during damp or inclement weather.
19. Medium and high voltage cables exposed at equipment terminations shall be provided with a suitable insulating sleeve from over the cable insulation to terminal points of the equipment.
20. Special attention shall be given to the shielded cable to maintain the continuity of the metallic shielding tape and to the proper termination and grounding of the shield at each splice of the cable run and at each end.
21. Cable warning tape shall be installed in all conduit trenches as specified.
22. Junction boxes containing conductors of different voltages shall be permanently labeled to identify voltage and disconnecting location. Conductors shall be color coded to identify voltage.

7.3.2 Grounding Wire

Contractor shall abide by the following installation requirements:

1. Grounding splices shall not be insulated.
2. The grounding conductor shall be continuous and shall be connected to the ground system at all supporting poles and structures, to each transformer, to each sign support assembly, to each gate, and to each grounding conductor in a multi-conductor cable assembly. Additional grounding rod electrodes shall be installed to obtain a maximum value of 10 ohms to ground.
3. Single ground rods shall be driven vertically until the top of the rod is at least 12" below the finished ground.
4. A length of #6 base copper, seven-stranded wire shall be attached to the ground rod with suitable ground rod clamps and connected to the grounding system.
5. Bolted grounding connections of solder-less type made of the high strength electrical bronze with silicon bronze clamping bolts and hardware may be used; designed such that, bolts, nuts, lock washers and similar hardware which might nick or otherwise damage the ground wire will not directly contact the ground wire.
6. Non-dielectric circuit(s) going into and leaving communication equipment cabinet(s) shall be equipped with TDOT-approved Surge Protective Device (SPD) system.
7. Exothermic welded ground connections shall be used where specified on the Plans.

7.3.3 Electrical Connection

Electrical power service, from the power service provider, shall be provided at the Demarcation Points as indicated on the Plans. The Contractor shall be responsible for all coordination with the power service provider as well as all materials, labor, or any other means to install electrical service to the field cabinets as indicated on the Plans.

7.3.4 Demarcation Site for Electrical Service

Contractor shall abide by the following installation requirements:

1. The installation of all electrical devices including wire sizing, conduit sizing, electrical conductor splicing in pull boxes, transformers, and grounding/bonding shall be as shown on the Plans and in accordance with the National Electrical Code (NEC) and National Electrical Safety Code (NESC).
2. See Plans for identification of electrical utility companies involved on this project.
3. Contractor is responsible for contacting each electrical utility company for service feed information. Each utility company may vary in its procedure for obtaining and providing electrical service.
4. It is the Contractor’s responsibility to coordinate with each electrical utility well ahead of the desired (scheduled) date for electrical service, so that proper procedures can be followed for each electrical utility provider.
5. The address for each electrical demarcation point is shown on the Plans.

6. The Contractor shall get all finished electrical demarcation points inspected by the appropriate authority, as determined by each electrical utility provider, prior to asking for required activation from the electrical utility.
7. The Contractor shall coordinate with the electrical utility to ensure conformance with interface requirements for point of attachment and metering.
8. The Contractor shall not order service activation more than 60 calendar days before anticipated installation of the ITS equipment cabinet to be served, so as not to incur unwarranted service costs.
9. Electrical service may not be connected to a cabinet or other device until all required grounding installation is complete.
10. If the site is an Overhead installation, the wood pole for demarcation equipment shall be embedded a minimum of 5' into the ground and in accordance with the power service utility's requirements.

7.3.5 Transformer (Types A and B)

Contractor shall abide by the following installation requirements:

1. Set transformer plumb and level on concrete pads. The pad is to extend a minimum of 6" from the edge of all sides of the transformer.
2. All transformers shall be installed to form a complete installation ready for operation.
3. Check for damage and tight connections prior to energizing transformer.
4. Measure primary and secondary voltages and make appropriate tap adjustments with transformer 100% design load.
5. After installation is completed, the transformer shall be tested prior to acceptance as defined in the Testing Subsection of this SP725 Section.

7.3.6 Equipment Cabinet Uninterruptible Power Supply

Contractor shall abide by the following installation requirements:

1. Install in equipment rack the location designated on the Plans.
2. Ensure area around vents are free of obstructions.
3. All UPS and supplemental battery packs (if required) shall be mounted adjacent within the equipment rack.
4. Connect UPS input directly to the cabinet equipment receptacle. Extension cords or power strips are not acceptable.
5. Connect all battery packs and allow UPS to charge completely prior to connecting loads.
6. All load connections shall be clearly identified with printed labels, and cables neatly routed within the cabinet.

7.3.7 Surge Protective Device (SPD)

Contractor shall abide by the following installation requirements:

1. The Contractor shall provide SPD on all electrical service points at the load side of distribution panels.
2. The Contractor shall install SPD as follows:
    a. The placement of equipment and wiring within an outside enclosure shall be arranged so that the surge suppressors are located near the conductor's point of entry.
    b. Surge suppressors shall be located as close as possible to the electrical panel board.
    c. SPD shall be mounted on the underside of riser and ground-mounted demarcation point breaker panel enclosures.
    d. The surge suppressor grounding conductor shall be free from sharp bends.

7.3.8 Power Distribution Breaker Panel

1. Contractor shall install power distribution breaker panels on the hub, cabinets, and equipment support racks as indicated on the Plans.
2. All breakers shall be clearly labeled with printed schedules.

7.3.9 Disconnect Switch

1. Contractor shall fuse and secure disconnect switches installed at the demarcation to the demarcation pole or equipment support rack at the locations indicated on the Plans.
2. Disconnect switches installed at transformer locations shall be fused and secured to the primary side of the transformer.

7.4 Testing Requirements

7.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.
3. Testing shall be performed in accordance with TDOT Standard Specifications Section 714.
4. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
5. Payment for all testing is included in the cost of the Electrical Equipment.

7.4.2 Factory Acceptance Test

FAT is not required for Electrical Equipment.

7.4.3 Bench Test Component

BTC is not required for Electrical Equipment.

7.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. BTS of Electrical Equipment will be performed in conjunction with other components in this SP725 that are reliant upon the Electrical Equipment.

7.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to any applicable structures.
3. Verify the Electrical Equipment has no internal or external damage.
4. Verify that grounding has been installed as required and installation follows NEC and other applicable codes/standards.
5. Test and document transformer voltage, current, and insulation resistance.
6. Test and document the duration for which the UPS can run all connected equipment at the site autonomously by disconnecting the site from grid power. The test shall be performed from 100% battery charge to 5% battery charge. At 5% battery charge remaining, the site shall be reconnected to grid power. Include the average load over the course of the test in the documentation.

7.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

7.6 Method of Measurement

7.6.1 Electrical Cable (1/C #14 AWG - #4/0 AWG)

The Electrical Cable will be measured in units of linear feet per cable installed and paid for at the contract price per linear feet of each cable. The bid price shall include furnishing, installing, configuring, and testing of the electrical power cable including all required splices and other ancillary items required for complete installation of the cable. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.6.2 Electrical Connection

Electrical Connections shall be paid for on a lump sum basis wherein no measurement will be made. Electrical Connections shall cover the Contractor's time and costs for coordinating with the utility companies as described in these SP725. This price shall include any charges from the utilities for installation charges associated with providing power to the demarcation points which may include overhead primary or secondary conductors, overhead transformer, pad mount transformer, and utility poles (excluding demarcation site).

7.6.3 Demarcation Site (Overhead Power)

Demarcation Site (Overhead Power) shall be measured in units of each and shall include the power service meter base, power distribution breaker panel or mini load center, wood pole, SPD, all RGS conduit risers and weather head, conduit from nearest pull box to the pole, connection hardware, grounding, wiring, and all related appurtenances as necessary to provide power service to each site. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.6.4 Demarcation Site (Underground Power)

Demarcation Site (Underground) shall be measured in units of each and shall include the power service meter base, fusible disconnect switch, power distribution breaker panel, Unistrut rack, incidental concrete paving, SPD, mounting brackets, concrete poles, RGS conduit from nearest pull box to the demarcation point, connection hardware, grounding, wiring, and all related appurtenances as necessary to provide power service to each site. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.6.5 Transformer (Types A and B)

The transformer will be measured in units of each and paid for at the contract price per each. The bid price shall include but not be limited to furnishing and installing of the transformer, mounting brackets, transformer disconnect switch, SPD, incidental connecting wire and conduit to an adjacent equipment cabinet, equipment support rack, conduit riser or ground-mounted brackets and all work, equipment, and appurtenances as required effecting the full operation of the transformer. The bid price shall also include all documentation including configuration drawings, equipment interconnect diagrams, full operation documentation, block diagrams, and other material necessary to document the installation of the cabinet transformer and testing according to this SP725 detailed herein, on the Plans and/or in the contract document. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

7.6.6 Uninterruptible Power Supply

Equipment Cabinet Uninterruptible Power Supply (UPS) shall be measured in units of each and shall include furnishing, installing, configuring, and testing for an operational battery backup system that meets the requirements within this SP725. The bid price shall also include electronic user documentation for all management, configuration and operation hardware and firmware settings, installation procedures, and the MIB. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.6.7 Surge Protective Device (SPD)

The SPD is included in the quantities of other pay items and will not be measured separately for payment.

7.6.8 Power Distribution Breaker Panel

The Power Distribution Breaker Panel is included in the quantities of "Demarcation Point Riser Assembly" and will not be measured separately for payment.

7.6.9 Disconnect Switch

Fused disconnect switch shall be included in the quantities of other pay items and shall include connection hardware, grounding, wiring, and all related appurtenances as necessary to provide a

disconnecting means to equipment and is inclusive of coordination efforts for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-20.51	CABLE (1/C #14 AWG.)	LF
725-20.52	CABLE (1/C #12 AWG.)	LF
725-20.53	CABLE (1/C #10 AWG.)	LF
725-20.54	CABLE (1/C #8 AWG.)	LF
725-20.55	CABLE (1/C #6 AWG)	LF
725-20.56	CABLE (1/C #4 AWG)	LF
725-20.57	CABLE (1/C #2 AWG)	LF
725-20.58	CABLE (1/C #1/0 AWG)	LF
725-20.59	CABLE (1/C #2/0 AWG)	LF
725-20.60	CABLE (1/C #3/0 AWG)	LF
725-20.61	CABLE (1/C #4/0 AWG)	LF
725-20.71	ELECTRICAL CONNECTION	LS
725-21.43	DEMARCATION SITE (OVERHEAD POWER)	EA
725-21.44	DEMARCATION SITE (UNDERGROUND POWER)	EA
725-21.71	TRANSFORMER TYPE A (10KVA)	EA
725-21.72	TRANSFORMER TYPE B (5KVA)	EA
725-21.85	UNINTERRUPTIBLE POWER SUPPLY	EA

All 725 Electrical Equipment items listed will be paid per each as follows:

1. Stored materials will be paid per TDOT Standard Specifications.
2. Final Payment will be made after complete installation and satisfactory completion of Stand Alone Site Test of all items for which it is specified.

8 EQUIPMENT CABINETS

8.1 Description

This section specifies the minimum requirements for equipment cabinets furnished and installed on this project as shown on the Plans. The cabinet will provide a protective outdoor housing enclosure in which to install field hardware required for ITS devices to communicate with the TDOT Regional TMC. Major elements of the equipment cabinet include the cabinet housing and equipment mounting hardware, interior wiring and termination facilities, power supplies, electrical accessories, and field installation.

8.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

8.2.1 General

1. Furnish only new equipment and materials.
2. Furnish equipment cabinets and integral materials recommended by the manufacturers for outside plant use and the intended application. This requirement includes wiring, electrical materials and configurations (including connector pinouts) that are wholly or partially related to the field device applications (CCTV, RDS, DMS, ESS, RSU, OVDS, WIM, HAR, Wireless Ethernet Radio and Antenna, etc.).
3. Furnish and configure equipment cabinets to be installed at locations as shown on the Plans. Furnish and configure all equipment and materials for each specific location as shown on the Plans.
4. Provide electrical system and components with UL-listings for the appropriate application.
5. Unless otherwise specified, provide wire and cable with stranded copper conductors, 75°/90°C wet/dry rated insulation, and sized for the maximum voltage and current in the circuit.
6. All components specified as rail-mounted shall be compliant as follows:
    a. DIN EN 50022 (NS35) component rails
    b. Component rails shall be the perforated type and of sufficient length as to protrude beyond the mounted components for fastening to cabinet panels as specified herein
    c. UL 1059
    d. UL 486E
    e. NEMA ICS-4
7. Terminal blocks and component terminals shall be nickel-plated copper, copper alloy, or brass.
8. Terminal blocks shall have voltage and current ratings greater than or equal to the ratings of the wires that are terminated and shall be assembled into housing enclosures such that all exposed

surfaces are touch safe. Conductor fastening screws shall be captive. Incoming power service terminals shall be able to terminate wires from #8 AWG to #4/0 AWG wiring. Terminal block housings shall be colored as follows:

a. 120VAC line/hot: black

b. 120VAC neutral: white

c. 24VDC positive: red

d. 24VDC negative: gray

e. RS485 communications: orange

f. Ground: green or green/yellow

9. Provide door locks for all cabinet doors, keyed to TDOT standard Corbin #B4R01365 using #8960 heavy-duty blanks and mastered to #B4R87965. Provide 1 key with each cabinet.

10. Provide sunshields and mounting fasteners on all cabinets (except Type D). Sunshields and fasteners shall meet the following minimum requirements:

    a. Sunshields shall be 0.125" aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.

    b. Cabinets shall be equipped with press-in threaded inserts on the cabinet wall interior surface. Sunshields shall be mounted by fasteners and aluminum or stainless-steel standoffs tightened into the threaded inserts.

    c. Provide a minimum of 4 inserts/fasteners for top face sunshields.

    d. Provide a minimum of 6 inserts/fasteners for any door or side sunshield.

    e. For doors or sides greater than 54" tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27" between any fasteners.

    f. Furnish and install a top face sunshield on all cabinets.

    g. Furnish and install door or side sunshields on all cabinet faces except for pole attachment faces (for pole-mounted cabinets only).

11. Provide agency name, device name, and ID labels on all cabinets. Labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1" in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. The agency name labels shall be "TDOT ITS" in one continuous adhesive sheet.

    d. The device ID labels shall include the device ID(s) and shall be one continuous adhesive sheet. Device ID shall include including region number, device type letter designation, route designation, mile marker, and direction as indicated on the Plans. Examples: "R4A-0I040-XXX.XE", "R4E-0I040-XXX.XE", "R4G-0I040-XXX.XE".

e. Labels shall be installed along the top of the cabinet door (front cabinet door on Type B cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.

12. Provide a voltage label on all cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1" in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are "120VAC" or "24VDC".

    d. Labels shall be installed on all cabinet doors.

8.2.2 Type A Cabinet

Type A shall meet the following requirements:

1. Provide a Type A cabinet intended for outdoor use with a minimum NEMA 3R rating.
2. The cabinet enclosure shall be manufactured from 0.125" aluminum.
3. The cabinet shall provide a minimum of 1 ventilation louver on at least 2 sides. Any louver opening greater than 3/16" in any dimension shall be screened to prevent insect entry.
4. The cabinet shall be intended for strapped pole-mounting; provide all mounting hardware necessary including ½" stainless steel mounting straps.
5. Provide a Type A cabinet enclosure with dimensions of 18" (H) by 14" (W) by 8" (D) with a tolerance of +/- 0.25".
6. Cabinet door shall reveal the entire front opening of the cabinet for accessibility. The hinge shall be designed to prevent the door from sagging.
7. Include a single-piece 0.125" aluminum back panel covering no less than 90% of the cabinet back wall. Back panel shall be affixed to the enclosure with threaded fasteners and shall be removable from the enclosure with hand tools only and without requirement to remove the cabinet door, mounting straps, or any other components other than communications or device wiring.
8. The cabinet shall be furnished with doorstops, which retain the doors open in 90 degree and 120-degree positions.
9. Din Rail mount, main cabinet surge protector for single-phase 120VAC service entrance, UL 1449 Current Edition Listed, parallel wired with a Voltage Protective Rating (VPR) of 700V or less for L-N & N-G, and a nominal discharge current (I_n) of 10kA.
10. Din Rail mount, UL 497B Listed, series connected SPD for each data/Ethernet connection. SPD shall consist of 3 stages of surge suppression.
11. Provide on the back panel a grounding lug capable of terminating #6 AWG wire and directly bonded to the back panel.
12. All Type A cabinets supporting RDS units shall meet the following requirements:

a. Identical in manufacture and assembly regardless of the number of RDS units shown on the Plans at a specific location.

b. Provide a remote RDS communications wiring module, comprised of DIN rail-mounted components, which includes the following:

    i. Component rail physically and electrically fastened to the cabinet back panel.

    ii. Strain relief brackets for the RDS cable(s) and the RDS unit harness cables.

c. Din Rail mount, UL 497B Listed, Parallel or Series-connected surge protector for the 12-24VDC power supply for the RDS units with integral or separate terminals for a minimum of 3 RDS cables and 2 RDS unit harness cables.

d. Local/remote communications disconnect module for the ethernet data signals that includes the following:

    i. Terminal facilities for 1 remote RDS cable connection from the surge protector, bus-connected to 2 separate local/remote disconnect switches, 1 for each RDS unit that simultaneously makes/breaks all the ethernet signal lines for a given RDS unit.

    ii. Separate terminal facilities for each of the RDS unit harness cables on the local side of the local/remote disconnect switch.

    iii. Separate RJ45 connectors for each of the RDS units, bus-connected with the RDS unit harness cable terminals on the local side of the local/remote disconnect switches. Provide protective covers for RJ45 connectors.

    iv. Provision for installing ethernet terminating resistors on the terminals on the remote side of the local/remote disconnect switch. Provide terminating resistors at cabinet locations in accordance with the RDS manufacturer's recommendations.

    v. Alternately, provide 2 separate local/remote communications disconnect modules, 1 per RDS unit, with jumper wiring between the remote side terminals of the 2 modules.

e. Connection/jumper wiring between the surge protectors and the local/remote communications disconnect module(s) shall be of the same conductor size, type, and insulation color as in the RDS cable.

8.2.3 Type B Cabinet

Type B cabinets shall meet the following requirements:

1. All Type B cabinets shall be identical in manufacture and assembly, capable of supporting 2 RDS units, 2 CCTV cameras, 3 ESS units, 1 RSU, 1 Type A network switch, 2 Wireless Ethernet Radios and Antennas, RDS cable, ESS cable, uninterruptible power supply (UPS), and fiber drop panel terminations, regardless of the devices shown on the Plans at a specific location.

2. A complete Type B cabinet shall be an assembly consisting of a cabinet housing, electrical subsystems, and an RDS communications subsystem.

3. Provide a Type B cabinet housing meeting the following requirements:

a. Conforms to the standards for a Type 170 336S (approximate exterior dimensions 46" H x 24" W x 23" D), including standard EIA 19" rack cabinet cage, as defined in the latest version of the Caltrans Transportation Electrical Equipment Specifications (TEES). The minimum clear vertical inside dimension of the 19" rack for equipment mounting shall be 39.5". Standard cabinet accessories for traffic signal operations, such as controller, power distribution assembly, input/output file, and termination panels, and the police panel, are not required as part of this cabinet assembly.

b. Provide a thermostatically controlled 100 CFM fan and louvered air intake in door with a pleated filter.

c. Provide all pole mounting hardware necessary including ¾" stainless steel mounting straps.

d. Includes hooks, welded to the inside of each cabinet door, for hanging a side-opening, re-sealable, opaque, heavy-duty plastic documentation pouch with metal or hard-plastic reinforced holes for the door hooks. Provide 1 pouch with each cabinet.

e. Includes a rack-mounted cabinet sliding storage drawer in accordance with the following:

    i. Approximate exterior dimensions 1.75" H x 16" W x 14" D.

    ii. Telescoping drawer guides to allow full extension from the rack cage.

    iii. Opening storage compartment lid to access storage space for cabinet documentation and other items.

    iv. Supports a weight of 25 lb. when extended.

    v. Non-slip plastic laminate surface attached to the compartment lid which covers a minimum of 90% of the surface area of the lid.

    vi. Mounted in the rack cage with the bottom surface approximately 9" above the bottom of the rack cage.

f. Includes side panels within the 2 sides of the rack cabinet cage, inserted and fastened from the inside of the cage. Use side panels fabricated from 0.125" 5052 sheet aluminum alloy and sized to the full inside dimensions of the rack cabinet cage. Side panel surfaces for equipment mounting are denoted by cabinet side, with the "right" side being the support pole side, and by upper or lower as related to the sliding storage drawer. Upper right-side panel (support pole side of cabinet, above the drawer) and lower left side panel (opposite side from the support pole, below the drawer) are example side panel surface names.

g. Includes a 12" long DIN rail (for future components) mounted in the horizontal and vertical center of the lower left side panel.

4. Provide Type B cabinet electrical subsystems meeting the following requirements:

    a. Includes an electrical distribution module comprised of the following DIN rail-mounted components:

        i. Service entrance terminal block with positions for 120VAC line, neutral, and ground and capable of terminating minimally #8 through #4/0 AWG wire, located at one end of the mounting rail with an approximately 0.75" blank spacer module adjacent to the main cabinet breaker.

ii. Main cabinet overcurrent 15A circuit breaker that is UL-listed and of the thermal-magnetic type rated for use from -18°C to 40°C minimum.

iii. Main cabinet surge protector for single-phase 120VAC service entrance, UL 1449 Current Edition Listed, parallel wired with a Voltage Protective Rating (VPR) of 700V or less for L-N & N-G, and a nominal discharge current (I_n) of 10kA. SPD peak surge current rating shall equal or exceed 10kA per mode. Per phase rating shall equal or exceed 20kA per phase.

iv. Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge protector. The noise filter shall be UL 1283 listed.

v. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors parallel wired to the main cabinet surge protector but non-filtered, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the terminal block as "ACCY POWER."

vi. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the block as "EQUIP POWER."

vii. Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of 2-#2 AWG conductors and 10-#10 to #18 AWG conductors.

viii. Ground fault circuit interrupter duplex receptacle (NEMA 5-15R) with 2.5A circuit breaker connected to the ACCY POWER distribution block. Permanently affixed to the receptacle, provide 2 red, orange, or green/yellow labels with minimum 0.25" lettering with the legend "300 WATTS MAX". This receptacle is for technician use only and shall not be used to power equipment.

ix. Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type B cabinet.

b. Include a cabinet lighting subsystem comprised of the following components:

i. Two LED lighting assemblies, minimum 600 lumens, mounted on the inside top front and top rear portion of the cabinet, with a white color temperature (4000K or higher) with shatter-proof cover.

ii. A resistor-capacitor network noise suppressor installed across the light fixture power terminals.

iii. Two door-actuated switches installed to turn on the cabinet lights when either door is opened.

iv. Powered from the ACCY POWER distribution block.

c. Include 2 duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right-side panel. Provide 2 red, orange or green/yellow labels with minimum 0.25" lettering with the legend "350 WATTS MAX" permanently affixed to the receptacle.

5. Provide a Type B cabinet RDS communications subsystem meeting the following requirements:

    a. Include a remote RDS communications wiring module as specified in Section 8.2.2 item 12, regardless of the number of RDS units shown on the Plans at a specific location.

    b. Include a headend RDS communications wiring module, comprised of DIN rail-mounted components, which includes the following:

        i. Nominal 24VDC output power supply, capable of user setting between 23 and 28VDC minimum, with minimum 1A output rating and minimum operating temperature range of -25°C to +70°C. Power supply shall provide terminal facilities for a minimum of 3 sets of #14 AWG conductors (in the RDS cable). Maximum size of the power supply shall be 1" W X 7" H X 7" D. Connect the power supply to the EQUIP POWER distribution block for 120VAC input.

        ii. UL 497B Listed, series connected surge protector for the RS485 data signal. The surge protector shall protect the 4-wire RS485 data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge protector shall have a response time no greater than 1 nanosecond. The surge protector shall provide terminal facilities for a minimum of 4 two-pair cables of #22 AWG conductors (in the RDS cable or wired to the adjacent remote RDS communications wiring module).

        iii. UL 497B Listed, series connected surge protector for the ethernet data signal. The surge protector shall protect the 8-wire ethernet data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge protector shall have a response time no greater than 1 nanosecond. The surge protector shall provide protection for power over ethernet for both data and power and shall use RJ-45 connectors.

    c. Complete subsystem of remote and head end modules mounted on the same DIN rail located on the bottom half of the cabinet upper right-side panel.

8.2.4 Type C Cabinet

The Type C cabinet shall meet the following requirements:

1. If Type C Cabinet is used for DMS, see Section 11 of this SP725 for additional Requirements.
2. Shall meet the same 19" rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.
3. Shall be ground mounted.
4. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8".
5. All inside and outside edges shall be free of burrs.
6. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.
7. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.
8. All welds shall be made by using the Heliarc welding method.
9. The cabinet should be of sufficient size to hold all the Field Junction support equipment as shown on the Plans.

10. Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8" diameter aluminum.
11. The hinge pins shall be constructed of stainless steel.
12. Shall be furnished with a three-point latching system (top, bottom, center locations).
13. Shall be furnished with a doorstop, which retains the door at 90 degree and 120-degree positions.
14. Shall have thermostatically controlled fan located at the top of the cabinet.
15. Minimum fan rating of 100 CFM.
16. Fan thermostat shall have a user adjustable range from 80ºF to 125ºF.
17. Minimum of 2-½" (length) galvanized anchor bolts shall be used to secure the cabinet to the foundation.
18. Includes hooks, welded to the inside of each cabinet door, for hanging a side-opening, re-sealable, opaque, heavy-duty plastic documentation pouch with metal or hard-plastic reinforced holes for the door hooks. Provide 1 pouch with each cabinet.
19. Includes a rack-mounted cabinet sliding storage drawer in accordance with the following:
    a. Approximate exterior dimensions 1.75" H x 16" W x 14" D.
    b. Telescoping drawer guides to allow full extension from the rack cage.
    c. Opening storage compartment lid to access storage space for cabinet documentation and other items.
    d. Supports a weight of 25 lb. when extended.
    e. Non-slip plastic laminate surface attached to the compartment lid which covers a minimum of 90% of the surface area of the lid.
20. If indicated on the Plans, provide a Type C cabinet RDS communications subsystem meeting the following requirements:
    a. Include a remote RDS communications wiring module as specified in Section 8.2.2 item 12, regardless of the number of RDS units shown on the Plans at a specific location. This may be required even for locations where no RDS units are shown on the Plans at a specific location.
    b. Include a headend RDS communications wiring module, comprised of DIN rail-mounted components, which includes the following:
        i. Nominal 24VDC output power supply, capable of user setting between 23 and 28VDC minimum, with minimum 1A output rating and minimum operating temperature range of -25°C to +70°C. Power supply shall provide terminal facilities for a minimum of 3 sets of #14 AWG conductors (in the RDS cable). Maximum size of the power supply shall be 1"(W) X 7"(H) X 7"(D). Connect the power supply to the EQUIP POWER distribution block for 120VAC input.
        ii. UL 497B Listed, series connected surge protector for the RS485 data signal. The surge protector shall protect the 4-wire RS485 data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge protector shall have a response time no greater than 1 nanosecond. The surge protector shall provide terminal facilities for a minimum of 4 two-pair

cables of #22 AWG conductors (in the RDS cable or wired to the adjacent remote RDS communications wiring module).

iii. UL 497B Listed, series connected surge protector for the ethernet data signal. The surge protector shall protect the 8-wire ethernet data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge protector shall have a response time no greater than 1 nanosecond. The surge protector shall provide protection power over ethernet for both data and power and shall use RJ-45 connectors.

c. Complete subsystem of remote and head end modules mounted on the same DIN rail located on the bottom half of the cabinet upper right-side panel.

21. Provide Type C cabinet electrical subsystems meeting the following requirements:

a. An electrical distribution module comprised of the following DIN rail-mounted components:

i. Service entrance terminal block with positions for 120/240VAC line, neutral, and ground and capable of terminating minimally #8 through #4/0 AWG wire, located at one end of the mounting rail with an approximately 0.75" blank spacer module adjacent to the main cabinet breaker.

ii. Main cabinet automatic overcurrent 30A (minimum) circuit breaker that is UL-listed and of the thermal-magnetic type rated for use from -18°C to 40°C minimum.

iii. Main cabinet surge protector for single-phase 120/240VAC service entrance, UL 1449 Listed, parallel wired with a Voltage Protection Rating (VPR) of 700V or less for L-L, L-N & N-G, and a nominal discharge current (I_n) of 20kA. SPD peak surge current rating shall equal or exceed 50kA per mode. Per phase rating shall equal or exceed 100kA per phase.

iv. Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge protector. The noise filter shall be UL 1283 listed.

v. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors parallel wired to the main cabinet surge protector but non-filtered, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the terminal block as "ACCY POWER."

vi. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the block as "EQUIP POWER."

vii. Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of 2-#6 AWG conductors and 10-#10 to #18 AWG conductors.

viii. Ground fault circuit interrupter duplex receptacle (NEMA 5-15R) connected to the ACCY POWER distribution block. Permanently affixed to the receptacle,

provide 2 red, orange or green/yellow labels with minimum 0.25" lettering with the legend "300 WATTS MAX". This receptacle is for technician use only and shall not be used to power equipment.

ix. Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type C cabinet.

x. Branch overcurrent (size as required) circuit breaker that is UL-listed and of the thermal-magnetic type rated for use from -18°C to 40°C minimum to supply external equipment or cabinets, when present.

b. Include a cabinet lighting subsystem comprised of the following components:

i. Two LED lighting assemblies, minimum 600 lumens, mounted on the inside top front and top rear portion of the cabinet, with a white color temperature (4000K or higher) with shatter-proof cover.

ii. A resistor-capacitor network noise suppressor installed across the light fixture power terminals.

iii. Two door-actuated switches installed to turn on the cabinet lights when either door is opened.

iv. Powered from the ACCY POWER distribution block.

c. Include 2 duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right-side panel. Provide 2 red, orange or green/yellow labels with minimum 0.25" lettering with the legend "300 WATTS MAX" permanently affixed to the receptacle.

8.2.5 ITS Communications Hub (Cabinet)

The ITS Communications Hub Cabinet shall meet the following requirements:

1. Shall meet the same 19" rack, and ventilation requirements as Caltrans Type 170 model 342 cabinet.
2. Shall be ground mounted.
3. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8".
4. All inside and outside edges shall be free of burrs.
5. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.
6. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.
7. All welds shall be made by using the Heliarc welding method.
8. The cabinet should be of sufficient size to hold all the ITS Communications support equipment as shown on the Plans.
9. Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8" diameter aluminum.
10. The hinge pins shall be constructed of stainless steel.
11. Shall be furnished with a three-point latching system (top, bottom, center locations).
12. Shall be furnished with a doorstop, which retains the door at 90 degree and 120-degree positions.

13. Shall have thermostatically controlled fans located at the top of the cabinet.
14. Minimum fan rating of 100 CFM.
15. Fan thermostat shall have a user adjustable range from 80ºF to 125ºF.
16. Minimum of 2-½" (length) galvanized anchor bolts shall be used to secure the cabinet to the foundation.
17. Includes hooks, welded to the inside of each cabinet door, for hanging a side-opening, re-sealable, opaque, heavy-duty plastic documentation pouch with metal or hard-plastic reinforced holes for the door hooks. Provide 1 pouch with each cabinet.
18. Includes a rack-mounted cabinet sliding storage drawer in accordance with the following:
    a. Approximate exterior dimensions 1.75" H x 16" W x 14" D.
    b. Telescoping drawer guides to allow full extension from the rack cage.
    c. Opening storage compartment lid to access storage space for cabinet documentation and other items.
    d. Supports a weight of 25 lb. when extended.
    e. Non-slip plastic laminate surface attached to the compartment lid which covers a minimum of 90% of the surface area of the lid.
19. Provide ITS Communications Hub Cabinet electrical subsystems meeting the following requirements:
    a. An electrical distribution module comprised of the following DIN rail-mounted components:
        i. Service entrance terminal block with positions for 120/240VAC line, neutral, and ground and capable of terminating minimally #8 through #4/0 AWG wire, located at one end of the mounting rail with an approximately 0.75" blank spacer module adjacent to the main cabinet breaker.
        ii. Main cabinet automatic overcurrent 30A (minimum) circuit breaker that is UL-listed and of the thermal-magnetic type rated for use from -18°C to 40°C minimum.
        iii. Main cabinet surge protector for single-phase 120/240VAC service entrance, UL 1449 Listed, parallel wired with a Voltage Protection Rating (VPR) of 700V or less for L-L, L-N & N-G, and a nominal discharge current (I_n) of 20kA. SPD peak surge current rating shall equal or exceed 50kA per mode. Per phase rating shall equal or exceed 100kA per phase.
        iv. Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge protector. The noise filter shall be UL 1283 listed.
        v. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors parallel wired to the main cabinet surge protector but non-filtered, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the terminal block as "ACCY POWER."

vi. Electrical distribution terminal block fed from a 3.5A circuit breaker for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of 6 conductors of #10 to #18 AWG. Label the block as "EQUIP POWER."

vii. Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of 2-#6 AWG conductors and 10-#10 to #18 AWG conductors.

viii. Ground fault circuit interrupter duplex receptacle (NEMA 5-15R) connected to the ACCY POWER distribution block. Permanently affixed to the receptacle, provide 2 red, orange or green/yellow labels with minimum 0.25" lettering with the legend "300 WATTS MAX". This receptacle is for technician use only and shall not be used to power equipment.

ix. Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type C cabinet.

x. Branch overcurrent (size as required) circuit breaker that is UL-listed and of the thermal-magnetic type rated for use from -18°C to 40°C minimum to supply external equipment or cabinets, when present.

b. Include a cabinet lighting subsystem comprised of the following components:

i. Four LED lighting assemblies, minimum 600 lumens, mounted on the inside top front and top rear portion of the cabinet, with a white color temperature (4000K or higher) with shatter-proof cover.

ii. A resistor-capacitor network noise suppressor installed across the light fixture power terminals.

iii. Four door-actuated switches installed to turn on the cabinet lights when any door is opened.

iv. Powered from the ACCY POWER distribution block.

Include 2 duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right-side panel. Provide 2 red, orange or green/yellow labels with minimum 0.25" lettering with the legend "300 WATTS MAX" permanently affixed to the receptacle.

8.2.6 Maintenance Work Pad

Provide concrete pad or wood platform for technician to stand on while performing maintenance activities at each cabinet. Wood platform may be required on sloped areas to provide appropriate dimension to the bottom of the cabinet as required by the Plans. If wood platform is to be used, Contractor shall provide proposed solution to the Engineer for approval.

1. Provide a 2' x 3' concrete pad with 1.5" thickness or 4' x 8' wood platform as required by the Plans and slope at each cabinet site.

2. Concrete pads shall be precast polymer concrete reinforced with woven fiberglass. Top surface shall have 0.5 coefficient of friction, skid resistant surface. Pad shall be installed per manufacturer's specifications.
3. Wood platform shall be of a composite material such as trek and all wood used must be pressure treated.
4. Maintenance Work pad shall be level in all directions as best as practical.
5. Provide shop drawings and proposed design for maintenance work pad for Engineer approval prior to beginning construction on pad.
6. Areas around the work pad shall be sloped appropriately and backfilled with compacted backfill as allowed by the Engineer and as per the Plans and TDOT Standard Specifications.

8.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections.

8.3.1 General

1. Install and configure cabinets as shown on the Plans, including installations and dimensions given for pole-mounting in relationship to the surrounding grade.
2. Bond all cabinets to the pole grounding lug with #6 AWG (minimum) stranded copper bare or green-insulated cabinet grounding wire. Alternately on existing poles only, bond the cabinet grounding wire to an existing pole grounding wire with a cast brass or copper alloy threaded compression connector within 4" of the existing pole grounding lug.
3. Do not install electrical service or electronic devices in the cabinet or connect to the cabinet until ground testing for the pole or structure has been successfully completed and accepted, and the cabinet ground connection has been installed.

8.3.2 Type A Cabinets

1. Install and configure equipment in the Type A cabinet in accordance with the requirements for that equipment, including RDS units, ESS units, HAR and/or fog flashing warning beacons, Wireless Ethernet Radios and Antennas, and/or fiber distribution or drop panels.
2. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.
3. If required, install fiber drop panels as per the Plans.
4. Couple Type A Cabinet to the Pole Structure using a 45 degree Type LU conduit body.

8.3.3 Type B and C Cabinets

1. Install and configure equipment in the Type B and C cabinet in accordance with the requirements for that equipment, including RDS units, CCTV, ESS, RSU, DMS controller, UPS, Type A network switches, Wireless Ethernet Radios and Antennas, UPS, and/or fiber distribution or drop panels.
2. UPS shall be installed and powered using the equipment receptacle.
3. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.

4. Provide protection bollards at every Type C Cabinet location.
5. Install Type A network switches in the topmost area of the cabinet rack. Use the UPS for the power source.
6. Install supporting equipment/electronics for CCTV on the lower area of the cabinet upper left side panel. Ensure there is no physical or access conflict with the network switch. Use the UPS for the power source.
7. Install fiber drop panels in a vertical configuration on the lower rear edge of the cabinet upper right-side panel.
8. Couple Type B Cabinet to the Pole Structure using a 45 degree Type LU conduit body.

8.3.4 ITS Communications Hub (Cabinet)

1. Install and configure equipment in the ITS Communications Hub Cabinet in accordance with the requirements for that equipment, including Type A network switches, Type B field aggregation ethernet switches, Wireless Ethernet Radio and Antennas, UPS, and/or fiber distribution or drop panels.
2. UPS shall be installed and powered using the equipment receptacle.
3. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.
4. Provide protection bollards at every ITS Communications Hub Cabinet location.
5. Install network switches in the topmost area of the cabinet rack. Use the UPS for the power source.
6. Install fiber drop panels in a vertical configuration on the lower rear edge of the cabinet upper right-side panel.

8.3.5 Maintenance Work Pad

1. Install a concrete pad or wooden deck maintenance work pad at each equipment cabinet location as indicated on the Plans. The maintenance work pad shall be installed level to provide a safe and sturdy location for a maintenance technician to open and work inside the equipment cabinet from.

8.4 Testing Requirements

8.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the Equipment Cabinet.

8.4.2 Factory Acceptance Test

FAT is not required for Equipment Cabinets.

8.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the Equipment Cabinets have no internal or external damage.
2. Verify that manufacturer-supplied electrical components are properly connected and attached to the ground bus.
3. Verify that Equipment Cabinet doors properly seal, lock, unlock, and smoothly open and close.
4. Test all Equipment Cabinet components including circuit breakers, receptacles, fan, thermostat, lights, and door switches to verify functionality.

8.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The BTS shall include the following tests and inspections:

1. Test and verify the functionality of one completely assembled Type A Equipment Cabinet that includes all potential field devices hosted from a Type A cabinet in the project (RDS, CCTV, ESS, RSU, communications, electronics, etc.). This test is not required if there are no Type A cabinets included in the project.
2. Test and verify the functionality of one completely assembled Type B Equipment Cabinet that includes all potential field devices hosted from a Type B cabinet in the project (RDS, CCTV, ESS, RSU, communications, electronics, etc.). This test is not required if there are no Type B cabinets included in the project.
3. Test and verify the functionality of one completely assembled Type C Equipment Cabinet that includes all potential field devices hosted from a Type C cabinet in the project (DMS, RDS, CCTV, ESS, RSU, communications, electronics, etc.). This test is not required if there are no Type C cabinets included in the project.
4. Test and verify the functionality of one completely assembled ITS Communications Hub Cabinet that includes all potential field devices hosted from a Hub Cabinet in the project (RDS, CCTV, ESS, RSU, communications, electronics, etc.). This test is not required if there are no Hub Cabinets included in the project.

8.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. Contractor shall perform SAT on all Equipment Cabinets on this project after field installation is complete including but not limited to all field devices (DMS, RDS, CCTV, ESS, RSU, communications, electronics, etc.) to be installed in or connected to that given cabinet. SAT for a given Equipment Cabinet shall only be performed in conjunction with the SAT for all devices installed in or connected to that given cabinet. The SAT shall include the following tests and inspections:

1. Verify all components within the Equipment Cabinets have been installed per manufacturer requirements.

2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to any applicable structures.
3. Verify the Equipment Cabinets have no internal or external damage.
4. Verify that grounding has been installed as required and installation follows NEC and other applicable codes/standards.
5. Verify that cabinet documentation is present.
6. Test all cabinet equipment including circuit breaker, receptacles, fan, thermostat, lights, and door switches to verify functionality.
7. Test DC power supplies operating under full load. Test shall include measuring voltage and current input and output to ensure that both are within acceptable ranges according to manufacturer ratings.
8. A ground resistance test shall be performed at each electrical service grounding point. Ground resistance tests shall be conducted using a 3- or 4-Point Fall-of-Potential method defined by IEEE Standard #81 or other industry approved test method. Each grounding electrode shall be tested prior to connection to the ground system. Resistance-to-Ground of the ground system shall not exceed 10 ohms. Ground resistance measurements shall be conducted in normally dry conditions not less than 48 hours after the latest rainfall. All ground resistance tests shall be conducted in the presence of the Engineer. The Contractor shall document all test recordings and provide a copy of all test reports to the Engineer upon completion in accordance with the Project Submittal Program Requirements in Section 2.7.

8.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

8.6 Method of Measurement

8.6.1 Cabinet (Type A, Type B, Type C, and ITS Communications Hub (Cabinet)

Cabinets will be measured in units of each and paid for at the contract price per each. The bid price shall include furnishing and installing the equipment cabinet and all related material and equipment specified on the Plans and this SP725, and all labor, device integration, testing, system documentation, and miscellaneous materials necessary for a complete and accepted installation. The unit price shall also include but not be limited to the cabinet and all interior materials, mounting hardware foundations, protection bollards, external conduit entrances including conduit bodies and nipples, electrical service and pole grounding terminations, and protection bollards. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

8.6.2 Maintenance Work Pad (Concrete Pad or Wood Platform)

Maintenance work pads will be measured in units of each and paid for at the contract price per each. The bid price shall include furnishing and installing the work pad and all related material specified on the Plans and this SP725, and all labor and miscellaneous materials necessary for a complete and accepted installation. The unit price shall also include but not be limited to the work pad and all related materials not already included in payment for the cabinet. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

8.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-20.09	MAINTENANCE WORK PAD (CONCRETE PAD)	EA
725-20.10	MAINTENANCE WORK PAD (WOOD PLATFORM)	EA
725-24.01	CABINET (TYPE A)	EA
725-24.02	CABINET (TYPE B)	EA
725-24.03	CABINET (TYPE C)	EA
725-24.12	ITS COMMUNICATIONS HUB (CABINET)	EA

Equipment Cabinet will be paid per each as follows:

1. 40% of the contract unit price for delivery of the cabinet housings and satisfactory completion of Bench Testing Component test.

2. Additional 40% of the contract unit price for complete installation of equipment cabinet and all interior components, electrical service feed (activated), interior cabinet components, all conduit entrances, grounding connection, and satisfactory completion of Bench Test System testing.
3. Additional 10% of the contract unit price for satisfactory completion of Stand Alone Site Test of all field devices housed or connected to the equipment cabinet.
4. Final 10% of the contract unit price upon Final System Acceptance.

9 POLES AND STRUCTURES

9.1 Description

This section specifies the minimum requirements for equipment poles and structures furnished and installed in accordance with this SP725 and the Plans. This work shall consist of furnishing, installing, and testing 50’ and 80’ galvanized steel camera poles with foundations; 20’, 25’, and 35’ light standards and foundations; and overhead sign structures all in accordance with this SP725 and the TDOT Standard Specifications.

9.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

9.2.1 Light Standards (for CCTV, RDS, ESS, WIM, or OVDS)

1. This work shall consist of furnishing detection poles with foundations. Heights shall be as indicated on the Plans or as directed by the Engineer. All work shall be in accordance with the TDOT Standard Specifications. The poles shall be galvanized steel or aluminum and shall be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) standard "LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals,” current issue with interims.
2. Poles heights shall be as indicated on the Plans.
3. The Contractor shall supply poles as specified on the Plans and install as shown on the Plans.
4. Light Standards for CCTV, RDS, ESS, WIM, or OVDS shall include but not be limited to a pole, anchor bolts, breakaway base, base plate, ground rod array, communication and power conduit inside foundations, grounding conduit, spare conduit, and foundation as shown on the Plans.
5. Pole foundations shall be constructed with Class A Concrete (f’c = 3,000 psi) in accordance with Section 604.03 of the TDOT Standard Specifications. Reinforcing steel shall be Grade 60 and conform to ASTM A615 in accordance with Section 907.01 of the TDOT Standard Specifications.
6. Design computations for the poles shall be completed and provided to the Engineer and shall include but not be limited to the following:
    a. Consideration for all parts of the structure.
    b. Consideration for all possible loading combinations including wind and ice loads.
    c. Design stresses and allowable stresses for all components which comprise the proposed structure.
    d. All complete shop drawings and design computations shall bear the stamp and signature of a Professional Engineer registered in the state of Tennessee.

e. Shop drawings shall be approved prior to fabrication. Approval of the shop drawings does not relieve the Contractor of responsibility for the design, fabrication, and erection of the structure.

f. The Engineer reserves the right to reject a pole design if the calculated deflection exceeds that specified herein.

g. The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base, 5' pole intervals, and at each slip joint splice.

7. For each pole as shown on the Plans, the following information shall be provided to the Engineer:

   a. The pole's diameter, thickness, section modulus, moment of inertia, and cross-sectional area.

   b. The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each trapezoidal pole segment.

   c. The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio (CSR) at each elevation.

   d. The pole's angular and linear deflection at each elevation.

9.2.2 CCTV Pole & Foundation

Contractor shall provide Fifty-foot (50') CCTV pole and foundation, Eighty-foot (80') CCTV pole and foundation with lowering device, One-hundred-ten-foot (110') CCTV pole and foundation with lowering device, conduit, connections, clamps, anchor bolts, shoe bases, and all other members in conformance with the following specifications. Poles, foundations, and all related items shall be designed and fabricated in accordance with the Standards and requirements listed below. Design and materials documentation shall be furnished as part of the approval request submittal. Certifications will be furnished upon request by the Engineer.

1. The CCTV Pole shall be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) standard "LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals," current issue with interims.

2. The Contractor shall submit manufacturer's shop drawings signed and sealed by a Professional Engineer registered in the state of Tennessee, layout drawings and specifications for equipment and appurtenances for the approval of the Engineer within 90 calendar days of Notice to Proceed.

3. Fabricator: The Fabricator shall be certified under Category I, "Conventional Steel Structures" as set forth by the American Institute of Steel Construction Quality Certification Program. Contractor shall submit proof of this certification along with the structural submittal(s).

4. Welding: All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) DI. 1 Structural Welding Code.

5. Tackers and welders shall be qualified in accordance with the American Welding Society Structural Welding code.

6. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Contractor shall furnish inspection records to the Engineer.

7. Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole and arm splices shall be ultrasonically and radiographically inspected. Inspection records will be furnished to the Engineer.

8. Camera Pole System shall consist of a pole, anchor bolts, base plate, ground rod array, communication and power conduits inside foundations, grounding conduit, spare conduit, and foundation.

9. Design computations for the camera poles shall be completed and provided to the Engineer and shall include but not be limited to the following:

    a. Consideration for all parts of the structure.

    b. Consideration for all possible loading combinations including wind and ice loads.

    c. Design stresses and allowable stresses for all components which comprise the proposed structure.

    d. The top of the pole deflection shall not exceed the following:

        i. 1” deflection from center (2” deflection diameter) due to 30 mph (non-gust) winds for the 50’ poles.

        ii. 1.5” deflection from center (3” deflection diameter) due to 30 mph (non-gust) winds for the 80’ poles.

        iii. 2” deflection from center (4” deflection diameter) due to 30 mph (non-gust) winds for the 110’ poles.

    e. All complete shop drawings and design computations shall bear the stamp and signature of a Professional Engineer registered in the state of Tennessee.

    f. Shop drawings shall be approved prior to fabrication. Approval of the shop drawings does not relieve the Contractor of responsibility for the design, fabrication, and erection of the structure.

    g. The Engineer reserves the right to reject a pole design if the calculated deflection exceeds that specified herein.

    h. The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base, 5’ pole intervals, and at each slip joint splice.

10. For each pole as shown on the Plans, the following information shall be provided to the Engineer:

    a. The pole’s diameter, thickness, section modulus, moment of inertia, and cross-sectional area.

    b. The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each trapezoidal pole segment.

    c. The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio (CSR) at each elevation.

    d. The pole’s angular and linear deflection at each elevation.

11. Pole foundations shall be constructed with Class A Concrete (f'_c = 3,000 psi) in accordance with Section 604.03 of the TDOT Standard Specifications. Reinforcing steel shall be Grade 60 and conform to ASTM A615 in accordance with Section 907.01 of the TDOT Standard Specifications.

12. Pole foundation piling shall conform to Section 606 of the TDOT Standard Specifications.

13. Pole Mounted Cabinet Access Conduit Nipple shall conform to the following requirements:

    a. Each pole will be manufactured with a 3" diameter rigid threaded nipple for conduit connection to a pole mounted cabinet.

    b. The height of this nipple above the base of the pole shall be such that a cabinet mounting height of 2.5' above ground height can be achieved as shown in the typical details on the Plans.

14. Hand Holes shall conform to the following requirements:

    a. The hand hole openings are reinforced with 2" wide hot rolled steel bar. The opening shall be rectangular and at least 5" x 8" nominal.

    b. The cover shall be 11-gauge steel and shall be secured to a clip-on lock with a tamper-proof screw.

    c. The reinforcing rim shall include a ½" tapped hole and ½" hex head cap screw for grounding.

    d. For poles with lowering devices 2 hand holes shall be approximately 18" apart, center to center, or as recommended by the lowering device manufacturer.

    e. The hand holes shall be fully compatible with the Camera Lowering Device and Portable Lowering Tool. If desired and compatible with the lowering device, 1 larger hand hole may be provided in place of 2 separate hand holes.

    f. Hand holes on poles with pole mounted cabinets and transformers shall be placed toward oncoming traffic. For all other poles, hand holes shall face away from traffic.

15. Pole Top Junction Box shall conform to the following requirement: All camera poles shall have a pole top connector box fastened to the pole top for cable strain relief.

16. Cable Supports (J-Hooks & Eyelets) shall conform to the following requirement: Top and bottom J-hooks and eyelets shall be located within the pole directly aligned with each other.

17. Base Plates shall conform to the following requirements:

    a. Base plates shall conform to ASTM A572.

    b. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar.

    c. Plates shall be hot dip galvanized.

18. Anchor Bolts shall conform to the following requirements:

    a. Anchor bolts in foundation shall be ASTM F1554 in accordance with Section 730.11 of the TDOT Standard Specifications. All anchor bolts shall be fitted with 2 heavy hex nuts; all nuts and not less than 10" of the threaded ends of anchor bolts shall be hot-dip galvanized according to ASTM A153.

b. Each anchor bolt shall be supplied with 2 hex nuts and 2 hardened washers.

c. The strength of the nuts shall equal or exceed the proof load of the bolts.

d. The top nut shall be torqued to produce 60% yield stress of anchor bolt.

e. The Contractor shall not grout between bottom of base plate and top of concrete foundation.

9.2.3 Camera Lowering Device Requirements for 50', 80', and 110' Poles

All 50', 80', and 110' poles shall have a heavy-duty Camera Lowering Device(s) (CLD) with the design capabilities of supporting IP based CCTV cabling. The camera lowering system shall be designed to support and lower IP closed circuit television camera, lens, housing, PTZ mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The camera lowering system device(s) and the pole are interdependent; and thus, must be considered a single unit or system. The lowering system shall consist of a suspension contact unit, divided support arm, and a pole adapter for attachment to a pole top tenon, pole top junction box, conduit mount adapter, and camera connection box. The CLD shall also meet the following requirements.

1. The CLD shall be safely operable by 1 technician working alone, to lower the Camera Assembly to ground level for maintenance as necessary and return the Camera Assembly to the pole top mounting and secure it in place, eliminating the need for access by a bucket truck.
2. Weatherproof connectors (camera to the lowering device) shall allow for adaptation of the camera and the dome type housing for lowering and hoisting and be provided as an integral part of the design to provide a water-resistant seal when the camera is raised and secured in place for surveillance operation.
3. Lifting and lowering shall be done with a motorized gear box (winch).
4. The CLD should be a stand-alone device mounted on a camera pole to be supplied by the Contractor and included in the cost of the associated pole.
5. An integrated CLD with pole assembly may be procured provided it meets all specifications.
6. The Camera Lowering Device shall be designed to preclude the lifting cable from contacting the power, control or video cabling. In the case where there are dual lowering devices each lifting cable shall not come in contact with the other CCTV's lifting cable, power or video cabling. The only cable permitted to move within the pole or lowering device shall be the stainless-steel lowering cable(s). All other cables must remain secure and separate from the lowering cable(s).
7. The Camera Lowering Device shall support the Camera Assembly a minimum of 20" from the pole.
8. The composite cable between the camera and the CCTV cabinet will be a continuous run with available slack. No pole top interconnections or splices will be permitted.
9. The tenon top shall be a plate mounted tenon that allows for field modification of the arm/camera orientation up to 360 degrees. The tenon shall have mounting holes and slots as required for the mounting of the CLD. Unless otherwise noted, when DUAL mount lowering devices, the mounting slots shall be 180 degrees apart.

10. For dual lowering devices on the same pole the lowering devices shall be designed and installed to work independently of the other. The CLD shall be installed such that the cables from either CCTV will not come into contact with the other's cabling.

9.2.4 Lowering Tool for Camera Lowering Device

The Contractor shall furnish 1 Portable Lowering Tool capable of being operated by a hand winch and an electric drill motor, which is fully compatible with the Camera Lowering Device and the Steel Camera Pole and meets the following requirements:

1. The Portable Lowering Tool shall be one recommended by the manufacturer of the Camera Lowering Device and compatible with the installed CLD.
2. The Portable Lowering Tool shall have a minimum load capacity of 200 lbs. with a 4 to 1 safety factor.
3. The tool shall consist of a lightweight metal frame and winch assembly with cable, a quick release cable connector, an adjustable safety clutch, and a variable speed industrial duty electric drill motor.
4. This tool shall be compatible with the hand hole of the pole and the Camera Lowering Device inside the hand hole.
5. When attached to the hand hole, the tool will support itself and the load assuring lowering operations and provide a means to prevent freewheeling when loaded.
6. The Portable Lowering Tool shall be delivered to the Engineer upon project completion.
7. The Portable Lowering Tool shall have a reduction gear to reduce the manual effort required to operate the lifting mechanism.
8. The Portable Lowering Tool shall be provided with an adapter for operating the lowering device with a portable drill using a clutch mechanism. The Portable Lowering Tool shall be equipped with a positive locking mechanism to secure the cable reel during raising and lowering operations.

9.2.5 Steel Overhead Sign Structure

This section describes the requirements for the span type structures (Sign Bridge) to support the DMS elements.

1. The work to be completed by the Contractor includes the verification of field dimensions, assembly of the component parts and installation including sign span type structures, footings, associated attachment hardware, conduit, wiring, and testing of the structure.
2. The sign structure shall have demonstrated long-term durability to withstand extreme temperatures and weather conditions.
3. Each structure shall be fully warranted for rust, corrosion, and structural failure at a minimum as a complete assembly by the manufacturer for a period of 5 years and prorated for up to 7 years.
4. The following are the DMS structure criteria that must be verified by the Contractor:
    a. Minimum vertical clearance between pavement or shoulder to the lowest DMS or DMS mounting structure component: 20'.

b. The sign design area for wind load shall be 1.5 times the width of the entire roadway under the sign truss times the maximum height of the DMS sign per Section **Error! Reference source not found.**.

c. The DMS Support shall be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) standard "LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals," current issue with interims.

d. Support structure steel shall conform to ASTM A709 Grade 50 or 50W for plates or ASTM A709 Grade 50S for rolled shapes in accordance with Section 908.01 of the TDOT Standard Specifications.

e. Bolts shall conform to ASTM F3125, Grade 325 and Grade 490. Nuts shall conform to ASTM A563. Washers shall conform to ASTM F436. See Section 908.04 of the TDOT Standard Specifications.

f. Foundation steel reinforcement shall be ASTM A615 Grade 60 in accordance with Section 907.01 of the TDOT Standard Specifications.

g. Anchor bolts in foundation shall be ASTM F1554 in accordance with Section 730.11 of the TDOT Standard Specifications. All anchor bolts shall be fitted with 2 heavy hex nuts; all nuts and not less than 10" of the threaded ends of anchor bolts shall be hot-dip galvanized according to ASTM A153.

h. Cast-in-place foundation concrete shall be Class A (f'_c = 3,000 psi) in accordance with Section 604.03 of the TDOT Standard Specifications.

i. Foundation piling shall be in accordance with Section 606 of the TDOT Standard Specifications.

5. The Contractor shall provide to the Engineer additional calculations as necessary to design the connections between DMS and the structure and special attachment details.

6. The sign manufacturer shall consider truck induced wind loading in deflection calculations. The natural frequency response of the structure to truck induced wind loads when span type DMS structures are used shall be considered. More information can be obtained on this subject in the Transportation Research Board (National Research Council) "Truck Induced Wind loads on Variable Message Signs," Research Record No. 1594, published in 1997.

7. The Contractor shall verify the actual length of support columns for all sign structures based on existing field conditions and as indicated on the Plans.

9.2.6 Suspension Unit

1. The Manufacturer shall design the required pole mounting adapters, brackets, and mounting hardware for review and approval by the Engineer.

2. The Camera Lowering Device shall have a minimum load capacity 200 lbs. with a 4 to 1 safety factor.

3. The enclosure receptacle and camera enclosure shall incorporate a mating device.

4. The mating device shall have a minimum of 2 latching devices. These latching devices shall securely hold the camera housing and its control equipment free of vibration or motion between the enclosure receptacle and camera enclosure.

5. The latching devices shall lock and unlock by alternately raising and lowering the camera enclosure.
6. When the camera enclosure is latched, all weight shall be removed from the lowering cable.
7. The enclosure receptacle and camera enclosure shall have a heavy-duty tracking guide.
8. The tracking guide and latching devices shall lock the camera enclosure in the same position each time.
9. Electrical contacts shall be provided to support all camera functions for IP based CCTVs. The electrical contacts shall be brass or copper and be gold coated to prevent corrosion. The contacts shall be minimum 0.09" diameter, or as approved by the Engineer.
10. Replaceable gaskets shall be provided to seal the electrical contacts and latching devices from moisture and dust.
11. The Camera Lowering Device shall be designed to permit a ±3 degree of horizontal adjustment for leveling the dome enclosure.
12. The lowering cable shall be a minimum 5/32" diameter stainless steel aircraft cable with a minimum breaking strength of 1740 lbs.
13. Weights and/or counterweights shall be provided to assure the alignment pin and connectors for the camera connection can be raised into position without binding and that it can be lowered properly.

9.3 Installation Requirements

Contractor shall install all equipment according to the manufacturer's recommendations and as indicated on the Plans. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.

9.3.1 Pole and Foundation

The camera and detection poles shall be installed as indicated on the Plans and shall conform to the following requirements:

1. All poles shall be installed in accordance with the National Electric Safety Code and AASHTO.
2. Foundations:
    a. Pole foundations shall be constructed at the locations indicated on the Plans. If the field locations of the pole foundations vary from the locations indicated on the Plans, the Contractor shall provide TDOT with the new foundation location and request if new borings are required. New soil borings shall be submitted to TDOT for verification of the foundation design indicated on the Plans. Soil data shall be included as part of the as-built design plan set for the project.
    b. The foundations shall be constructed in accordance with the TDOT Standard Specifications and as indicated on the Plans.
    c. If soil conditions require the use of any shoring, casings, or Sonotube for proper installation of the foundations, the cost of the shoring, casings or Sonotube shall be included in the cost of the pole and foundation.

d. Foundation dimensions and reinforcement details shall be as indicated on the Plans. Pour foundations after setting anchor bolts and reinforcing steel in their proper position.

e. Cast-in-place concrete pole foundation shall cure a minimum of 7 calendar days before any load is applied to the foundation.

f. Foundation piles shall be installed in accordance with Section 606 of the TDOT Standard Specifications.

g. Conduit shall be installed in the pole foundation for access and includes conduit to the nearest pull box as shown on the Plans.

3. A minimum of 1-2" spare conduit shall be installed in all camera pole foundations as shown on the Plans. Spare conduits in pole foundations shall be sealed with blank duct plugs as specified in Section 3.2.10.

4. Grounding System:

   a. The Contractor shall supply and install a grounding system with ground rod array at the base of all poles as shown on the Plans.

   b. The ground rod array system shall be connected to the pole through an appropriate UL listed ground clamp.

   c. A #6 AWG copper stranded bonding wire shall be installed between the pole and the field cabinet providing a common ground system for each site.

   d. All ground bonding wires shall be unspliced.

5. The installation method for the CCTV poles and cameras shall be such that the camera can be rotated as needed around the pole for optimum placement.

9.3.2 Steel Overhead Sign Structure

1. DMS Structures shall be installed according to the manufacturer's recommendations and as indicated on the Plans.

2. Shop drawings for all items associated with the manufacturing, construction, and installation of the DMS sign structure, and its attachments shall be submitted to and approved by the Engineer prior to erection of the DMS sign structure.

3. Materials certifications, including mill test reports, shall be submitted to and approved by the Engineer prior to erection of the DMS sign structure.

4. Foundations:

   a. DMS structure foundations shall be constructed at the locations indicated on the Plans. If the field locations of the DMS structure foundations vary from the locations indicated on the Plans, the Contractor shall provide TDOT with the new foundation locations and request if new soil borings are required. New soil borings shall be submitted to TDOT for verification of the foundation design indicated on the Plans. Soil data shall be included as part of the as-built design plan set for the project.

   b. The foundations shall be constructed in accordance with the TDOT Standard Specifications and the Plans.

c. If soil conditions require the use of any shoring, casings, or Sonotube for proper installation of the foundations, the cost of the shoring, casings or Sonotube shall be included in the cost of the DMS structure and foundation.

d. Foundation dimensions and reinforcement details shall be as indicated on the Plans. Pour foundation after setting anchor bolts and reinforcing steel in their proper position.

e. Cast-in-place concrete DMS structure foundations shall cure a minimum of 7 calendar days before any load is applied to the foundation.

f. Foundation piles shall be fabricated and installed in accordance with Section 606 of the TDOT Standard Specifications.

5. DMS structures shall be grounded in accordance with the DMS and the structure manufacturers' recommendations, TDOT Standard Specifications, and as indicated on the Plans.

6. Incidental paving shall be provided 18" around drilled shaft foundations as indicated on the Plans.

7. Grounding System:

   a. The Contractor shall supply and install a grounding system with ground rod array at the base of all structures as shown on the Plans.

   b. The ground rod array system shall be connected to the pole through an appropriate UL listed ground clamp.

   c. A #6 AWG copper solid bonding wire shall be installed between the structure and the field cabinet providing a common ground system for each site.

   d. All ground bonding wires shall be unspliced.

9.4 Testing Requirements

9.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.

2. All test results shall confirm physical and performance compliance with this SP725.

3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.

4. Payment for all testing is included in the cost of the Pole or Structure.

9.4.2 Factory Acceptance Test

FAT is not required for Poles and Structures.

9.4.3 Bench Test Component

BTC is not required for Poles and Structures.

9.4.4 Bench Test System

BTS is not required for Poles and Structures.

9.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements and the Plans.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to the structures.
3. Verify the Poles and Structures have no internal or external damage.
4. Test the functionality of the Portable Lowering Tool for both hand winch operation and electric drill motor operation.
5. Test the functionality of each Lowering Device by fully lowering each camera and raising back up. Verify functionality of the cameras after lowering and raising.
6. Test the functionality of each collapsible railing by raising, locking in position, and lowering the railing back down. The railing shall remain lowered down once testing is complete.
7. A ground resistance test shall be performed at each structure. Ground resistance tests shall be conducted using a 3- or 4-Point Fall-of-Potential method defined by IEEE Standard #81 or other industry approved test method. Each grounding electrode shall be tested prior to connection to the ground system. Resistance-to-Ground of the ground system shall not exceed 10 ohms. Ground resistance measurements shall be conducted in normally dry conditions not less than 48 hours after the latest rainfall. All ground resistance tests shall be conducted in the presence of the Engineer. The Contractor shall document all test recordings and provide a copy of all test reports to the Engineer upon completion in accordance with the Project Submittal Program Requirements in Section 2.7.

9.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

9.6 Method of Measurement

9.6.1 Light Standards (20 FT, 25 FT, 35 FT Pole Height)

Light Standards, for CCTV, RDS, ESS, WIM, and OVDS, will be measured in units of each and paid for at the contract price of each. The bid price shall include but not be limited to a light standard pole, breakaway base, foundation, conduit inside foundation, connections to support structures, satisfactory completion of testing requirements, and all work, equipment, and appurtenances as required to effect the full operation of the light standard site complete, in place, and ready for installation of the CCTV, RDS, ESS, WIM, or OVDS. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.6.2 CCTV Pole & Foundation (50FT Pole w/Lwring Device)

CCTV Pole and Foundation (50' Pole) will be measured in units of each and paid for at the contract price per each. The bid price shall include but not be limited to a 50' steel strain pole, foundation, lowering

devices (as quantified on the Plans), conduit inside foundation and to the nearest pull box, wiring between pole-mounted devices and field cabinet, connections to support structures, satisfactory completion of testing requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete in place and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.6.3 CCTV Pole and Foundation (80FT Pole w/Lwring Device)

CCTV Pole and Foundation (80’ Pole) will be measured in units of each and paid for at the contract price of each. The bid price shall include but not be limited to a 80’ steel strain pole, foundation, lowering devices (as quantified on the Plans), foundation, conduit inside foundation and to the nearest pull box, wiring between pole-mounted devices and field cabinet, grounding, connections to support structures, and satisfactory completion of testing requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete, in place, and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.6.4 CCTV Pole and Foundation (110FT Pole w/Lwring Device)

CCTV Pole and Foundation (110’ Pole) will be measured in units of each and paid for at the contract price of each. The bid price shall include but not be limited to a 110’ steel strain pole, foundation, lowering devices (as quantified on the Plans), foundation, conduit inside foundation and to the nearest pull box, wiring between pole-mounted devices and field cabinet, grounding, connections to support structures, and satisfactory completion of testing requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete, in place, and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.6.5 Lowering Tool for Camera Lowering Device

Lowering Tool for Camera Lowering Device will be measured in units of each and paid for at the contract price of each. The bid price shall include the complete operational device including all attachments. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.6.6 Steel Overhead Sign Structure (All Span Lengths)

DMS Structure will be measured in units of each and paid for at the contract price of each. The price shall include but not be limited to support structures, foundations, catwalk, connection hardware, conduit on the structure, conduit inside foundations, grounding, incidental paving and material restoration around the foundations, satisfactory completion of testing, and all work, equipment, and appurtenances as required to have the structure complete, in place, and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
714-08.09	LIGHT STANDARDS (20 FT POLE HEIGHT)	EA
714-08.10	LIGHT STANDARDS (25 FT POLE HEIGHT)	EA
714-08.11	LIGHT STANDARDS (35 FT POLE HEIGHT)	EA
725-20.01	CCTV POLE & FOUNDATION (50FT POLE W/LWRNG DVICE)	EA
725-20.02	CCTV POLE & FOUNDATION (80FT POLE W/LWRNG DVICE)	EA
725-20.03	LOWERING TOOL FOR CAMERA LOWERING DEVICE	EA
725-20.11	CCTV POLE & FOUNDATION (110FT POLE W/LWRNG DVICE)	EA
725-20.21	STEEL OVERHEAD SIGN STRUCTURE (SPANS UP TO 50FT)	EA
725-20.22	STEEL OVERHEAD SIGN STRUCTURE (SPANS 51FT TO 70FT)	EA
725-20.23	STEEL OVERHEAD SIGN STRUCTURE (SPANS 71FT TO 90FT)	EA
725-20.24	STEEL OVERHEAD SIGN STRUCTURE (SPANS 91FT TO 110FT)	EA
725-20.25	STEEL OVERHEAD SIGN STRUCTURE (SPANS 111FT TO 120FT)	EA
725-20.26	STEEL OVERHEAD SIGN STRUCTURE (SPANS 121FT TO 130FT)	EA
725-20.27	STEEL OVERHEAD SIGN STRUCTURE (SPANS 131FT TO 150FT)	EA
725-20.28	STEEL OVERHEAD SIGN STRUCTURE (SPANS 151FT TO 180FT)	EA
725-20.29	STEEL OVERHEAD SIGN STRUCTURE (SPANS 181FT TO 200FT)	EA
725-20.30	STEEL OVERHEAD SIGN STRUCTURE (SPANS 201FT TO 250FT)	EA

The CCTV Pole and Foundation Items, Light Pole Standards Items, and Steel Overhead Sign Structures Items will be paid per each as follows:

1. 25% of the contract unit price upon complete installation of foundations.
2. Additional 45% of the contract unit price upon delivery of poles or structure to the site.
3. Additional 25% of the contract unit price upon satisfactory completion of Stand Alone Site Test of poles or structure.
4. Final 5% of the contract unit price upon Final System Acceptance

Lowering Tool for Camera Lowering Device will be paid at the unit price for each device when delivered to TDOT.

10 CCTV CAMERA SYSTEM

10.1 Description

This Section specifies the minimum requirements for CCTV Camera Systems furnished and installed on this project. The CCTV Camera System selected for use on this project shall be pre-approved and listed on the TDOT ITS Qualified Product List.

The CCTV Camera System will provide TDOT Regional TMC personnel with live streaming video of the roadway network via CCTV Camera Systems installed at locations shown on the Plans. It is the Contractor's responsibility to furnish, program, install, and integrate the CCTV camera system in the field and at the TDOT Regional TMC. The Contractor shall install and integrate CCTV cameras into the existing video display wall and TDOT ATMS software.

The Contractor shall submit a plan for display of the CCTV cameras on the existing video wall equipment and submit it to the Engineer for approval. The Contractor shall work with the video wall manufacturer and the CCTV manufacturer to create a plan for the integration of the cameras into the video wall. This coordination and integration effort shall be included in the cost of the CCTV.

10.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

The firmware pre-installed on the device shall meet the minimum version listed in APPENDIX D at the time of device installation in the field.

10.2.1 General Capabilities and Performance Requirements

1. Overall CCTV Camera System capabilities and performance requirements include the following:
    a. CCTV Camera System shall be placed at fixed locations as shown on the Plans to provide coverage within the project limits including the mainline travel lanes and shoulders.
    b. The CCTV Camera System components shall be compatible with each other and be of rugged design and suitable for reliable operation when mounted in the configuration as specified in this SP725 and the Plans.
    c. The CCTV Camera System shall be capable of attended and unattended, continuous twenty-four hours per day operation at the sites as shown on the Plans.
2. The CCTV Camera System shall respond to camera control signals from an operator of the system and transmit video images to remote locations interfaced to the system for observation.
3. The camera shall be fully digital, IP addressable, and compliant with the H.264 video encoding standard.

4. The camera shall operate over wide dynamic light conditions ranging from low light/dusk to full sunlight having day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.
5. The CCTV Camera System shall be capable of being remotely controlled and programmed.
6. The camera shall be mounted together with the zoom lens and integrated into the pan and tilt device within the enclosure forming a totally integrated, easily removable assembly.
7. The camera shall include a high-quality integrated camera/lens combination.
8. The camera shall be equipped with an auto-iris lens capability compatible with the zoom lens supplied.
9. Iris capability shall include a provision for manual override via software.
10. The camera shall be capable of auto-focus during zoom-in or zoom-out, with provisions for override via software.
11. Overexposure protection shall be provided – the camera shall not be degraded or damaged under normal reasonable operating conditions.
12. The capability for local control of pan, tilt, and zoom functions shall be provided at the ITS equipment cabinet using vendor-supplied software installed on a laptop computer.
13. The camera shall have image stabilization to reduce image jitter during viewing of the video.

10.2.2 IP Camera Unit

The minimum IP Camera Unit requirements include:

1. **Image Sensor Size**: Not less than Diagonal 6mm (1/3" type).
2. **Image Resolution**: Not less than 1280 x 720.
3. **Day/Night Operation**: Adjustable (Auto, Color, and Mono Modes) via removable IR cut filter.
4. **Maximum Lens Aperture**: Not less than f/1.6 (wide) to f/2.8 (tele).
5. **Optical Zoom Range**: Not less than 30X.
6. **Optical Zoom Speed**: 2 speeds.
7. **Horizontal Angle of View**: Optical: Not less than 55.2 degrees to 3.2 degrees.
8. **Minimum Focus Distance**: Not greater than 0.01m (wide), 1.0m (tele).
9. **Auto Focus**: Selectable Auto/Manual, Minimum Scene Illumination for Reliable Auto Focus shall be no more than 50% video output.
10. **Manual Shutter**: Selectable.
11. **Auto Iris**: Selectable auto/manual, Iris shall automatically adjust to compensate for changes in scene illumination to maintain constant video level output within sensitivity specifications.
12. **Sensitivity**: Scene Illumination minimums, F1.6 @ 50% Video
    a. 1.8 Lux (0.18 fc) @ 1/30 shutter, color mode
    b. 0.1 Lux (0.01 fc) @ 1/30 shutter, mono mode

10.2.3 H.264/MJPEG Encoding Engine

The IP Camera Positioning System (IPCPS) shall fully integrate within its enclosure an H.264/MJPEG encoding component with functions as specified below. The Contractor may submit a nonintegrated solution installed in the traffic control cabinet or separate CCTV cabinet if it provides the same capabilities and is hardened for extreme temperatures, under approval by the Engineer.

1. **Video Encoding**: H.264 (Main Profile/Level 3.1) and MJPEG standards.
2. **Video Streams**: 2 independently configurable streams: 1 H.264 and 1 MJPEG.
3. **Video Stream Configuration Properties**:
    a. Stream Settings:
        i. Video Stream 1: H.264.
        ii. Video Stream 2: MJPEG.
    b. Video Resolution: Not less than 480p and 720p.
    c. Streaming Mode: Capable of selectable CBR or VBR.
    d. Frame Rates: 30, 15, 7, 4, 2, 1 fps.
4. **Data Rate**: Adjustable in a range of not more than 256 Kbps up to 8 Mbps for streaming video.
5. **Connection Types**: Uni-cast and multi-cast.
6. **IPCPS Video Latency**: <150ms.
7. **Supported Network Protocols**: RTP, RTSP, UDP, TCP, IP, DHCP, DNS, HTTP, HTTPS, ARP, ICMP, IGMPv2 and SNMPv2c/v3 as a minimum.

10.2.4 Positioning Drive

1. **Pan Movement**: 360 degrees continuous rotation.
2. **Pan Speed**: Variable from 0.1 to 90 degrees/second or better.
3. **Pan Repeatability**: +/- 0.25-degree precision or better.
4. **Pan Preset Speed**: 180-degree movement < 2 Seconds.
5. **Tilt Movement**: Minimum of +90 to –90 degrees.
6. **Tilt Speed**: Variable from 0.1 to 45 degrees/second or better.
7. **Tilt Repeatability**: +/- 0.25-degree precision.
8. **Tilt Preset Speed**: 180-degree movement < 3 Seconds or better.

10.2.5 Operational

1. The CCTV camera shall utilize NTCIP 1205 v01.08 communication protocol.
2. **Presets**: Minimum of 64, with each preset consisting of a pan, tilt, zoom, and focus coordinate.
3. **Preset Tours**: Minimum 8 tours required, each tour shall consist of up to 32 pre-programmed presets, with individual dwell time property per preset per tour.

a. Tour presets shall be useable in any order.

b. Presets may be used multiple times in tour.

c. Tours shall stop upon receipt of any pan/tilt positioning command.

d. Tour data shall be stored in non-volatile memory and shall not be lost if a power failure occurs.

4. **Sector Zones**: Provide a minimum of up to 16 user defined sector zones with each zone having a unique 24-character ASCII title programmed for description purposes.

5. **Camera Site ID**: Provide up to 2 lines of up to 24 ASCII characters each on video for user site description ID. If both lines are programmed, line 1 of ID shall always appear above line 2 regardless of top or bottom selection.

6. **Preset ID**: Provide 1 line of up to 24 ASCII characters on video for Preset ID description. 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.

7. **Scalable Zoom**: Variable speed pan/tilt ranges based off zoom position. This adds the capability of limiting the maximum pan/tilt speed, while maintaining variable speed capability, throughout the zoom range of the camera.

8. **Updates**: The IPCPS shall allow updates of firmware for new features via the Ethernet network communication channel. An internal IPCPS web server shall be provided for performing this task.

9. The IPCPS shall return to previous position and state of operation upon power loss and restoration.

10.2.6 IP Management

The IPCPS shall provide at minimum the following network configuration properties.

1. **IP Configuration**: DHCP or Static IP address entry.

2. Net mask address entry.

3. Gateway address entry.

10.2.7 Power Input

The IPCPS shall fully comply with and include independent laboratory test results confirming compliance with the following electrical operating conditions.

1. **Power**: <100 Watts Maximum.

2. **Operating Voltage**: 24VAC.

3. The nominal voltage shall be 120VAC per NEMA-TS2.

10.2.8 Mechanical

1. **Connectors**: weatherproof non-corrosion type.

2. **Weight**: Maximum 25lbs.

3. **Construction**: Light Colored Powder Coated aluminum, all internal and external parts corrosion protected, stainless steel fasteners.
4. Faceplate shall be optically correct glass.
5. **Camera Mount**: Provided to match pole locations on the Plans. See the Plans for variable types of poles.
6. Camera housing shall be equipped with a 1.5" NPT pipe thread to allow for connection to the Camera Lowering Device connection box.

10.2.9 Environmental

The IPCPS shall fully comply with and include independent laboratory test results confirming compliance with the following environmental operating conditions.

1. **Temperature**: The operating ambient temperature range shall be from -34°C to 60°C.
2. **Vibration**: Per Nema-TS2, 5-30Hz sweep @ 0.5g applied in each of 3 mutually perpendicular planes.
3. **Shock**: Per Nema-TS2, 10g applied in each of 3 mutually perpendicular planes.
4. **Water Spray**: Per IEC 60529+A1, 1999, Solid water stream delivered thru 12.5mm nozzle @ 25 gallons/minute @ 9ft for 3 minutes.
5. **External Icing**: Per Nema-TS2 250-2003.
6. **Corrosion Protection**: Per NEMA 250-2003.
7. **Humidity**: The IPCPS shall withstand the effects of humidity up to 100% without condensation forming inside the unit.
8. **Minimum Standards**: IP66.

10.2.10 Certifications

1. CE (24VAC).
2. FCC Class A.

10.2.11 Surge Protection

All CCTV Camera System electrical interconnects shall be protected from transient over-voltages (surges) including lightning and external electromagnetic fields coming into the cabinet. All cables shall be protected from a surge coming in on the ground and load side of the cabinet. The minimum surge protection requirements include:

1. Surge protectors shall be furnished for all non-dielectric cable and conductors (video, data/signal, and device/assembly power) between the CCTV Camera System and the equipment cabinet.
2. The surge protectors shall have leads that are kept to a minimum length as recommended by the surge device manufacturer.
3. All surge protection devices shall be designed and selected to meet the temperature and humidity requirements specified in section 10.2.9. Surge suppressors including variable temperature components (i.e., PTCs) shall not impede signals at any elevated temperatures.

4. All Surge protectors shall be U.L. listed (UL 1449 Current Edition, UL 497, 497A, 497B,) and bonded to the same single-point ground point. Any DIN rail mounted SPDs shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.
5. Any directional SPDs shall be clearly marked as "Protected Side" and "Unprotected Side" and installed such that the Protected Side faces the equipment, and the Unprotected Side faces the conductors coming into the cabinet.
6. Low Voltage/Signal Cable Surge protectors for data/signal/control cable shall meet/provide the following functionality:
    a. **Peak Surge Current**: 10,000-amperes for an 8x20 microsecond waveform.
    b. Shall be rated for the appropriate voltage.
    c. **Response Time**: 1 nanosecond or less.
    d. **Life Expectancy**: Capable of surviving at a minimum of 25 occurrences at 2000-amperes.
    e. Surge suppressor shall be self-resetting.
7. CCTV power surge protectors for power from equipment cabinet power distribution to the CCTV Camera System shall meet/provide the following functionality:
    a. **Frequency**: DC to 10MHz.
    b. **Clamping Voltage**: < 30VAC (rms) or 42VDC.
    c. **Insertion Loss**: < 0.2dB.
    d. **Input/Output Impedance**: 75 ohms, typical.
    e. **Peak Surge Current**: 3000-amperes.
    f. **Response Time**: 1 nanosecond or less.
    g. Surge suppressor shall be self-resetting.

10.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections. All equipment shall be installed according to the manufacturer's recommendations, the Plans and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
2. Shall include all materials needed to permanently mount the CCTV camera to the support structure as indicated on the Plans.
3. Furnish and install power, video, and data cables, and any and all ancillary equipment required to provide a complete and fully operational CCTV system site.
4. Verify all wiring meets NEC requirements where applicable.
5. All above requirements apply to both new CCTV sites as well as sites where an existing CCTV is being replaced under the contract.

6. Cameras shall be mounted in positions which allow 360-degree continuous rotation and mounting arm position shall be as indicated on the Plans and approved by the Engineer prior to pole placement.
7. Furnish and install all appropriate field surge protection devices and ensure proper ground per manufacturer recommendations.
8. Coordinate with TDOT Regional TMC IT for IP addresses, and video encoding settings for all CCTV camera sites prior to turn-on/installation and site testing.
9. The CCTV system shall be compatible with and integrated by the contractor into the existing TDOT Regional TMC video wall and TDOT ATMS software. It shall be the Contractor's responsibility to coordinate with the TDOT Regional TMC operations personnel for Contractor integration of the new CCTV cameras into the existing video wall and TDOT ATMS software. It is the Contractor's responsibility to integrate and test all PTZ control and video display of the cameras at the TDOT Regional TMC.

10.4 Testing Requirements

10.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the CCTV Camera System.

10.4.2 Factory Acceptance Test

FAT is not required for CCTV Camera System.

10.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the Camera has no internal or external damage.
2. Test all Camera functionality including pan, tilt, zoom, iris, and focus to verify functionality.

10.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The BTS shall include the following tests and inspections:

1. Verify Camera attachment compatibility with the camera lowering device.
2. Verify that the Camera is compatible and supports operational interoperability with the communication equipment, TDOT ATMS software, and any existing equipment at the camera site.

10.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to the Pole Structure.
3. Verify the Camera has no internal or external damage.
4. Verify the Camera has been properly connected to the UPS for continuous, conditioned power.
5. Verify the Camera and cabinet equipment are protected by surge suppression.
6. Verify local PTZ, iris, and focus control.
7. Verify PTZ, iris, and focus control through the local Ethernet Switch.

10.5 Warranty

All materials specified in this section shall carry a minimum three-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

10.6 Method of Measurement

10.6.1 CCTV Camera System (Pan Tilt & Zoom)

CCTV Camera System will be measured in units of each and paid for at the contract price per each. The bid price shall include furnishing, installing, successful device integration, documentation, and testing of a complete CCTV Camera System including the CCTV Camera Assembly, positioner unit, zoom lens, enclosure, camera controller/receiver, required data and power cables, surge protectors and conduit between the camera and the cabinet, connections to support structures, attachment hardware and brackets and all incidental items to provide and install the CCTV Camera System as intended, as well as the satisfactory completion of all testing requirements and all work, equipment, and appurtenances as required for a full CCTV Camera System. The bid price shall also include all local configuration and control manufacturer software, system documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams and other materials necessary to document the operation of the CCTV Camera System. The bid price shall include integration and configuration into the existing TDOT Regional TMC video wall and TDOT ATMS software, testing for camera control, and display of the video on the existing video wall. This price shall be full compensation for all labor, tools, materials, equipment, software development and incidentals necessary to complete the work and integrate the CCTV Camera system into the existing TDOT ATMS software platform.

10.7 Payment

The contract unit price shall be full compensation for all the work specified in this Section.

Payment will be made under:

Item No.	Description	Unit
725-20.91	CCTV CAMERA SYSTEM (PAN TILT & ZOOM)	EA

The CCTV Camera System will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component and Bench Test System test results.
2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.
3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results including CCTV video display on existing video wall.
4. Final 10% of the contract unit price upon Final System Acceptance.

~~11 DYNAMIC MESSAGE SIGN~~

SECTION NOT USED

12 RADAR DETECTION EQUIPMENT

12.1 Description

12.1.1 General Description

This section specifies the minimum requirements for Radar Detection Systems (RDS) furnished and installed on this project. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, test, and operate a working RDS System for TDOT.

The RDS will provide roadway monitoring capabilities via microwave radar detectors transmitting data over wireline network equipment specified in this SP725. The data provided includes but is not limited to lane occupancy, speeds, classification, and volume. The RDS device shall support high-definition radar consisting of multiple radar beams. 2 receive antennas shall be positioned side-by-side with enough space between to create two, separate high-definition beams.

It shall be the Contractors responsibility to ensure that the submitted RDS is compatible with the travel time module within the TDOT ATMS software and can operate as designed on the Plans. It shall be the Contractor's responsibility to submit a product that is in compliance with this specification and the locations on the Plans. The Contractor shall notify the Engineer of any deviation or issue with the Plans or specifications prior to submitting, furnishing, and installing the RDS.

12.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

All functionality of the RDS data communications shall be ethernet-based and integral to the Device and Data Processor housings. Terminal servers shall not be used to facilitate data communications between the Device and Data Processor.

The firmware pre-installed on the device shall meet the minimum version listed in APPENDIX D at the time of device installation in the field.

12.2.1 Microwave Transmission

1. The microwave radar detector shall transmit on a frequency band of 24.0-24.25 GHz, or another spectral band approved by the Engineer. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The RDS shall not interfere with any known equipment.

12.2.2 Area of Coverage

The RDS's field of view shall cover an area defined by a beam its maximum detection range shall be as follows:

1. Elevation Beam Width 40^{o} or more

2. Azimuth Beam Width 15º or less

3. Range 6’ to 250’, minimum

12.2.3 Detection Zones

1. The minimum number of detection zones defined shall be no less than 12 lanes simultaneously.

12.2.4 Capabilities

The RDS shall be a true presence detector. It shall be suitable for mounting on road side poles or on overhead structures and provide the following:

1. Presence indication of moving or stopped vehicles in either direction in its detection zones, provided by contact closure.
2. The RDS shall have TCP/IP connection.
3. Traffic data, periodically accumulated over user defined time intervals in a 20 to 600 sec range, shall be transmitted via ethernet communications over Category 6 (minimum) cable to the local ethernet switch.
4. Traffic data shall be available simultaneously with detection zone contact closures and ethernet communications.
5. Side-fired configuration data shall include the following in each of up to 12 detection zones (lanes):
    a. Volume
    b. Lane occupancy
    c. Average speed
    d. Vehicle classification by length in a minimum of 8 user defined classes
6. RDS shall allow the user to define the contents of transmitted data.
7. Furnish the unit with the required software for data collection, processing, configuration and set-up, and data logging and retrieval. An operator shall be able to use the software to set detector count periods, sensitivities, and other operational features and parameters. The software must be capable of providing both manual and automatic setup and calibration.

12.2.5 Measurement Accuracy

1. The following error levels shall be achievable and demonstrated during testing:

Parameter	Error Percentage
Presence	5%
Volume	8%
Lane Occupancy	10%
Average Speed	10%
Length Classification Limits	10%

Parameter	Error Percentage
Time Event	10 ms
Input Voltage	2%

12.2.6 Environmental Conditions and Protection

Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after installation subjecting to any combination of the following:

1. Ambient temperature range of -37°C to +74°C.
2. Relative humidity from 5% to 95%, non-condensing.
3. Winds up to 90 mph (sustained) with a 30% gust factor.
4. Rain and other precipitation up to 2" per hour rate.
5. Power surge of ± 1kV (rise time = 1.2 µsec, hold = 50µsec) applied in differential mode to all lines, power and output, as defined by IEC 1000-4-5 and EN 61000-4-5 standards.
6. Printed circuit boards shall be conformal coated for protection against humidity.
7. Except as may be otherwise stated herein for a particular item, no item, component, or subassembly shall emit a noise level exceeding the peak level of 55db when measured at a distance of 3' away from its surface.
8. The microwave radar detector shall be resistant to vibration in accordance with IEC 60068-2-30 (test Fc), NEMA TS2 (latest edition), or approved equivalent.
9. The microwave detector shall be resistant to shock in accordance with IEC 60068-2-27 – Test Ea and guidance: Shock, NEMA TS2 (latest edition), or approved equivalent.

12.2.7 Mechanical

1. The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (IP 66 or greater compliant enclosure).
2. Maximum weight of the microwave radar detector assembly: 10 lbs.
3. The mounting assembly shall have all coated steel, stainless steel, or aluminum construction, and shall support a load of 20 lbs. or more. The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be tilted in both axes and then locked into place, to provide the optimum area of coverage.

12.2.8 Electrical

1. The RDS unit shall be operable from 12 – 24VDC and shall include necessary power supply to derive this voltage from a 120VAC nominal source.

12.2.9 Electrical Isolation and Surge Protection

1. All power lines, contact closures and the data port shall be surge protected within the unit. Contact closures and the data ports shall be isolated.

12.2.10 Data Processor

Data communications shall be full duplex asynchronous, configurable as:

1. RJ-45 port for ethernet communications.
2. Both point-to-point and multi-dropped configurations shall be supported.

12.2.11 RDS Comm Cable

1. The RDS comm cable shall be outdoor wet/dry rated cable with UV-resistant PVC or polyethylene outer jacket in accordance with UL 444 and wiring that supports a temperature rating of 105ºC.
2. The RDS comm cable shall support Power over Ethernet to supply both data and power over the same cable.
3. Cable connectorization and termination pin-out on all cables shall be in accordance with TIA 568B and the manufacturer's recommendations.
4. Connection between the RDS and the cabinet equipment shall be provided by a single RDS comm cable that is terminated with an IP67-rated shielded RJ-45 8P8C male push-pull connector with eight-position non-keyed and eight gold anodized pins or other Ethernet-compatible locking weathertight connector at the RDS and terminated to a surge suppressor prior to the RDS Data Processor in the equipment cabinet. No splices are permitted in the RDS comm cable.
5. Provide cable labels that meet the following requirements:
    a. Self-coiling wrap-around type.
    b. PVC or equivalent plastic material with UV and fungus inhibitors.
    c. Base materials and graphics/printing inks/materials designed for underground outside plant use including solvent resistance, abrasion resistance, and water absorption.
    d. Minimum size of 2.5" wide by 2.5" long
    e. Minimum thickness of 0.01".
    f. Orange label body with pre-printed text in bold black block-style font with minimum text height of 0.375".
    g. Pre-print the following text legibly on RDS Cable labels:
        i. RDS CABLE
        ii. TDOT ITS
    h. On all cable labels, print the text specified above twice on the label with the text of the second image reversed. The result shall be text which "reads right" when the label is coiled onto a cable.

12.2.12 Programmable Logic Controller (PLC)

If required as indicated on the Plans, the PLC shall process select data from the RDS unit and drive various field devices for turnkey applications.

1. Core requirements:

a. Minimum of 58 MHZ microprocessor

b. Minimum of 1024K of SRAM

c. Minimum of 512K of non-volatile flash memory

d. Real-time clock with battery backup

e. Watchdog timers to prevent device lockup

2. Physical requirements:

a. Weight less than 0.5 lb.

b. Din rail mounting

c. Hot-swappable

3. Power requirements:

a. Power supply 9-28 VDC

b. Power consumption: less than 10 W

4. Environmental requirements:

a. Ambient operating temperature: -34°C to +74° C

b. Relative humidity: 95%

5. Connectivity requirements:

a. Four (4) independent physical serial ports (two RS-232 and two RS-485)

b. Two (2) multi-functional digital input ports

c. Two (2) solid state contact closure output ports

6. Communication requirements:

a. Converts RS-232 to RS-485 and vice versa

b. Support the following baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps

7. Contact closure to Ethernet device:

a. Provide a contact closure device that will input contact closure relay signals from the RDS and output onto the 10/100Base-T Ethernet network to local Ethernet Switch.

b. Device shall be rack, DIN rail, or wall mountable.

12.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections.

12.3.1 Radar Detection System

1. The RDS shall be mounted in side-fired configuration on poles as shown on the Plans, using mounting brackets. The brackets shall be attached with approved ¾" wide stainless-steel bands. The various mounting configurations include attaching to new light standard poles where the

wiring shall be installed inside the pole; attaching to new CCTV poles where the wiring shall be installed inside the pole; and attaching to existing overhead truss structures where conduit risers may be required on the outside of the truss structure.

2. The Contractor shall install the detector unit on a pole at the manufacturer's recommended height above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified elevation angle as suggested by the manufacturer.

3. When installing a detector near metal structures, such as buildings, bridges, or sign supports, the sensor shall be mounted and aimed so that the detection zone is not under and does not pass through any structure to avoid distortion and reflection.

4. The RDS mode of operation, detection zones, and other calibration and set up will be performed using a Microsoft Windows-based software and a Notebook PC. The software shall allow verification of correct setup and diagnostics. It shall include facilities for saving verification data and collected data as well as saving and retrieving sensor setup from a non-volatile memory device.

5. Unused conductors in the RDS unit harness cable shall be grounded or un-terminated in the cabinet in accordance with the manufacturer's recommendations. Un-terminated conductors shall be individually doubled back and taped, then loosely bundled and secured.

6. Contractor shall install a local / remote disconnect switch or a RDS communications wiring module in accordance with Section 8.2.2, 8.2.3, or 8.2.4 and as shown on the Plans.

7. The RDS power supply shall be connected to the UPS within the cabinet.

12.3.1.1 Device Configuration

The RDS shall be configured within the ATMS software as part of the setup process. The following configuration parameters shall be followed.

1. Use field verification to determine proper link/lane configuration at the detector site.

2. Create links for each portion of the main line roadway and each auxiliary portion of the roadway. Split existing links into multiple if necessary.
    a. Main line roadway is named like the detectors; for example: "R3G-00I24-43.6E (143)" and "R3G-00I24-43.6W (143)". Note the difference in roadway direction for each link.
    b. Auxiliary roadway links are named like the main line, but with an additional suffix. Add "Off Ramp", "On Ramp", or "Auxiliary" to the name after the mile marker and direction; for example: "R3G-00I24-56.7E Off Ramp (267)"
    c. Length of the link can be estimated by using roadway satellite imagery or a map of the detector locations. The length is defined as half the distance from a detector to its upstream neighbor, plus half the distance from the detector to its downstream neighbor.
3. Create expected lanes within each link.
    a. Lane number is not the same as the sensor detection zone number. In fact, they will typically be reversed.
        i. Sensor detection zones start at zero and increase moving away from the sensor (e.g., 0-7 for an eight-lane highway).
        ii. Lane numbers start at one (1) in the center of the roadway (left-most when facing in the direction of travel) and increase moving outwards (to the right when facing

in the direction of travel). Lane numbering is the same for each travel direction of the roadway, so there is expected to be overlap in numbers.

iii. Lane numbers for auxiliary lanes re-start at one (1) for the center-most auxiliary lane and increase moving outwards. Again, these are numbered for each auxiliary line independently.

b. In the ATMS configuration, each lane belongs to a given link. Each link, therefore, must have at least one lane created.

c. Lane names for main line links will use a suffix in the format "-Lane#"; for example, "R3G-00I24-43.6E (143)-Lane1".

d. Auxiliary lanes will use the auxiliary classification from the link as a suffix in the format "-OffRamp#"; for example, "R3G-00I24-56.7E (267)-OffRamp1". Note that the auxiliary classification is used only once in the lane suffix, not carried over from the link portion of the name. The name has a limited number of characters, so it cannot have both.

e. Assign the expected detection zone to the lane based on what the sensor is seeing. Recall the detection zones start at zero and increase moving outwards from the sensor location.

4. Detector software configuration:

a. Each detector make/model may have different configuration software. The following are general guidelines for setting up the sensor and should be supplemented with the installation manual for the device for manufacturer recommendations.

b. The sensor shall be set up to report US/Imperial units for speed and vehicle length.

c. Calibration of the device for detection zones and speeds shall be performed during a moderate- or high-traffic period since vehicles must be readily present within the detection zones to properly identify them.

i. The number of detection zones on the sensor shall match the number of lanes configured in the ATMS software.

d. Update length bin classifications to the values in the following Table.

RDS Length Classification Bins		
Bin #	**Description**	**Length Range**
1	Motorcycle/small vehicle	0.0-8.9
2	Most passenger vehicles	9.0-18.9
3	Large pickup/van	19.0-23.9
4	Bus	24.0-25.9
5	Small/single unit truck (SU)	26.0-40.9
6	5-axle semitrailer | WB-40 intermediate semitrailer	41.0-50.9
7	6-axle single / 5-axle multi semitrailer | WB-50/WB-62 large/"full" semitrailer	51.0-70.9
8	6+-axle multi semitrailer | WB-65/67 Interstate semitrailer	71.0+

12.3.2 RDS Comm Cable

12.3.2.1 RDS Cable Shipping and Delivery

1. Package the cable for shipment on reels. Each package shall contain only 1 continuous length of cable. Construct the packaging to prevent damage to the cable during shipping and handling.
2. Seal both ends of the cable to prevent the ingress of moisture.
3. Include with each reel a weatherproof reel tag attached identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable. Include with each cable a cable data sheet containing the following information:
    a. Manufacturer name
    b. Cable part number
    c. Factory order number
    d. Cable length
    e. Factory measured continuity and attenuation of each conductor and shield

12.3.2.2 RDS Cable Installation

1. Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer. Continuously monitor pulling tensions with calibrated measuring devices, such as a strain dynamometer.
2. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.
3. Take all necessary precautions to protect reeled cable from vandals or other sources of damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section.
4. Whenever unreeled cable is placed on the pavement or surface above a pull box, provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.
5. Keep the cable continuous throughout the pull. Terminate the cable only in equipment cabinets on terminal blocks. Cable splices are not permitted.

12.3.2.3 RDS Cable Storage and Labeling

1. Safely store all cable to minimize susceptibility to damage. Maintain proper bend radius, both short and long term, during cable storage. Storage coils shall be neat in even length coils, with no cross over or tangling. Storage coils of different cables shall be kept separate. Storage coils shall be secured to cable racking hardware with tie wraps, Velcro straps, or non-metallic cable straps with locking/buckling mechanism. Do not use adhesive or self-adhering tapes, metal wires and straps, or rope/cord.
2. Unless otherwise noted on the Plans, the following are the requirements for cable storage for underground applications:
    a. Cable in Type C pull box – 20’.
    b. Cable in Type D pull box – 20’.

c. Cable in Type E pull box – 20'.

3. Install cable labels on all RDS Cables. Clean the installed cable of all dirt and grease before applying any label.

4. Label all cables in or at every location where the cable is exposed outside of a conduit, inner-duct, or pole. As a minimum, install cable labels in the following locations:

    a. Within 12" of every cable entry to a pull box or equipment cabinet.

    b. Every 10' for the entire length of cable in any storage coil in pull boxes.

12.4 Testing Requirements

12.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.

2. All test results shall confirm physical and performance compliance with this SP725.

3. Payment for all testing is included in the cost of the Radar Detection Equipment.

4. All RDS Cables under test shall be removed from all wiring termination devices until testing is completed. All RDS Cable conductors shall be connected to ground immediately after testing to ensure elimination of all capacitive charges and potentials.

5. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7. Test documentation shall include:

    a. RDS Cable Identification:

        i. Cable ID and Location – physical location (device ID and station number of equipment cabinet) and conductor/pair/shield ID for both the beginning and ending point

        ii. Operator Name

        iii. Engineer's Representative

        iv. Date & Time

    b. Setup and Test Conditions Parameters:

        i. Battery charge and proper operation of ohmmeter

        ii. Battery charge and proper operation of insulation resistance tester

        iii. Ambient Temperature

    c. Test Results for Continuity Test:

        i. Conductor continuity

        ii. Resistance (ohms)

        iii. Measured Length (Cable Marking)

d. Test Results for Insulation Resistance Test:

i. Measured Cable Length

ii. Insulation resistance (exceeds manufacturer's specifications for at least 60 seconds.)

12.4.2 Factory Acceptance Test

FAT is not required for Radar Detection Equipment.

12.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the Radar Detection Equipment has no internal or external damage.
2. Test all Radar Detection Equipment functionality using vendor software.
3. Perform continuity test on all conductors and shield in the RDS Cable.

12.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The BTS must be performed utilizing the maximum total length of the RDS Cable required in this project. The BTS shall include the following tests and inspections:

1. Verify Radar Detection Equipment attachment compatibility with the mounting bracket.
2. Verify that the Radar Detection Equipment is compatible and supports operational interoperability with the communication equipment, TDOT ATMS software, and any existing equipment at the Radar Detection Equipment site.
3. Verify that the RDS can be configured and calibrated using the vendor software.
4. Verify that the required operational characteristics of the device are valid including the counting of volume and speed.

12.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to the Pole Structure.
3. Verify the Radar Detection Equipment has no internal or external damage.
4. Verify the Radar Detection Equipment has been properly connected to the UPS for continuous, conditioned power.
5. Verify the RDS and cabinet equipment are protected by surge suppression.
6. Verify volume and speed data can be observed through the direct local connection.
7. Verify volume and speed data can be observed through the Network Ethernet Switch.

8. Test and document the accuracy of the RDS in accordance with the accuracy requirements specified in Section 12.2.5. A portion of this test requires the contractor to use a calibrated radar gun to compare observed speeds on a per lane basis between the calibrated radar gun and RDS data over a 5-minute period. All data collected during the test shall be documented and submitted to the Engineer for approval.
9. Perform continuity test and insulation resistance test on all conductors and shield in the RDS Cable.

12.5 Warranty

All materials specified in this section shall carry a minimum three-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

12.6 Method of Measurement

12.6.1 Radar Detection System

The Radar Detection System (RDS) will be measured in units of each and paid for at the contract price per each. The bid price shall include furnishing and installing of the RDS including the unit, power supply, all conduit, risers, and weather head between the RDS and the cabinet, interconnection wiring to the ethernet switch, connections to support structures (includes all incidental components, attachment hardware, mounting brackets, mounting arms, bolts, or any other items to mount the RDS as intended), and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the RDS site complete in place and ready for use. Furnishing and installing of RDS harness cabling to be bid under the RDS Comm Cable pay Item. The bid price shall include satisfactory completion of device integration and testing of a complete RDS, including the unit, the RDS harness cabling, and interconnection wiring. The bid price shall also include all documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other material necessary to document the operation of the RDS. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

In locations where an RDS is connected to an existing cabinet via RDS Cable, the bid price for the RDS shall include furnishing, installing, and testing of a RDS communication subsystem inside the existing cabinet. This RDS communications subsystem shall meet the specifications in Section 12.2.

12.6.2 RDS Comm Cable

RDS Comm Cable will be measured in units of linear feet and paid for at the contract price per linear feet of actual cable installed as measured from the cable sequential length markings. The bid price shall include furnishing, installing, device integration, and testing of a complete RDS Comm Cable installation with operational RDS units and shall include cable labels and all ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP725 or the Plans.

12.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-21.91	RADAR DETECTION SYSTEM	EA
725-21.96	RDS COMM CABLE	LF

Radar Detection System (RDS) will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component and Bench Test System test results.
2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.
3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.
4. Final 10% of the contract unit price upon Final System Acceptance.

RDS Cable will be paid per linear foot as follows:

1. 25% of the contract unit price upon delivery and reel test.
2. Additional 35% of the contract unit price for complete installation of cables.
3. Additional 30% of the contract unit price for successful completion of Stand Alone Site Test results of the complete cable in any lineal foot between terminations in equipment cabinets and Stand Alone Site Testing of all RDS units communicating through this section of cable.
4. Final 10% of the contract unit price upon Final System Acceptance.

~~13 ENVIRONMENTAL SENSOR SYSTEM (ESS)~~

SECTION NOT USED

~~14 ROAD SIDE UNIT (RSU)~~

SECTION NOT USED

~~15 OVERHEIGHT VEHICLE DETECTION SYSTEMS~~

SECTION NOT USED

~~16 HIGHWAY ADVISORY RADIO (HAR)~~

SECTION NOT USED

~~17 WEIGH IN MOTION (WIM) SYSTEM~~

SECTION NOT USED

~~18 PERMANENT SPEED FEEDBACK SIGN~~

SECTION NOT USED

19 NETWORK SWITCH

19.1 Description

19.1.1 Overview

1. The Contractor shall furnish Network Ethernet Switch and Ethernet Bridge models indicated on the Plans and specified on the certification published on the TDOT Traffic Design Division website for proprietary items regarding Local Area Network devices:

   https://www.tn.gov/content/dam/tn/tdot/traffic-operations/its/qualified-products-list/Proprietary%20Item_Statewide_Exp%2009-23-2025_ITS%20SmartWay%20LAN.pdf

2. The Contractor shall furnish and install new Layer 2 (L2) Field Ethernet Switches at the locations identified on the Plans. Upon successful completion of Bench Testing, the Contractor shall deliver the L2 Field Ethernet Switches to TDOT Regional TMC IT for TDOT to configure and provision the switches. TDOT Regional TMC will notify the Contractor when the configuration and provisioning of the L2 Field Ethernet Switches is complete and the switches are ready for pickup by the Contractor. Upon notice to the Contractor, the Contractor shall then collect the L2 Field Ethernet Switches and install them in the field. The Contractor shall then integrate the L2 Field Ethernet Switches into the TDOT communications network.

3. The Contractor shall furnish and install Layer 3 (L3) Aggregation Ethernet Switches and L3 Field Aggregation Ethernet Switches at locations identified on the Plans. Upon successful completion of Bench Testing, the Contractor shall deliver the L3 Aggregation Ethernet Switches to TDOT Regional TMC IT for TDOT to configure and provision the switches. TDOT Regional TMC will notify the Contractor when the configuration and provisioning of the L3 Aggregation Ethernet Switches is complete and the switches are ready for pickup by the Contractor. Upon notice to the Contractor, the Contractor shall then collect the L3 Aggregation Ethernet Switches and install them in the field. The Contractor shall then integrate the L3 Aggregation Ethernet Switches into the TDOT communications network.

4. The Contractor shall furnish and install new Ethernet Bridges at the locations identified on the Plans. The Contractor shall integrate the Ethernet Bridges into the TDOT communications network.

19.1.2 Virtual Local Area Network (VLANs)

1. For the L2 Field Ethernet Switches installed in the field, VLANs shall be developed to group devices by type. Where utilized, the management VLAN will be logically separate from all other VLANs to ensure manageability during network events and to provide additional security.

2. Common/consistent ports shall be used for the edge devices at each L2 Field Ethernet Switch. 2 ports shall be reserved for future edge devices. 1 port shall be reserved for network connection by a laptop computer at the equipment cabinet, which shall be the only port configured with access to the management VLAN.

19.1.3 Systems Design Report

1. See Section 22.2.4 for Systems Design Report requirements.

19.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

The firmware pre-installed on the device shall meet the minimum version listed in APPENDIX D at the time of device installation in the field.

19.2.1 General

1. Furnish equipment for the LAN that complies with applicable IEEE 802 standards. Furnish Network Ethernet Switches and Ethernet Bridges that are fully compatible and interoperable with the network monitoring software, the existing network architecture and configuration, and the existing firewall and Layer 3 switch at the TDOT Regional TMC.

2. Furnish Network Ethernet Switches and Ethernet Bridges that comply with the following electrical safety requirements: UL60950-1 or CAN/CSA-C22.2 No. 60950-1 (safety requirements for IT equipment) and FCC Part 15 Class A for EMI emissions.

3. All expansion modules, SFP modules, and power supplies furnished shall be from the same manufacturer as the Network Ethernet Switch or Ethernet Bridge furnished.

19.2.2 Network Switch (Type A) (L2 Field Ethernet Switch)

1. Furnish L2 Field Ethernet Switches that are indicated on the Plans.

2. L2 Field Ethernet Switches shall be DIN rail mounted.

3. Furnish L2 Field Ethernet Switches with a Power Supply meeting the following requirements:
   a. Shall be manufactured by the same vendor as the L2 Ethernet Switch.
   b. Shall be DIN rail mounted.
   c. Power supply shall have 2-stage isolation accomplished via 2 transformers: the first steps down from primary AC/DC to 48VDC; the second steps down from 48VDC to the final DC voltage required by the switch.
   d. Shall be sized to power the L2 Ethernet Switch.
   e. A power cord of not less than 5’ in length shall be supplied.

4. Furnish industrial SFP modules rated to service the Field Ethernet to Field Ethernet optical uplinks and Field Ethernet to Gig-E Hub Uplink rated for optical attenuation required to service the link. Use SFP modules that are LX or ZX and are matched and compatible with the SFP module it is mated with. LX SFP modules should be used for link lengths less than 10 km, EX SFP modules should be used for link lengths between 10 km and 40 km, and ZX SFP modules should be used for link lengths between 40 km and 80 km. Furnish attenuators, if required, to service link without saturating receiving optics.

5. If Cellular Communications are required for a specific L2 Field Ethernet Switch at a specific location as indicated on the Plans, the L2 Field Ethernet Switch shall also include dual active LTE-capable modules that support LTE and LTE-Advanced with carrier aggregation. The L2

Field Ethernet Switch shall be capable of concurrent connectivity to two separate cellular networks.

6. Furnish industrial SFP modules rated for use with the optical cable furnished under this project.

7. Furnish industrial SFP modules with LC connector or as indicated on the Plans and approved by the Engineer.

8. Furnish industrial SFP modules that are hardened to operate in temperatures from -40°C to 60°C.

9. Furnish single mode fiber jumper cables with appropriate connectors to connect with switch and adjacent fiber optic drop panel connectors and/or other switches. Single mode fiber jumper cables shall meet the requirements in Section 5 of this SP725.

19.2.3 Network Switch (Type B) (L3 Aggregation Ethernet Switch)

1. Furnish L3 Aggregation Ethernet Switches that are indicated on the Plans.

2. L3 Aggregation Ethernet Switches shall only be installed in environmentally-controlled ITS Communications Hub Buildings or TDOT Regional TMC.

3. L3 Aggregation Ethernet Switches shall be rack mounted.

4. Furnish L3 Aggregation Ethernet Switches with a Power Supply meeting the following requirements:
   a. Shall be manufactured by the same manufacturer as the L3 Aggregation Ethernet Switch.
   b. Shall have dual redundant Power Supplies installed in the Ethernet Switch power supply bays.
   c. Shall be sized to power the L3 Aggregation Ethernet Switch.

5. L3 Aggregation Ethernet Switches shall have a minimum of forty-eight 1G SFP fiber ports.

6. Furnish SFP modules for a minimum of twenty-four 1G SFP fiber ports with LC connector or as indicated on the Plans and approved by the Engineer. 1G SFP module shall support a link length of 25 miles or greater.

7. Furnish SFP+ modules for a minimum of 8 10G SFP+ fiber ports with LC connector or as indicated on the Plans and approved by the Engineer. 10G SFP+ module shall support a long-haul link length of 50 miles or greater.

8. Furnish industrial SFP modules rated for use with the optical cable furnished under this project.

9. Furnish industrial SFP modules with LC connector or as indicated on the Plans and approved by the Engineer.

10. Furnish industrial SFP modules that are hardened to operate in temperatures from -40°C to 60°C.

11. Furnish single mode fiber jumper cables with appropriate connectors to connect with switch and adjacent fiber optic termination cabinet and/or other switches. Single mode fiber jumper cables shall meet the requirements in Section 5 of this SP725.

19.2.4 Network Switch (Type C) (L3 Field Aggregation Ethernet Switch)

1. Furnish L3 Field Aggregation Ethernet Switches that are indicated on the Plans.

2. L3 Field Aggregation Ethernet Switches shall be hardened for use in ITS Communications Hub Cabinets.

3. L3 Field Aggregation Ethernet Switches shall be rack mounted.

4. Furnish L3 Field Aggregation Ethernet Switches with a Power Supply meeting the following requirements:
   a. Shall be manufactured by the same manufacturer as the L3 Aggregation Ethernet Switch.
   b. Shall have dual redundant Power Supplies installed in the Ethernet Switch power supply bays.
   c. Shall be sized to power the L3 Field Aggregation Ethernet Switch.

5. L3 Field Aggregation Ethernet Switches shall have a minimum of forty-eight 1G SFP fiber ports.

6. Furnish SFP modules for a minimum of twenty-four 1G SFP fiber ports with LC connector or as indicated on the Plans and approved by the Engineer. 1G SFP module shall support a link length of 25 miles or greater.

7. Furnish SFP+ modules for a minimum of 8 10G SFP+ fiber ports with LC connector or as indicated on the Plans and approved by the Engineer. 10G SFP+ module shall support a long-haul link length of 50 miles or greater.

8. Furnish industrial SFP modules rated for use with the optical cable furnished under this project.

9. Furnish industrial SFP modules with LC connector or as indicated on the Plans and approved by the Engineer.

10. Furnish industrial SFP modules that are hardened to operate in temperatures from -40°C to 60°C.

11. Furnish single mode fiber jumper cables with appropriate connectors to connect with switch and adjacent fiber optic termination cabinet and/or other switches. Single mode fiber jumper cables shall meet the requirements in Section 5 of this SP725.

19.2.5 Ethernet Bridge

1. Furnish Ethernet Bridges that are indicated on the Plans.

2. Ethernet Bridges shall be DIN rail mounted.

3. Furnish Ethernet Bridges with a Power Supply meeting the following requirements:
   a. Shall be manufactured by the same manufacturer as the Ethernet Bridge.
   b. Shall be DIN rail mounted.
   c. Power supply shall have 2-stage isolation accomplished via 2 transformers: the first steps down from primary AC/DC to 48VDC; the second steps down from 48VDC to the final DC voltage required by the switch.
   d. Shall be sized to power the Ethernet Bridge.
   e. A power cord of not less than 5' in length shall be supplied.

19.2.6 Software Requirements & Licensing

1. The manufacturer for the Network Ethernet Switches shall also supply the configuration and management software for the corresponding switch hardware. This software shall be provided at no additional cost and shall be included in the unit price of each Network Ethernet Switch pay item.

2. Necessary firmware updates shall be communicated to TDOT Regional TMC IT and performed by the Contractor during the life of the project. Prior to Final Project Acceptance, the Contractor shall notify their Network Ethernet Switch vendor representatives that TDOT Regional TMC IT will assume maintenance responsibilities on the switches themselves as well as any needed firmware updates after Final Acceptance. The vendor shall then communicate directly with TDOT Regional TMC IT or their ITS Maintenance Contractor representatives of any needed firmware updates.

19.3 Installation Requirements

Contractor shall abide by the following installation requirements:

1. Install L2 Field Ethernet Switches, L3 Aggregation Ethernet Switches, L3 Field Aggregation Ethernet Switches, Ethernet Bridges and all associated hardware for each component.

2. Install Power Supply and plug into UPS for continuous, conditioned power.

3. Coordinate all work at, near, or inside buildings with the Engineer. Do not work on buildings or enter buildings without prior, written authorization from the Engineer. Coordinate and obtain approval from Engineer regarding allowable working time in buildings. Obtain necessary permits and inspections. Work shall not commence until the necessary permits are issued, posted on site, and approved Plans are available on site. The Contractor shall coordinate installation with TDOT staff at least 2 weeks in advance of needing access to the installed cable(s)/network equipment.

4. Furnish MAC addresses in a spreadsheet for all equipment utilized as part of this project, in addition to the equipment models, serial numbers, and firmware revisions. Equipment shall be registered in the name of TDOT. Affix a MAC Address label to each device utilized. Furnish IP addresses for all equipment utilized as part of this project. Affix final IP address to each device utilized. Use labels that do not smear or fade.

5. In field equipment cabinets, fully integrate new Network Ethernet Switches with the fiber optic termination patch panels. Integrate all field equipment as shown on the Plans.

6. No Ethernet switch configuration or deployment can occur until the Contractor's Systems Design Report has been approved in final form by the TDOT Regional TMC IT.

19.4 Testing Requirements

19.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP725.
2. All test results shall confirm physical and performance compliance with this SP725.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the Network Switch.

19.4.2 Factory Acceptance Test

FAT is not required for Network Switches.

19.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the Network Switch has no internal or external damage.
2. Test all Network Switch functionality using Cisco DNA Center software.

19.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. BTS of Network Switch will be performed in conjunction with other components in this SP725 that are reliant upon the Network Switch for communications.

19.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and within the Equipment Cabinet or Equipment Rack.
3. Verify the Network Switch has no internal or external damage.
4. Verify the Network Switch has been properly connected to the UPS for continuous, conditioned power.

19.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover

complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

19.6 Method of Measurement

19.6.1 Network Switch (Type A)

Network Switch (Type A) L2 Field Ethernet Switch will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All SFP modules, optics, cabling, jumper cables, patch cables, attenuators, power supplies, applicable configuration, and testing or other labor or materials required to install and integrate the Field Ethernet Switch will be considered incidental and not be paid for separately. If an L2 Field Ethernet Switch is required to provide cellular connectivity as indicated on the Plans, TDOT will provide the provisioned SIM card to achieve connectivity via coordination with the Contractor. Contractor shall coordinate with TDOT at the preconstruction meeting to ensure the SIM cards have been requested from Strategic Technology Solutions (STS) to avoid construction delays.

19.6.2 Network Switch (Type B)

Network Switch (Type B) L3 Aggregation Ethernet Switch will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All SFP modules, optics, cabling, jumper cables, patch cables, attenuators, power supplies, applicable configuration, and testing or other labor or materials required to install and integrate the Aggregation Ethernet Switch will be considered incidental and not be paid for separately.

19.6.3 Network Switch (Type C)

Network Switch (Type C) L3 Field Aggregation Ethernet Switch will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All SFP modules, optics, cabling, jumper cables, patch cables, attenuators, power supplies, applicable configuration, and testing or other labor or materials required to install and integrate the Field Aggregation Ethernet Switch will be considered incidental and not be paid for separately.

19.6.4 Ethernet Bridge

Ethernet Bridge will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All cabling, jumper cables, patch cables, power supply, configuration, and testing or other labor or materials required to install and integrate the Ethernet Bridge will be considered incidental and not be paid for separately.

19.7 Payment

Payment will be made under:

Item No.	Description	Unit
725-21.11	NETWORK SWITCH (TYPE A)	EA
725-21.12	NETWORK SWITCH (TYPE B)	EA
725-21.13	NETWORK SWITCH (TYPE C)	EA
725-21.16	ETHERNET BRIDGE	EA

L2 Field Ethernet Network Switch (Type A) will be paid per each as follows:

1. 50% of the contract unit price upon completion Bench Test Component and Bench Test System test results.

2. 20% of the contract unit price upon completion of Stand Alone Site Testing at the field cabinet.

3. 20% of the contract unit price upon Conditional System Acceptance test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

L3 Aggregation Ethernet Network Switches (Type B and Type C) will be paid per each as follows:

1. 50% of the contract unit price upon completion Bench Test Component and Bench Test System test results.

2. 20% of the contract unit price upon completion of Stand Alone Site Testing at the ITS Communications Hub.

3. 20% of the contract unit price upon Conditional System Acceptance test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

Ethernet Bridge will be paid per each as follows:

1. 50% of the contract unit price upon completion Bench Test Component and Bench Test System test results.

2. 20% of the contract unit price upon completion of Stand Alone Site Testing at the Equipment Cabinet or Building housing the Ethernet Bridge.

3. 20% of the contract unit price upon Conditional System Acceptance test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

~~20 ITS COMMUNICATIONS HUB BUILDING~~

SECTION NOT USED

21 PORTABLE SMART WORK ZONE SYSTEM (PSWZS)

21.1 Description

This section specifies the minimum requirements and materials for the Portable Smart Work Zone System (PSWZS) to be furnished and installed as shown on the Plans and in accordance with the contract documents.

21.2 Materials

All PSWZS shall be comprised of the highest quality materials and meet the requirements of this section.

The PSWZS shall be comprised of a trailer, mast assembly, Portable Closed-Circuit Television (PCCTV) camera, Portable Radar Detection System (PRDS), Portable Changeable Message Signs (PCMS), two pairs of flashing LED beacons, edge-lit traffic sign, localized encrypted RF relay system, flash controller, charge controller, battery bank, and solar panel array.

The PSWZS shall require multiple trailers in multiple configurations to be effective utilizing solar advanced warning systems, PCMS, edge lit regulatory signs, wig wag beacons, CCTV devices, and field programmable radio frequency communications.

Each trailer that is part of the PSWZS shall be equipped with sensors, changeable message sign, edge lit regulatory signs with wig wag beacons, CCTV devices, and/or and field programmable radio frequency communications.

All signs and traffic control devices are to conform to the latest adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD).

21.2.1 General Capabilities and Device Performance Requirements

PSWZS capabilities and performance requirements include the following:

1. PSWZS components shall be placed at locations shown on the Plans or specified by the contract documents, to provide full coverage over the project limits. This includes mainline travel lanes, shoulders, and side streets where applicable. The Department reserves the right to request relocation of devices throughout the life of the project.
2. The PSWZS field devices shall be compatible with each other and with the PSWZS software.
    a. They shall be of rugged make and suitable for reliable operation in adverse weather conditions.
3. The Contractor shall ensure the installed equipment provides unobstructed real-time data from the roadway, other current conditions around the field site, and within the project limits.
    a. The PSWZS shall respond to control signals and transmit data and video to a remote operator interfaced with the system.
4. Each device shall be capable of being remotely controlled and programmed via provided PSWZS software from the TDOT Regional TMC.
5. Field programmable radio frequency communications shall be fully integrated with the PSWZS devices and software and be part of the system.

21.2.2 Portable Smart Work Zone System (PSWZS) Trailer Requirements

The portable trailer shall serve as a standard platform for the components of the PSWZS.

The trailer shall be comprised of the following materials:

1. Minimum 11-gauge rectangular steel tubing that has been electrically welded following current ANSI specifications and powder coated with appropriate safety colored paint, orange, or other TDOT approved color.
2. A vertically raising mechanical mast assembly which can raise and lower the attached signs and sensors to a minimum height of 7 feet above the pavement.
    a. The mast assembly shall be operated with a brake and cable assembly that levers the mast into a position where it can be pinned for safety.
    b. The mast assembly shall allow for 360-degree sign rotation to allow the operator to easily turn the signs into the display position. Mast locks shall be provided at regular intervals to provide varied set up positions.
3. Adjustable, extendable (telescoping) crank type swivel jacks will be placed at all 4 corners of the trailer to allow the user to level and stabilize the system upon deployment to allow for maximum wind loading and stability.

The trailer shall be of sufficient size and capacity to allow safe travel at highway speeds up to 70 mph. it shall be designed in such a manner as to act as a stable platform for safe operation of all equipment, signs, beacons, and sensors.

21.2.3 Portable Closed-Circuit Television (PCCTV) Camera Requirements

The Portable Closed Circuit Television camera (PCCTV) shall be fully integrated with the PSWZS software. Pan, Tilt, Zoom (PTZ) functions and video streams shall be accessible through the PSWZS software, and shall not be accessed through a separate control software or link.

The PCCTV shall adhere to the following minimum requirements:

1. The PCCTV shall deliver high quality, full high definition (FHD) color images, at a minimum, and be fully compliant with all aspects of the National Television Standards Committee (NTSC) specifications and produce NTSC compatible video.
2. The PCCTV shall be able to operate in a wide variety of dynamic lighting conditions, including but not limited to, low light/dusk, full sunlight, and night.
    a. It shall have switchover iris control (color to monochrome) with user selectable manual and automatic control capabilities.
3. The PCCTV shall be able to deliver multiple streams simultaneously.
    a. The streams shall be H.264 and Motion JPEG video at up to 30 fps in all resolutions.
    b. Placement of the camera and local communications options withing the project limits shall determine best video frame rate at which to provide video.
    c. Contractor shall strive for the best frame rate and shall place the camera in an area with the best possible cellular coverage while keeping within the relative area shown on the Plans.
4. The PCCTV shall be of dome type 360-degree PTZ and be IP66 rated, at a minimum.

5. The PCCTV shall include iris capability to auto-focus during zoom-in and zoom-out operations and the ability to manually override it via the PSWZS software.
6. The PCCTV shall be of rugged nature and an all-weather installation integrated into a mobile trailer type mount.
    a. The mount shall be adjustable for camera height (mast) and solar array.
    b. The trailer shall be able to power the camera via solar panels and charger.
    c. The PCCTV shall not rely on outside power source.
    d. Adjustable height of camera mast shall be 32 feet measured from top of the roadway surface.
7. Battery bank shall be sized for 30-day autonomy, charged from solar array.

21.2.4 Portable Radar Detection System (PRDS) Requirements

The Portable Radar Detection System (PRDS) device, or queue detection system, shall be fully compatible and integrated with the PSWZS software. The device shall be auto-configurable, trailer mounted, battery-powered, solar charged, and provide HD microwave-based lane count, occupancy, and speed data to the PSWZS software. The PRDS must be capable of operation in all weather conditions, including rain, snow, freezing rain, wind, dust, and fog.

The PRDS shall pass all data in real-time to the PSWZS processing server and disseminated to the Operator and automated message generator to produce automated messages on the PCMS a maximum of 60 seconds after PRDS detects the data.

The PRDS shall adhere to the following minimum requirements:

1. The PRDS shall consist of a dual zone radar and transmit on a frequency band of 24 GHz ±25 MHz or other TDOT approved spectral band.
    a. The detector shall also comply with the limit for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority.
    b. The PRDS shall not interfere with any known equipment.
    c. The transmitter power shall not exceed 10 milliwatts (mW).
2. The PRDS shall have no less that ten (10) detection zones at a maximum of twenty (20) feet from the detector.
    a. Minimum separation between detected vehicles shall be no more than six (6) feet.
    b. The detector shall be capable of detection over barriers.
    c. Data collected shall include:
        1) Volume
        2) Travel Times
        3) Lane Occupancy
        4) Average Speed
        5) Vehicle Classification by length. Minimum 3 user defined classes.
3. The PRDS shall be rugged in nature and sealed in a weatherproof box to protect from water intrusion, dust, and other airborne particles.
    a. The PRDS shall be resistant to wind speeds up to 90 mph.
    b. Its enclosure shall be NEMA Type 3R or 4x rated.
4. The PRDS unit shall be operable from 12-24 VDS.
    a. It shall be powered by battery bank charged by an adjustable solar array on an industrial grade trailer platform.

5. PRDS communications connections and equipment to be determined by the manufacturer and PSWZS vendor for the fastest and most reliable data communications to the software and automated message generator.

21.2.5 Portable Changeable Message Signs (PCMS) Requirements

The PSWZS shall include Portable Changeable Message Signs (PCMS) at locations specified on the Plans or by the Department.

The PCMS shall provide autonomous automated messaging for motorists regarding congestion levels, travel times, detour routings, queue information, and cautions along the project limits and associated Smart Work Zone. Message override shall be available to the TDOT TMC Operators to display pertinent information as necessary.

The PCMS shall adhere to the following minimum requirements:

1. The PCMS shall be trailer mounted on an industrial grade trailer as described in this Specification.
2. The PCMS shall either be standard mono-color or full color matrix display.
    a. Sign case minimum dimensions for full matrix display shall be between 4.5’ H x 8.5’ W to 6’ H x 11’ W.
    b. The PCMS shall have at a minimum 5 high-intensity, solid state LEDs per 2-inch pixel.
    c. Individual Line matrix signs of individual characters shall not be allowed.
3. The PCMS panel shall be at least 7 feet above the pavement and present a level appearance.
    a. The panel shall be capable of displaying a minimum of eight (8) characters in each of the three lines of the full matrix display, at an eighteen inch (18”), character height.
    b. The panel shall be capable of displaying other fonts and character heights. Other fonts and heights may be used to display different traffic data.
    c. Those fonts shall be used at the discretion of the TDOT TMC Operations staff.
4. The full 18” Character height shall be visible from ¼ mile under both day and night conditions in accordance with MUTCD standards.
    a. Other font sizes and options for the full matrix display shall be documented and submitted to TDOT TMC operations personnel.
5. The sign shall be capable of providing 250 text, 60 graphics, and 20 arrow board display messages programmed in the controller.
    a. Additionally, 100 user-created messages shall be able to be stored in the controller.
6. The PCMS shall be compliant with NTCIP 1203v03.
7. The PCMS shall include automatic dimming feature for nighttime operations.
8. The PCMS shall utilize a hydraulic lift to raise the unit to the required display height.
9. The PCMS shall be battery powered and charged via adjustable soral panel array.
    a. Solar panels shall be sized to replace power used in a typical daily operation with less than four (4) hours of sun.
10. The battery bank shall have adequate amp-hour capacity to operate the PCMS continuously in the absence of solar recharge for a minimum of 21 days.

21.2.6 Edge-Lit Traffic Sign and Wig Wag Beacon Requirements

The PSWZS shall include edge-lit traffic signs with wig wag beacons at locations specified on the Plans or by the Department.

The edge-lit traffic signs and wig wag beacons shall provide autonomous automated activation of wig wag beacons for motorists regarding the presence of construction vehicles emerging from the work zone into the roadway along the project limits and associated Smart Work Zone.

The edge-lit traffic signs shall adhere to the following minimum requirements:

1. The edge-lit traffic signs shall be placed at locations shown on the Plans or specified by the contract documents, to provide full coverage over the project limits. The Department reserves the right to request relocation of devices throughout the life of the project.
2. Warning signs shall consist of a 48” x 48” panel with 8 amber LEDs arranged inside the sign border per MUTCD.
3. Regulatory signs shall consist of a 36” x 36” panel with 8 red or white LEDs arranged inside the sign border per MUTCD.

The wig wag beacons shall adhere to the following minimum requirements:

1. Two wig wag beacons shall be placed around each of the edge-lit traffic signs.
2. The beacons shall be 12” diameter and consist of PAR 46 LED lamps.
3. The beacons shall communicate over an onboard RF relay system.

21.2.7 Portable Smart Work Zone System (PSWZS) Communications Requirements

The Portable Smart Work Zone System (PSWZS) communications configurations shall adhere to the following minimum requirements:

1. The communications devices shall be of rugged design and support machine-to-machine applications.
    a. The communications devices shall be able to report GPS coordinates of the PSWZS devices.
2. The communications devices shall utilize appropriate security measures to prevent outside sources from connecting to and controlling the PSWZS devices.
    a. The security measures shall be at a minimum include onboard IPsec SSL VPN, MAC Address Filtering, IP filtering, Port Filtering, SSH and HTTPS.
3. Cellular communications and satellite communications are acceptable forms of communication.
    a. The selected form of communication shall provide the highest level of connectivity at the required data rates for the PSWZS devices, at the locations per the plans.
    b. The wireless communications system shall be reliable, dependable, and capable of operating at all times regardless of weather conditions, density of customers, and location on the project limits.
    c. Any adjustments to PSWZ device locations shall not affect the communications and shall be approved by the Engineer.
4. All required configurations will be performed by the contactor during system initialization at the beginning of the project.
    a. The system shall be fully operational prior to the beginning of any work on the project.
5. Each individual device shall communicate to the server independently and not rely on communication with another device or sensor.
6. The PSWZS shall have incorporated an error detection/correction mechanism to ensure the integrity of all traffic data and messages, as well as providing notification to Operators for action.

The contractor shall be responsible for all communications costs, utilities, and satellite or cellular services needed to provide dependable communications to the PSWZS components.

21.2.8 Portable Smart Work Zone System (PSWZS) Software Requirements

The PSWZS shall be provided and operate on an intuitive web-based portal (web-client) that adheres to the following minimum requirements:

1. The web-client shall provide a graphical user interface (GUI) for data verification, overall monitoring, and control of all of the system components by Operators at the Regional TMC.
    a. The web-client shall be accessible on all operator workstations at the Regional TMC.
2. The PSWZS software servers, or core collection system, shall collect data from the portable traffic sensors and automatically update the PCMS in real time, as required in the Automated Messaging Requirements Sections below.
3. TDOT Operators shall be given access to web-client with administrative rights, via username and password, for device control.
    a. Operators shall be able to access all historical and current data for download and use by the Department.
4. The web-client shall have the capability to provide access to the public and stakeholders at different user levels as deemed necessary by the Department.
5. The GUI shall be intuitive and user-friendly displaying a real-time color-coded map of the project corridor with a color-coded map displaying current roadway conditions.
    a. Color coding on the map shall be as follows: Red-Stopped Traffic, Yellow-Slowed Traffic, Green-Free Flowing Traffic.
    b. The messaging shall be able to be viewed by any person given access to the web-client.
    c. TDOT Regional TMC Operations and TDOT Construction personnel shall be given administrative access to the web-client to access command and control of the devices.
6. The PSWZS software shall be capable of providing automatic email updates to designate personnel when speeds drop below certain thresholds, as well the ability to download device data for performance monitoring or later evaluation as deemed necessary by the Department.
    a. The software shall also provide notification upon device error or malfunction.
    b. A message shall appear in the software to alert the Operator that communications have been lost, a device is malfunctioning, or power/ battery levels are low.
    c. All status and monitoring capabilities of the software shall be available to the TDOT Operators and Personnel.

21.3 Portable Smart Work Zone System (PSWZS) Operational Requirements

This section describes the operational requirements of the PSWZS.

All equipment shall be installed according to the manufacturers recommendations at the locations as shown on the Plans. Any necessary deviations from the plans for device placement shall be coordinated with and approved by the Department and the Engineer prior to placement and system configuration. The Contractor shall ensure that personnel deploying the PSWZS system shall be experienced with similar deployment configurations prior to installation.

During anytime throughout the life of the project, and at the request of the Department or the Engineer, the Contractor shall relocate the PSWZS devices to locations with better communications, data collection accuracy, message viewing, or overall camera coverage along the project.

To ensure prompt response to any device failure, upon notification from the Department, the Contractor shall have six (6) hours to investigate and rectify any issues identified. This includes all devices as part of the PSWZS system including but not limited to, PCCTV, PRDS, PCMS, wig wag beacons, edge lit signs, communications, etc.

The department reserves the right to terminate the use of a malfunctioning system at any time during the life of the project. A failing system is defined by the department or its representatives as any device that has failed a total of five (5) or more days during a 30-day period.

21.3.1 Portable Closed-Circuit Television (PCCTV) Operational Requirements

The PCCTV trailers shall be placed throughout the project corridor as shown on the Plans. These trailers shall be used to verify PCMS trailer messages and traffic conditions within the project limits.

The Department reserves the right to relocate the PCCTV trailers at any time during the life of the project in order to provide better accessibility and visibility to TMC staff and stakeholders.

21.3.2 Portable Radar Detection System (PRDS) Operational Requirements

The PSWZS shall include vehicle detection devices placed at areas indicated on the Plans where irregular queues and delays are anticipated or where construction vehicles may be entering the roadway. The vehicle detection devices shall calculate and relay real time travel speeds within the project limits and relay that data to TMC operators and TDOT staff. Or in the case, of locations where construction vehicles may be entering the roadway, they shall detect the presence of a vehicle to activate the edge-lit traffic signs and wig wag beacons.

The Department reserves the right to relocate vehicle detection devices at any time during the life of the project, should available data indicate the need or new areas of irregular queue and delay present themselves.

Each PRDS device shall be properly configured and calibrated once the device is placed as indicated on the Plans or as directed by the Engineer. The following error levels shall be achievable and demonstrated during testing:

Parameter	Error Percentage
Volume	8%
Lane Occupancy	10%
Average Speed	10%
Length Classification Limits	10%

21.3.3 Portable Changeable Message Signs (PCMS) Operational Requirements

The PSWZS shall include PCMS placed at locations as shown on the Plans. The PCMS shall be placed in such a way as to provide information to motorists regarding detours, travel times, congestion levels, and

possible incidents of stopped traffic along the corridor. The PCMS shall relay the data in real time to the PCMS from sensors within the PSWZS.

All PCMS shall provide advanced warning of construction activities, accidents, congestions, or queues, based on TDOT's operational criteria.

The department reserves the right to move or adjust the PCMS devices as deemed appropriate throughout the life of the project.

21.3.3.1 Portable Changeable Message Signs (PCMS) Automated Messaging Requirements

The automated messages will be determined by the Department in conjunction with the PSWZS vendor. The contractor shall coordinate and verify the automated messages with TDOT personnel and TMC Operations Manager prior to setting up the PCMS and sensors.

The Purpose of the PSWZS automated messaging is to alert and/or warn motorists of congestion, delays, and queues from data provided by the system's sensors. The messaging requires, at a minimum, a two-phased message.

1. The first message shall describe the problem, such as, *"slow traffic ahead",* or *"stopped traffic ahead"*
2. The second message shall provide motorists with a warning, delay estimate, or instructions such as, *"expect delays", "be prepared to stop",* or estimate delay durations.

The content of the automated messages shall be determined by the Department. The messages shall be invoked on the basis of vehicle speed within the Smart Work Zone and at the Department's discretion.

The Department reserves the right to edit these automated messages at any time during the life of the project as it sees fit to give motorist the most information available from the PSWZS.

21.3.4 Portable Smart Work Zone System (PSWZS) Software Operational Requirements

In addition to the requirements in this section the Contractor shall program the PSWZS to ensure the following general operational requirements are met:

1. The PSWZS shall operate continuously (24 hours a day, 7 days a week) when deployed on a project.
    a. It shall always be collecting and storing data while providing real time data feed to the TDOT Regional TMC.
2. The PSWZS shall be capable of providing current operational status, including but not limited, to current traffic data, messages, communication system, signs, sensors, and video feeds via a dedicated project web client.
3. The PSWZS shall provide remote sign operation through a password protected web client.
    a. Operators shall have the ability to manually override the automated messaging to display manual messages at any time.
    b. Operators shall be able to send pre-programed or manual messages to one or multiple signs simultaneously (Vendor to provide a "group send" feature).
    c. Operators shall be able to cancel manual override and reinstate all of the systems automated messaging features at any time.

4. The PSWZS shall allow project field staff with password privileges to manually override the automated messaging for a user specified duration, after which the automatic operation will resume.
5. The PSWZS shall have the capability to autonomously restart in the case of power failure in any part of the system.

21.4 Testing

The Contractor shall perform Stand Alone Tests (SAT) on all components of the PSWZS. The SAT shall demonstrate that all equipment and materials are in full compliance with all project and operational requirements. The SAT shall also demonstrate the PSWZS is fully functional as installed in its operational configuration. Refer to section 2.5 for additional Testing requirements and individual device sections for specific operational requirements, such as accuracy, movement, etc.

21.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this Section.
2. All test results shall confirm physical and performance compliance with this SP725.
3. Payment for all testing is included in the cost of the Portable Smart Work Zone System.

21.4.2 Factory Acceptance Test

FAT is not required for PSWZS.

21.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall include the following tests and inspections:

1. Verify the PSWZS devices have no internal or external damage.
2. Test all PSWZS equipment functionality using vendor software.
3. Perform communication test with all PSWZS functionality, ensuring that the devices can communicate with the PSWZS.

21.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The BTS shall include the following tests and inspections:

1. Perform communication test with all PSWZS functionality, ensuring that the devices can communicate with the PSWZS software.
2. Verify the PSWZS devices can be configured and calibrated using the vendor software.
3. Verify that the required operational characteristics of the PSWZS devices are valid including the counting of volume and speed and posting of messages.

21.4.5 Stand Alone Site Test

SAT shall be performed once the PSWZS devices are in position in the field and shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and to the trailer structure.

3. Verify the PSWZS devices have no internal or external damage.
4. Test and document the accuracy of the PRDS in accordance with the accuracy requirements specified in this SP. A portion of this test requires the contractor to use a calibrated radar gun to compare observed speeds on a per lane basis between the calibrated radar gun and PRDS data over a 5-minute period. All data collected during the test shall be documented and submitted to the Engineer for approval.

21.4.6 System Acceptance Test

System Acceptance Testing shall be performed in the presence of the Engineer. System Acceptance shall be granted upon the successful completion of the following tests and at the approval of the Engineer.

1. Perform communication test with all PSWZS functionality, ensuring that the devices can communicate with the PSWZS software.
2. Verify the PSWZS devices can be configured and calibrated using the PSWZS Software in the TDOT Regional TMC.
3. Verify that the required operational characteristics of the PSWZS devices are valid including the counting of volume and speed and posting of messages.

21.5 Training

Training shall be provided for up to ten (10) TDOT designated individuals, or a number, as specified in the contract documents and/or the plans. Training shall be a minimum of 6 hours, provided to the Department's operations personnel on a live system, once all devices have been fully deployed, tested, and integrated in the field with communications established with the PSWZS Software. The training shall provide personnel with general knowledge of the devices and advanced user knowledge of any PSWZS web-client interface. A second 6-hour training session shall be provided, on a different day, if requested by the Department.

Training shall encompass all areas of any web-client software, including:

1. Login and credentials.
2. Navigation of the PSWZS Software, including description of menu tabs and help tabs.
3. Description of the map.
4. General monitoring of the PSWZS through the web-client.
5. General operation of the automated function and procedures for changing the automated messages of intervals/speeds related to displaying those messages.
6. Operational override of the PCMS and procedure for posting manual messages on the PCMS, along with return to automated function.
7. Retrieval of PRDS data.
8. Monitoring of video streams and operation of PTZ system of the PCCTV cameras.

The Contractor shall submit to the Engineer for approval a detailed Training Plan including course agendas, detailed description of functions to be demonstrated, deviations in training location, and a schedule. The Contractor shall also provide all training material in electronic format to the Engineer.

21.6 Warranty

All materials specified in this section shall carry a warranty from the date of System Acceptance through completed use of the system against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment.

21.7 Method of Measurement

The PSWZS shall be measured for the entire system, fully deployed and functional per day for both directions.

21.7.1 Furnishing and Installing

The cost for furnishing and installing the PSWZS shall be included in the mobilization cost for the overall project under Pay Item 717-01. This will include initial procurement, setup, and transportation to the project site.

21.7.2 Operations

The operation, management, and maintenance of the PSWZS will be measured in units of days and paid for at the contract price per day. The per day cost shall include, integrating (including carrier communications), operating, maintaining, configuring, testing, and training of the complete PSWZS. The price shall also include all local and remote configuration and all central and local control manufacturer PSWZS software. Price shall include all documentation including but not limited to shop drawings, operations and maintenance manuals, block diagrams, and other materials necessary to document the operation of the PSWZS. The price shall be full compensation for all labor, tools, materials, equipment, and incidentals needed to complete the work.

21.7.3 Provisions for Non-Working System

Should a device fail to communicate or become inoperative for more than hours six (6) hours after the department's notification, the system will be considered non-working and payment for the entire system will be withheld for that day.

Should the department exercise its right to terminate a malfunctioning system payment will cease seven (7) days after the request has been sent by the department or when the system is removed from the project, whichever comes first.

21.8 Payment

The contract unit price shall be full compensation for all work specific in this section.

Payments will be made under:

Item No.	Description	Unit
725-21.07	PORTABLE SMART WORK ZONE SYSTEM	DAY

PSWZS will be paid per day as follows:

1. Payment for the Per Day item shall commence once the contractor shows all devices are deployed and communicating to the TDOT Regional TMC.
2. Should any project in which the PSWZS is deployed prior to or after the scheduled number of days shown on the Plans, the Department reserves the right to terminate the use of and payment of the PSWZS. Likewise, if the PSWZS proves to be not functioning as specified in this section, the Department reserves the right to terminate the PSWZS and cease payment thereof.

22 SYSTEMS INTEGRATION

22.1 Description

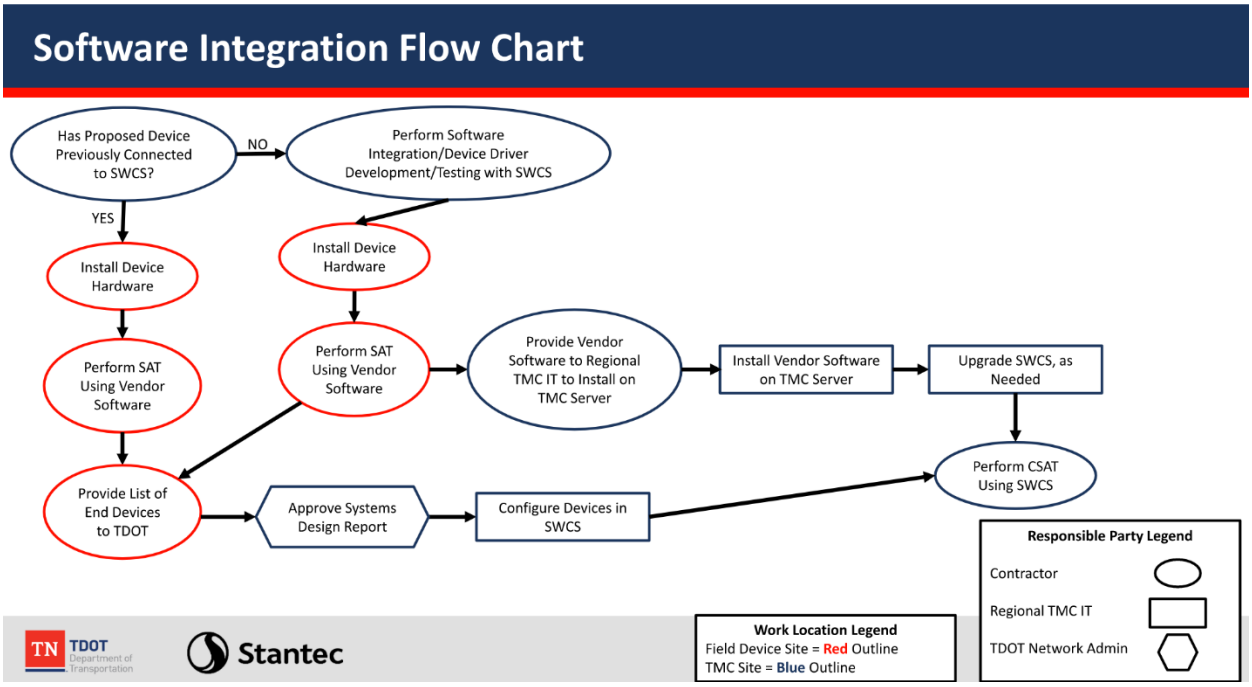
This section describes the system integration specifications and requirements for this project. The work consists of providing all labor, materials, software, software development, and incidentals necessary to integrate the proposed ITS devices into the TDOT ATMS software on the TDOT TMC Network. The work includes all additional licensing, documentation, and software necessary to operate the system as required in this SP725.

The Contractor shall be responsible for integrating the ITS devices provided in this contract into the TDOT ATMS software. This system supports multiple ITS device makes and models, but new device makes and models may require driver, API, and other software development for integration. Therefore, this contract is a total "turn-key" solution that ensures the DMS, RDS, ESS, RSU, flashing beacons, OVDS, HAR, CCTV subsystems, or any other ITS subsystem that is part of the project are fully functioning within the TDOT ATMS software.

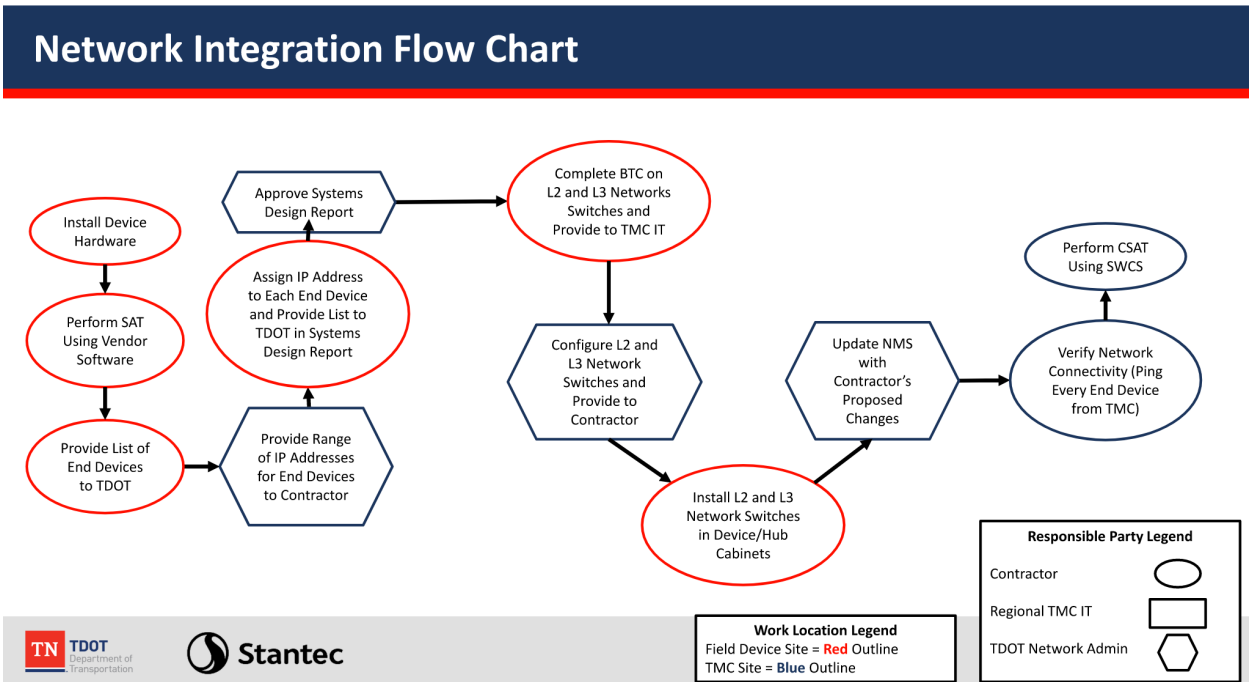
For all active electronic devices controllable through any type of communications interface, the Contractor shall coordinate with each respective system representative for each piece of equipment supplied, to support direct communication with and control of devices by the TDOT ATMS software. The Contractor shall be responsible for coordinating with the system vendors to ensure sufficient drivers are developed to support the proposed new device make and/or model provided and installed under this contract.

The systems integration may consists of two components: Software Integration and Network Integration.

The roles, responsibilities, location of work, and overall process for coordinating and completing the integration of devices into the TDOT ATMS software is detailed in the figure below and described further in this Section.



The roles, responsibilities, location of work, and overall process for coordinating and completing the network integration is detailed in the figure below and described further in this Section.



22.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using high quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall

submit and receive approval from the Engineer on a complete set of shop drawings of all the equipment and components listed within this Special Provision and included as part of the installation.

22.2.1 General Requirements

The components and system procured and installed by the Contractor under this contract shall support daily operations and maintenance activities associated with the TDOT SmartWay ITS Program.

1. Systems Design Report Submittal

   During mobilization, the Contractor shall document and submit a Systems Design Report to the Engineer for review and approval. Approval shall be received from the Engineer prior to any integration of new ITS field devices within the TDOT Regional TMC. The Systems Design Report shall document the Contractor's overall integration design into the TMC including overall network/architecture modification configuration, and confirmation of device support by the TDOT ATMS software management team. Detailed submittal requirements are included in Section 22.2.4. The cost for this submittal is included in the Network Integration pay item.

2. Local Area Network (LAN)

   a. The TDOT ATMS software operates over a TCP/IP client/server architecture, which will support operations over the TMC ATMS software local area network (LAN) and the TDOT network.

   b. The Contractor shall document in the Systems Design Report submittal the TMC building infrastructure (e.g., cabling, patch panels/cords, etc.) requirements needed to support the TMC system configuration.

3. TMC Hardware / Equipment

   a. The Contractor shall be responsible for the integration, configuration, and testing of all ITS field devices with TMC hardware and equipment through the TDOT ATMS software as specified herein.

   b. It is the Contractor's responsibility to install and test the TMC ATMS software LAN modifications along with the field network devices and ITS subsystems. This work must be performed in coordination with and at the approval of TDOT Regional TMC IT, specifically to allow time for TDOT Regional TMC IT to configure and provision the Ethernet Switches as detailed in Section 19.

4. Communications

   a. The TDOT Regional TMC shall be able to communicate with field devices via cellular, wireless, and fiber optic infrastructure that supports Ethernet communications.

22.2.2 Software Integration

Software Integration shall include all ATMS software integration tasks that are needed to meet all specification requirements but are not included specifically in the cost of other items.

This includes but is not limited to device integration with the ATMS software, coordination with TDOT Regional TMC IT and Network Administrators, and other related software integration activities to ensure full functionality of the hardware with the TDOT ATMS software such as the development of APIs, Device Drivers, and new ATMS Modules.

22.2.2.1 Wireless Ethernet Radio Network Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of configuring the Wireless Ethernet Radios from the TDOT Regional TMC over the network. This software will be used for configuring, testing, and verification only. Cost of the Wireless Ethernet Radio Software shall be included in the cost of the Wireless Ethernet Radio and Antenna units.

22.2.2.2 CCTV Software

The Contractor is responsible to determine TDOT's current operating software(s) at the TDOT Regional TMC for video management. The Contractor shall coordinate with the video distribution and TDOT ATMS software developer(s) to provide the required software drivers and any necessary ATMS software modifications for full integration of the CCTV elements included as part of this contract. Cost of the CCTV Software shall be included in the cost of the CCTV Camera units.

22.2.2.3 DMS Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing DMS commands from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the DMS Software shall be included in the cost of the DMS units. The software shall not require serial data converters (i.e., terminal servers) to establish DMS communications. The Contractor shall also coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the for all new DMS elements included as part of this contract.

22.2.2.4 RDS Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing RDS data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the RDS Software shall be included in the cost of the RDS units. The Contractor shall also coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the RDS elements included as part of this contract.

22.2.2.5 ESS Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing ESS data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the ESS Software shall be included in the cost of the ESS units. The Contractor shall coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the ESS elements included as part of this contract.

22.2.2.6 RSU Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing RSU data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the RSU Software shall be included in the cost of the RSU units. The Contractor shall coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the RSU elements included as part of this contract.

22.2.2.7 Flashing Beacon Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing flashing beacon data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the flashing beacon Software shall be included in the cost of the flashing beacons. The Contractor shall coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the flashing beacon elements included as part of this contract.

22.2.2.8 OVDS Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing OVDS data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the OVDS Software shall be included in the cost of the OVDS. The Contractor shall coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the OVDS elements included as part of this contract.

22.2.2.9 WIM Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing WIM data from the TDOT Regional TMC over the MS2 network. This software will be used for configuration, testing, verification, and operations. Cost of the WIM Software shall be included in the cost of the WIM.

22.2.2.10 HAR Software

The Contractor shall provide vendor supplied, Windows-compatible software capable of testing HAR data from the TDOT Regional TMC over the network. This software will be used for testing and verification only. Cost of the HAR Software shall be included in the cost of the HAR. The Contractor shall coordinate with the TDOT ATMS software developer to provide the required software drivers and any necessary ATMS software modifications for full integration of the HAR elements included as part of this contract.

22.2.3 Network Integration

Network Integration shall include all network integration tasks that are needed to meet all specification requirements but are not included specifically in the cost of other items.

This includes but is not limited to LAN integration, Fiber integration, WAN integration, wireless network link integration and configuration, cellular head end equipment integration, network monitoring integration and configuration, firewall integration and configuration, coordination with TDOT Regional TMC IT, network integration diagrams to document the overall configuration of the system, and other related network integration activities to ensure full access of the field devices to the TDOT TMC network.

22.2.3.1 Fiber Optic

Fiber Optic Network Integration shall include the necessary SFP optical transceivers, fiber optic patch cords, and CAT 6 (or greater) cables to complete the end-to-end communications between ITS field devices as well as communication hubs and the TDOT Regional TMC. Fiber Optic Network Integration shall also include end-to-end testing of the network in accordance with the testing requirements within this SP725. All materials provided including SFPs, fiber optic patch cords and CAT 6 cables must meet the material requirements within this SP725.

22.2.3.2 WAN

Wide Area Network Integration shall include any necessary VPN software licensing, service provider connection fees, service provider equipment, the configuration and integration of the MPLS or VPN communication links into the TDOT TMC Network, and any other software, materials, and hardware necessary to complete the end-to-end communications between ITS field devices as well as communication hubs and the TDOT Regional TMC. Wide Area Network Integration shall also include end-to-end testing of the network in accordance with the testing requirements within this SP725.

22.2.3.3 Wireless Ethernet Radio

Wireless Ethernet Radio Integration shall include the configuration and integration of the wireless communication links into the TDOT TMC Network to provide complete end-to-end communications between ITS field devices as well as communication hubs and the TDOT Regional TMC. Wireless Ethernet Radio Integration shall also include end-to-end testing of the network in accordance with the testing requirements within this SP725.

22.2.3.4 Cellular

Cellular Integration shall include any necessary cellular head-end equipment, service provider connection fees, service provider equipment, the configuration and integration of the cellular communication links into the TDOT TMC Network, and any other software, materials, and hardware necessary to provide complete end-to-end communications between ITS field devices as well as communication hubs and the TDOT Regional TMC. Cellular Integration shall also include end-to-end testing of the network in accordance with the testing requirements within this SP725.

22.2.3.5 Network Management and Remote Monitoring Software (NMS)

TDOT currently uses an existing NMS platform to monitor the field network. The existing platform is SNMPc by Castle Rock. Network Configuration Management and Network Performance Monitoring modules are monitored using the Orion Platform by SolarWinds. All new communications links and endpoints as well as any modifications to existing communications links and endpoints shall be configured into TDOT's NMS via coordination with TDOT Regional TMC IT.

22.2.3.6 Firewall

Any required Firewalls shall be provided by TDOT IT and installed and configured by the Contractor. The Firewall shall include management software and shall be compliant with TDOT's Cisco Network.

22.2.4 Project Submittal Program Requirements

1. General Requirements

    a. The Contractor shall provide project submittals for all TMC Systems as required in Section 2.7 of this SP725, including scheduling requirements. The project submittals for Systems Integration shall include but not be limited to the additional specific requirements in this Subsection.

2. Systems Design Report Submittal

    a. During mobilization, the Contractor shall develop and submit to TDOT Regional TMC IT for review and approval a Systems Design Report, which documents the detailed systems integration approach and includes all the elements specified in this section of this SP725. The Systems Design Report shall be a word-searchable electronic copy signed by the Contractor's qualified networking professional that must be reviewed and approved

by TDOT Regional TMC IT at least 30 calendar days prior to any procurement. Response and/or approval will be provided by TDOT Regional TMC IT and TDOT Network Administrators within 60 calendar days of Contractor submittal. The cost of the Systems Design Report shall be included in the cost of Network Integration.

b. The Contractor shall coordinate with TDOT Regional TMC IT to define the network. The document will contain:

    i. Complete description of the proposed implementation of the access, distribution, and core layers for the ITS network as described on the Plans and this SP725.

    ii. Client/server network and operating system requirements, if different from that specified in this section.

    iii. Development of an IP Design Scheme with ranges assigned to each node to be integrated by the Contractor using guidance from TDOT (e.g., address ranges, geographic distribution, and standards for addresses within each cabinet). The TDOT Regional TMC IT staff will provide the Contractor with an IP address range or ranges from which the Contractor shall develop the IP address scheme. The network architecture and IP address allocation shall be prepared by a qualified networking professional (minimum CCNA or a manufacturer-approved equivalent based on the approved hardware vendor) and will be approved by the Engineer. The Qualified network professional shall be present during the installation and testing of the local area network as well as during system testing.

    iv. Proposed IP subnet definition and addressing including all masks.

    v. Proposed IP multicast configuration including multicast routing (i.e., Protocol Independent Multicast (PIM) sparse or dense) and Rendezvous Point (RP) designation, as necessary.

    vi. Proposed recommendations for failover and redundancy including network device power, supervisor cards, and network ports.

    vii. Proposed expansions to the network addressing schemes and network traffic routing modifications.

    viii. Proposed configuration and guidelines for L3 routing including OSPF, VRRP, EIGRP, and RIP.

    ix. Proposed configuration and guidelines for VLAN assignments including management VLANs, device VLANs and routing VLANs.

    x. Proposed configuration and guidelines for L2 broadcast storm prevention, loop prevention and fault tolerance mechanisms. (Spanning Tree diagram with designated, blocking, and forwarding ports indicated. Root bridge and backup root bridge must also be specified.) Incorporation of Multiple Spanning Tree Protocol.

    xi. Proposed configuration and guidelines to mitigate common security threats such as denial of service, man in the middle, MAC/IP spoofing, and brute force dictionary attacks.

    xii. Proposed configuration and guidelines for 802.1p Class of Service (COS) queue assignments.

xiii. Proposed configuration and guidelines for specific port assignments on each of the L2 devices.

3. Other Submittal Documents

    a. The Contractor shall provide documentation on application data file format/structure as specified herein to TDOT Regional TMC IT at least 60 calendar days prior to CSAT.

    b. The Contractor shall provide detailed discussion and rationale for any and all requested changes or modifications to system design configuration, hardware, and software operating system requirements as specified in this section of this SP725.

    c. The Contractor may request that 1 or more of the requirements as specified herein be modified or replaced in support of their system solution. All requested modifications and changes to requirements shall be documented in detail in the submittal for consideration and approval by TDOT Regional TMC IT. The Contractor shall be responsible for any additional costs resulting from the requested changes.

22.3 Installation Requirements

Contractor shall abide by the installation requirements in the following sections. All equipment and software shall be installed according to the manufacturer's recommendations, TDOT Regional TMC IT policies, and the Plans.

Any beneficial use by TDOT of any portion of the ITS device deployment or integrated software system prior to CSAT completion does not constitute TDOT acceptance or waive any Contractor responsibility or testing requirements.

22.3.1 General

1. The Contractor shall configure, integrate, and test the networking hardware and equipment and ITS device and ATMS software in accordance with the Plans and this SP725.

2. Additional SFPs for existing Layer 3 switches to support communications back to the Regional TMC as indicated on the Plans shall be provided and installed by the Contractor.

3. The complete fiber pathway as indicated on the Plans, which may include existing and new fiber, is to be fully tested and characterized to identify any errors and impedance. If any errors or impedance are identified, they shall be a notice shall be located. If the errors or impedance are within the newly deployed fiber, the Contractor shall resolve the issues. If the errors or impedance are within the existing fiber infrastructure, the Engineer shall be notified. The Engineer will work with TDOT's ITS Maintenance Contractor to repair the fiber.

4. All patch cords and cabling within the TDOT Regional TMC and network hubs shall be consistent and meet the minimum cabling requirements as specified in this SP725.

5. The Contractor is responsible for ensuring that all cables, connectors, interfaces, supplies, and any other items necessary for the proper operation and function of any component or software product shall be installed, integrated, and tested to provide a fully operational system.

6. The Contractor shall be responsible for obtaining any Management Information Base (MIB) information for all field devices supporting simple network management protocol (SNMP). The Contractor shall coordinate with TDOT Regional TMC IT and TDOT Network Administrators to configure NMS software to meet all requirements of Section **Error! Reference source not found.**. In the NMS user interface, the Contractor shall coordinate with TDOT Regional TMC IT

and TDOT Network Administrators to configure the ITS Device IDs for each SNMP device on the network.

7. The Contractor shall fully integrate proposed switches with existing TDOT Regional TMC Core switches and computer and ATMS hardware to form a complete local area network that allows users from the TDOT Regional TMC as shown on the Plans to access applications on the application servers, the CCTV central hardware, and the proposed field communication network.
8. The Contractor shall fully integrate upgraded LAN to accomplish/maintain L2 Field Ethernet Switch, L3 Aggregation Ethernet Switch, L3 Field Aggregation Ethernet Switch, L3 Core Ethernet Switch, or Ethernet Bridge failover and fault tolerance.
9. The Contractor shall fully integrate network equipment to provide user authentication and security functions to prevent unauthorized users and data from entering the TDOT TMC Network.
10. If included in the project, the Contractor shall fully integrate wireless ethernet radio equipment, cellular head end equipment, and firewalls into the overall TDOT TMC Network.
11. If included in the project, the Contractor shall fully configure and connect the VPN tunnel or MPLS connection to the remote TDOT Communications Hub.
12. The Contractor shall coordinate with TDOT Regional TMC IT to install any software or software modifications on Test and Production TDOT Servers. All updates to software on Production Servers must be approved by the Change Advisory Board in advance.

22.4 Testing Requirements

22.4.1 General Requirements

1. The Contractor shall conduct a project testing program for System Integration as required in Section 2.5 of this SP725 and as detailed in this Subsection.
2. All test results shall confirm physical and performance compliance with this SP725.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing related to activities within this Section of the SP725 is included in the cost of Software Integration and Network Integration.

22.4.2 Factory Acceptance Test

FAT is not required for Systems Integration.

22.4.3 Bench Test Component

BTC shall be performed in the presence of the Engineer. The BTC shall demonstrate that any TDOT furnished equipment operates with Contractor furnished and installed software and network equipment. BTC shall include verification that the proposed equipment has no internal or external damage.

22.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The Contractor shall use TDOT Regional TMC Test Environment servers during the BTS for Software and Network Integration to demonstrate that the

System Integration meets the requirements of this SP725 and is operable with the new and existing systems.

22.4.5 Stand Alone Site Test

SAT for Network Integration shall be performed in the presence of the Engineer and shall include the following tests and inspections on components included within the Network Integration pay item such as SFPs, fiber optic patch cords, and CAT 6 cables:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other and within the Equipment Cabinet or Equipment Rack.
3. Verify the components have no internal or external damage.

SAT for Software Integration shall include oversight by the Engineer and shall include the following tests and inspections:

1. Software shall be installed in the TDOT ATMS Test Environment.
2. User Acceptance Testing (UAT) shall take place in the TDOT ATMS Test Environment for at least of 30 days to identify any software bugs or functionality issues.
3. If issues are identified, a follow-up UAT of at least 7 days shall be provided to verify the identified issues have been corrected.
4. Once the UAT has been approved, installation of the software in the TDOT ATMS Production Environment can be scheduled with the Change Advisory Board.

Final testing and verification of the Software Integration and Network Integration shall be performed as part of the Conditional Systems Acceptance Testing for the project.

22.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

22.6 Method of Measurement

22.6.1 Software Integration

Software Integration will be paid for on a lump sum basis wherein no measurement will be made. The bid price for Software Integration shall include all tasks that are needed to meet all specification requirements to integrate the ITS field devices into the ATMS software but are not included specifically in the cost of other items. This includes but is not limited to integration with the video distribution management system, device drivers as required by the proposed field devices, modifications to the ATMS software, integration between the various software packages, integration with the Hub UPS and security monitoring systems, integration with the building UPS monitoring systems, integration of all devices with the TDOT ATMS software, coordination with TDOT Regional TMC IT, Project Submittal documents, and other related software integration activities. Any additional application software, tools, and associated licenses that are

not listed in items 22.2 but are needed to provide a complete and operational system as well as meet the requirements of this SP725 shall be considered incidental and shall be included in the cost of the most appropriate item.

The bid price for Software Integration shall include full compensation for all labor, tools, materials, equipment, software, hardware, and incidentals necessary to complete the work.

22.6.2 Network Integration

Network Integration will be paid for on a lump sum basis wherein no measurement will be made. The bid price for Network Integration shall include all tasks that are needed to meet all specification requirements to integrate the communications infrastructure into the TDOT TMC Network but are not included specifically in the cost of other items. This includes but is not limited to LAN configuration and integration, WAN configuration and integration, wireless network configuration and integration, cellular head end equipment configuration and integration, NMS configuration, firewall configuration, coordination with TDOT Regional TMC IT, Project Submittal documents, and other related integration activities. Network Integration shall also include hardware required to complete the network integration as identified on the Plans. Additional Layer 3 SFPs, fiber optic patch cords, and CAT 6 cables required to connect the project back to adjacent Hub Buildings, Hub Cabinets, or the Regional TMC as indicated on the Plans shall be incidental and not paid for separately. All cabling, hardware, accessories, labor, and materials not provided with TDOT furnished network equipment required to make the unit function as part of this project shall be considered incidental and not paid for separately.

The bid price for Network Integration shall include full compensation for all labor, tools, materials, equipment, software, hardware, and incidentals necessary to complete the work.

22.6.3 Wireless Ethernet Radio Software

Wireless Ethernet Radio Software is vendor software for configuration, testing, monitoring, and operations. The software shall be paid for under the Wireless Ethernet Radio and Antenna pay items.

22.6.4 CCTV System Software

For all active CCTV related devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS and video distribution software representatives to support direct communication with and control of devices by the TDOT ATMS software and video distribution system. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the CCTV Cameras System pay item.

22.6.5 DMS System Software

DMS Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For DMS devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Dynamic Message Sign pay item.

22.6.6 RDS System Software

RDS Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For RDS devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Radar Detection System pay item.

22.6.7 ESS System Software

ESS Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For ESS devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Environmental Sensor System pay item.

22.6.8 RSU System Software

RSU Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For RSU devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Roadside Unit pay item.

22.6.9 Flashing Beacon System Software

Flashing Beacon Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For flashing beacon devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Flashing Beacon Controller pay item.

22.6.10 OVDS System Software

OVDS Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For OVDS devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Overheight Vehicle Detection System pay item.

22.6.11 WIM System Software

WIM Software is vendor software for configuration, testing, and operations. For WIM devices controllable through any type of communications interface, the Contractor shall integrate with the MS2 Network to support direct communication. Software development may be required to complete this integration. The effort required to accomplish this task as well as the cost of acquiring, installing, and configuring the vendor software shall be paid under the Weigh in Motion pay item.

22.6.12 HAR System Software

HAR Software is vendor software for configuration and testing only; therefore, there is no separate payment for this item. For HAR devices controllable through any type of communications interface, the Contractor shall coordinate with the TDOT ATMS software representatives to support direct communication with and control of devices by the TDOT ATMS software. Software development may be required to complete this integration. The effort required to accomplish this task shall be paid under the Software Integration pay item. The cost of acquiring, installing, and configuring the vendor software shall be paid under the Highway Advisory Radio System pay item.

22.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-24.52	SOFTWARE INTEGRATION	LS
725-24.54	NETWORK INTEGRATION	LS

Integration items will be paid on a lump sum basis as follows:

1. 30% of the contract unit price upon successful completion of the Bench Test System as stated in Section 2.5.4 of this SP725.
2. Additional 60% of the contract unit price upon Conditional System Acceptance as stated in Section 2.5.6 of this SP725.
3. Final 10% of the contract unit price upon Final System Acceptance as stated in Section 2.5.9 of this SP725.

23 SPARE PARTS INVENTORY

23.1 Description

This Section specifies the requirements for furnishing and maintaining a Spare Parts Inventory.

23.2 Materials

The Contractor shall have available and maintain the listed quantity of spare parts detailed in APPENDIX C. Spares will be replenished as used, so that the quantities in working order are available at all times and will be delivered to TDOT at the conclusion of the Burn-In Period. Note that the items listed as Spares shall include all components and equipment included in the pay item specified for that particular item. All supporting, incidental, ancillary, and peripheral items necessary for a fully populated and complete installation shall also be maintained in the inventory. For example, conduit would also require couplers, pull tape, tone wire, blank duct plugs, cable duct plugs, etc. Prior to Conditional System Acceptance, the Contractor shall submit a full Spare Parts Inventory list including the incidental items in Microsoft Excel format to the Engineer. The Spare Parts Inventory shall include as a minimum:

Manufacturer

Model number

Descriptive title

Serial number

Location

Purchase date

Date installed – when applicable

Location of installation – when applicable

Warranty expiration date – when applicable

All items in the Spare Parts Inventory measured by linear foot shall be single continuous unspliced lengths. If a portion of a length in inventory is used for repair, the remainder of the original length shall remain TDOT property in the inventory and the Contractor shall procure a replacement continuous length of the minimum above.

All items in the Spare Parts Inventory must match the approved products installed in the field under the project.

All items in the Spare Parts Inventory shall have bar code labels attached using the existing bar code system equipment supplied by TDOT in accordance with the requirements in Section 24.7.

23.3 Storage

The Contractor shall store and maintain all Spare Parts in a secure environment that aims to avoid theft or damage to the Spare Parts. The Contractor is fully responsible for the Spare Parts and shall insure the inventory of spares against all hazards or loss and name TDOT as the beneficiary in the case of loss. A copy of the insurance documents must be provided to TDOT. TDOT has the right to audit the inventory at any time by providing the Contractor with a five-day notice. When items from the Spare Parts inventory

are used, the Contractor shall replenish the inventory within 30 calendar days of use. Contract payments will be held if this is not done within 30 calendar days.

Maintenance of the Spare Parts shall be performed while in storage in accordance with the Maintenance requirements in Section 24.

23.4 Testing Requirements

All Spare Parts shall include BTC as required for that particular item within this SP725.

23.5 Warranties

All Spare Parts shall include the same warranty required in the pay item specified for that particular item within this SP725.

23.6 Method of Measurement

23.6.1 Spare Parts

Spare Parts will be paid at the lump sum bid price for Spare Parts. The bid price shall include the furnishing and testing of the specified parts. Any installation costs are covered in Section 24. The bid price shall be full compensation for all labor, tools, materials equipment, and incidentals to furnish and test the Spare Parts. The cost of storing and maintaining the inventory of Spare Parts and equipment should also be included in the lump sum cost of the Spare Parts.

Prior to the Conditional System Acceptance of the project, the Contractor shall submit to TDOT an itemized breakdown of the lump sum cost indicating the amount for each item in the Spare Parts inventory. Should changes during construction require a change in the number or type of Spare Parts needed, this breakdown of the initial bid price will be used to determine the appropriate change in the lump sum bid price. As Spare Parts are used, replacements to the inventory will be at the Contractor's expenses unless the additional equipment is needed due to an act of God or another special request from TDOT. In these cases, the replacements will be reimbursed at invoice price including tax plus 15%.

Compensation for materials requested by TDOT, in addition to the Spare Parts listed, will also be at the rate of actual invoice price including tax plus 15% for procurement expenses. Any extraordinary costs to the Contractor will not be paid unless approved in advance by TDOT.

23.7 Payment

Payment will be made under:

Item No.	Description	Unit
725-24.31	SPARE PARTS	LS

Spare Parts will be paid at the lump sum price upon complete delivery to TDOT.

24 SYSTEM MAINTENANCE REQUIREMENTS

24.1 Description

The purpose of this Section is to describe the required maintenance activities that the Contractor must provide during the Burn-In Period in accordance with the timeframe detailed in Section 2.5.7. The Contractor shall provide these maintenance activities for all equipment installed as part of this Contract. The maintenance requirements described in the Section shall include all necessary labor, materials, equipment, tools, transportation, supplies, and incidentals required to complete the work. The maintenance period is divided into Preventive Maintenance and Unscheduled Maintenance. The duration of the maintenance period may be extended at the discretion of TDOT via exercising of the Annual Maintenance options.

24.1.1 Definitions

Preventive Maintenance shall begin at the completion of CSAT. Preventive Maintenance for the System consists of regularly scheduled activities including but not limited to electrical testing, replacement of necessary parts, cleaning, and lubrication. Each device shall have at least one Preventive Maintenance cycle completed during the Burn-In Period. The Contractor shall perform all Preventive Maintenance activities in accordance with the Preventive Maintenance Procedures detailed in the Project's Regional Maintenance Contract SP in APPENDIX B. This shall include the periodic inspection and cleaning of the equipment and updating the resulting documentation of this inspection.

Repair Maintenance consists of responding to the various failures reported concerning the various field components of the system. Repair Maintenance will include the reactive, day-to-day repair, replacements, and diagnostic work necessary to keep the System fully operational. A Repair Maintenance response is defined as the Contractor receiving notice from TDOT of a failure and the Contractor responding with a field assessment of the problem, preparation of a plan, and schedule for repair and submission of that report to TDOT. The Response Report shall be submitted via email.

24.1.2 General Requirements

The Contractor shall manage all ITS assets within the project limits and will perform work that produces end results in accordance with TDOT Standard Specifications including all Supplemental Specifications and Special Provisions. These include but are not limited to:

1. TDOT Standard Specifications (Latest Adopted Edition).
2. Manual on Uniform Traffic Control Devices (Latest Adopted Edition).
3. TDOT Standard Drawings (Latest Adopted Edition).

The Contractor shall take proper health and safety measures to ensure safety for the traveling public, TDOT employees, Contractor employees, Subcontractor employees, and any other personnel within the project limits.

Maintenance of traffic during system maintenance is solely the responsibility of the Contractor. Under no circumstances will maintenance of traffic be an additional pay item.

Unless specified otherwise on the Plans, TDOT will pay all monthly electric and any required leased line communication bills. Responsibility for maintaining power to devices will be as follows:

1. From the utility to the demarcation point (or end of overhead secondary conductors) – Local Utility Companies.
2. From the demarcation point (or end of overhead secondary conductors) to the control cabinet or breaker and from the control cabinet or breaker to and within the devices – Contractor.

The Contractor shall maintain an electronic maintenance log which shall detail all maintenance action items and the dispositions of the items contained in the log. The log will be kept on the maintenance computer within the TDOT Regional TMC. Prior to the beginning of the Burn-In Period, TDOT will provide the Contractor an empty Microsoft Access or Excel database file that contains the required formatting for the database. In Regions where an ITS asset management software is being utilized to track maintenance, the Contractor shall provide device information to the Engineer in a pre-formatted Excel spreadsheet. The spreadsheet will then be imported into the ITS asset management software by a TDOT System Administrator via coordination with TDOT Regional TMC IT. Once imported, the Contractor shall utilize the ITS asset management software to track system maintenance during the remainder of construction and burn-in.

All overhead work over impacted traffic lanes shall include proper lane closures in accordance with MUTCD, except when the Contractor is working inside a DMS enclosure. TDOT must approve all lane closures in advance. Requests for lane closures shall be submitted at least 7 calendar days in advance of work for all preventive maintenance activities.

The Contractor is required to provide all operational crews with working cell phones at all times. In addition, the Contractor shall provide a single phone contact for the Contractor's supervisor. The Contractor shall provide to TDOT and keep current all cell phone contact numbers. It is essential that the operating crews can contact the TDOT Regional TMC to ensure correct operation of equipment and verify equipment status in the control center.

TDOT will appoint a representative that will act as contract administrator with the responsibility of ensuring that work is done to a specified standard defined in this SP725. This representative will be responsible for verifying that the Contractor satisfactorily completes the work. The TDOT representative will be responsible for the overall monitoring of the Contractor's work.

24.1.3 Form of Contract

Under the terms of this contract there are several requirements:

1. The first requirement will be for performing the Preventive Maintenance for the System. Preventive Maintenance consists of regularly scheduled activities including but not limited to communications and electrical testing, replacement of necessary parts, cleaning, and lubrication. The Contractor shall perform all Preventive Maintenance activities in accordance with the Preventive Maintenance Procedures detailed in the Project's Regional Maintenance Contract SP in APPENDIX B. This shall include the periodic inspection and cleaning of the equipment and the resulting documentation of this inspection.
2. The second requirement is for performing Repair Maintenance. Repair Maintenance consists of responding to the various failures reported concerning the various field components of the system. Repair Maintenance will include the reactive, day-to-day maintenance, replacements, and diagnostic work necessary to keep the System operational. The Contractor must provide all necessary labor, tools, equipment, and engineering for the repair maintenance work. A Response Report containing the items identified must be submitted to TDOT within the time frames noted

below. Notice of a failure will be communicated to the Contractor via a phone call and a follow up email or fax.

The Repair Maintenance during the Burn-In Period shall be included in the cost bid for the Burn-In Period. With the exception of acts of God as described below, no separate payment will be made for keeping the system operational during the Burn-In Period. Repair Maintenance beyond the Burn-In Period will be considered "Unscheduled Maintenance."

Work items generated by failures caused by acts of God, other construction activities, or other special requests from TDOT shall be considered Unscheduled Maintenance. The Contractor must provide the required number of personnel and all necessary tools, equipment, and engineering for the unscheduled maintenance work. All labor and material items described above shall be included in hourly unit price as described in the payment section.

If a failure involves a DMS Sign, multiple cameras, or poses a safety threat to the motoring public as determined by TDOT, the Contractor shall respond on-site within 4 hours of notice of a failure by TDOT. This four-hour response requirement applies 24 hours a day, 7 days a week.

For other failures that do not include a DMS sign, multiple cameras, or do not pose a safety threat, the Contractor shall respond on-site within 8 hours of notice of a failure by TDOT. This eight-hour response requirement is limited to normal business hours (8:00 am to 5:00 pm) Monday thru Friday.

The Contractor and TDOT will work together to develop a tracking system to document and track all Unscheduled Maintenance Labor. Once a repair task is complete, the Contractor shall submit final paperwork including a follow-up maintenance response report within 3 calendar days. Failure to submit this paperwork within the specified time is subject to non-payment. If ITS asset management software is used in the TDOT Region that the project is located within, the ITS asset management software shall be used as the tracking system.

3. In addition to the items of work described above, there may be special circumstances where TDOT requests work that cannot be covered by one of the pay items included in this contract. (Example situations may include pole knock downs, re-location of facilities to accommodate other construction activities, minor system modifications or expansions, etc.). If and when those situations occur, the Contractor may be asked to submit a separate cost proposal and schedule to TDOT for consideration and approval. Once approved the Contractor shall start the work within 10 calendar days of approval and execute the work with due diligence according to the schedule agreed upon. It will be TDOT's sole decision to determine whether or not a specific item of work can be completed within the existing pay items.

24.2 Schedule Of Work

TDOT will permit access to facilities as required by the Contractor for the purposes of maintenance. The Contractor shall provide the Maintenance Activities throughout the entire contract period.

TDOT reserves the right to either cancel this Maintenance Agreement in part, or in its entirety without liability to TDOT on 30 calendar days written notification to the Contractor or at the end of an option period. TDOT shall direct that the work under this Maintenance Agreement be performed by the Contractor in one-year increments with each yearly increment being exercised at the sole option of TDOT. Failure of TDOT to exercise an option will terminate the Contract. TDOT shall have no obligation in excess of the amount contracted for, or for services rendered by the Contractor, which are not performed within the specified period.

24.2.1 Monthly Status Meetings

Each month the Contractor shall hold a status meeting with TDOT. At these meetings, the Contractor shall discuss the previous month's repairs, anticipated work for the next month, spare purchases for the month, and other operational problems that may arise. The Contractor is responsible for taking and distributing the minutes of these meetings. These minutes must be transmitted to TDOT within 7 calendar days for approval by TDOT. Progress payments for Annual Maintenance may be withheld until meeting minutes are submitted to TDOT. Note that on some occasions more frequent meetings may be warranted for special conditions. No additional costs will be allowed for these additional meetings.

24.3 Equipment To Be Maintained

All equipment installed by the Contractor as part of this project shall be subject to the Preventive, Repair, and Unscheduled Maintenance procedures through the Burn-In Period until Final Acceptance is given. Following Final System Acceptance, the Contractor may enter into an Annual Maintenance contract that will be renewable in one-year increments at TDOT's discretion. The Contractor would continue to be responsible for Preventive, Repair and Unscheduled Maintenance during the Annual Maintenance Period for all subsystems listed above.

24.4 Maintenance Procedures

For each major equipment type there are defined minimum Preventive Maintenance procedures. These minimum procedures are defined in APPENDIX B. Each equipment's preventive maintenance procedure has a fixed period between procedures. These are defined in APPENDIX B. It is also the Contractor's responsibility to obtain and submit to TDOT the Preventive Maintenance procedures recommended by the equipment manufacturers including but not limited to all requirements to meet warranty standards.

Maintenance procedures performed under Repair Maintenance shall use materials and installation procedures as specified in this SP725 for new construction. At the sole discretion of the Engineer, certain repairs that are not possible to complete to the same standard as the new construction may be made utilizing materials and procedures as directed by the Engineer.

Should the Contractor perform an Unscheduled Maintenance action and within 5 calendar days the same fault is reported on the same piece of equipment, it is the Contractor's responsibility to make the second and any subsequent same-fault repairs at no cost to TDOT. Should a particular device persist in its failures, upon TDOT's instruction, such device shall be replaced and paid for by TDOT under the Unscheduled Maintenance procedures.

Upon completion of any maintenance activity, the work shall be subject to a random inspection by TDOT. Work that is determined to be unacceptable shall be re-performed by the Contractor at the Contractor's expense.

For damage caused by acts of God, other Contractors, or TDOT personnel, the Contractor is responsible for photographing all damaged structures and equipment; obtaining crash reports and/or driver information; and for submitting this information to TDOT.

24.5 Record Keeping Procedures

The Contractor shall use an existing database that will be provided by TDOT to the Contractor to track all Preventive, Repair, and Unscheduled Maintenance activities. If a maintenance tracking software is used in the TDOT Region that the project is located within, the maintenance tracking software shall be used as the tracking system. The required format for each input will be provided to the Contractor by TDOT prior

to Conditional System Acceptance. The Contractor shall prepare a separate database to track the inventory of current spares. The database files shall be updated and emailed to TDOT weekly beginning prior to Conditional System Acceptance. If a maintenance tracking software is being used to track maintenance in the TDOT Region that the project is located within, sending the maintenance tracking software database will not be required as the software is cloud-based, providing access to all parties at any time. This email shall also include a summary of the next week's planned maintenance activities.

The records for both Preventive Maintenance and an Unscheduled Maintenance Response Report on the database shall at a minimum include the following information. Additional information may also be required as requested by TDOT:

1. Date and time of failure report or date of unscheduled maintenance
2. Person or source of the report
3. Location of device
4. Description of failure or symptom
5. Name of person responding
6. Arrival time at location of reported failure
7. Weather and condition of the site
8. Actions taken
9. Schedule of initiating corrective work and estimated completion of work
10. Date and time of completion of work
11. Spare part details
12. Any consequential events including but not limited to failure to operate or secondary failure

The Contractor shall maintain accurate and complete records of all work activities, status reports, meeting notes, cost proposals, invoices, inventory records, etc. The project As-built documentation, including the System Equipment Inventory, shall be updated if any information contained therein is changed due to scheduled or unscheduled maintenance activity. As-built documentation shall include but not be limited to modifying cabinet drawings, wiring diagrams, device layouts, conduit routing and location, fiber optic splice and termination details, and all other plan details. As-built documentation during maintenance shall be in accordance with the standards and requirements in this SP725. All project records will be the property of TDOT and shall be returned to TDOT prior to final payment of the Contract.

24.6 Equipment Control

The Contractor shall maintain a sufficient inventory of spares to ensure the repair response time specified in APPENDIX B. The minimum amount of required Spare Parts by equipment type is also defined in APPENDIX C. These spares will be purchased by the Contractor and owned by TDOT in accordance with the requirements in Section 23. As equipment is used from the Spare Parts inventory during Burn-In and Device Warranty Period, the Contractor shall replace at their own expense.

However, if the need to use spare parts equipment is due to acts of God, other special requests by TDOT, or repairs beyond the Device Warranty Period during the Annual Maintenance Period, the Contractor may invoice TDOT for replacement spares added back to the inventory. However, the cost of the replacement

spares shall be submitted to TDOT for approval prior to ordering. A 15% markup will be allowed on direct material costs of the replacement spares needed due to acts of God or other special requests by TDOT. Shipping, insurance, and purchase costs should be paid directly by the Contractor and billed to TDOT. TDOT must give prior written approval for each monthly order made by the Contractor.

In addition to maintaining the Spare Parts inventory, the Contractor shall also ensure the availability and access to all vehicular equipment (trucks, bucket trucks, backhoes, front end loaders, and diagnostic equipment, etc.) and engineering/technical equipment needed to respond to and repair equipment failures and malfunctions. All equipment that is typically needed for an ITS maintenance contract shall be available and on-site within the required response time frame requirement outlined. If typical maintenance equipment is not available within this timeframe, the Contractor shall be considered to have missed the required response requirement. If specialty equipment is needed that is not typical, the Contractor shall notify TDOT of this need and TDOT will determine if an exception can be made in that situation.

24.7 Bar Code System

TDOT has an existing bar code system. The Contractor shall ensure that all new and replacement equipment has bar code labels attached using this existing bar code system equipment supplied by TDOT. The purpose of the bar code system is to track the equipment inventory and to be able to determine the various maintenance activities that have occurred with that piece of equipment. The Contractor shall initially install bar code labels on all equipment prior to installation during the construction phase. The cost of installing the initial bar code labels shall be included in the cost of other items. Data corresponding to each equipment item must be recorded in the barcode system at TDOT. The implementation of the bar code system must be completed by the Contractor prior to the installation of any electronic equipment. The Contractor shall follow TDOT's existing bar code system structure but shall provide the bar code labels needed for the equipment.

24.8 Staffing / Management Plan

The Contractor must provide a minimum of 1 technician for the duration of maintenance related contract periods to ensure satisfactory completion of all maintenance and repair activities. Before the start of Burn-In Period, the Contractor shall submit a Staffing/Management Plan defining the key staff for ITS Maintenance and the Project Management Team for approval by the Engineer. Resumes for the key staff must be provided. Changes to the key staff and Project Management Team shall require approval of TDOT or TDOT's authorized designee prior to use of the staff on the project. TDOT shall have the right to reject any proposed replacement staff and request another replacement.

The staffing/management plan should be:

1. Proposed plan for communication and coordination among the Team and key staff.
2. Qualifications of all personnel. All staff must be qualified for the various types of devices and equipment they will be working on. Qualifications must include at least 1 year of installing and/or maintaining the types of ITS devices in this contract, or equivalent experience as approved by the Engineer. If qualified personnel are not available on Contractor's staff, a factory trained manufacturer representative must perform the work.

24.9 Staffing Qualifications

All staffing associated with this project must be qualified for the work that is to be performed. Specifically, technicians that are responsible for the electronic components, must have a minimum of a

two-year associate degree plus 2 years relevant work experience or equivalent. An equivalent to this qualification would be more than 3 years of relevant experience. Any proposed equivalent must be approved by TDOT. The Contractor shall furnish staff that is familiar with the equipment that is installed in this project.

24.10 Safety Plan

The Contractor is required to follow all applicable safety laws, regulations, and TDOT standard safety procedures. This includes compliance to the requirements of the MUTCD, OSHA, and others as applicable. Appropriate safety attire for personnel in the field, clear markings, and functional yellow lights on vehicles must be part of the safety plan.

24.11 Contractor's Responsibility for Utility, Property, and Service

At point where the Contractor's operations are adjacent to the properties of any utility, including railroads, and damage to which might result in considerable expense, loss, or inconvenience, work shall not commence until arrangements necessary for the protection thereof have been completed.

The Contractor shall cooperate with owners of utility lines so that removal and adjustment operations may progress in a reasonable manner, duplication of adjustment work may be reduced to a minimum, and services rendered by those parties will not be unnecessarily interrupted.

Should the Contractor cause a cut in any communications media it is the Contractor's responsibility to repair that cut within 1 hour of the cut occurring.

If any utility service is interrupted as a result of accidental breakage or of being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the authority in the restoration of service. If utility service is interrupted, repair work shall be continuous until service is restored. No work shall be undertaken around fire hydrants until the local fire authority has approved provisions for continued service.

24.12 Performance Of the Contractor

Throughout this Contract, TDOT will conduct a review of the various works performed by the Contractor. These reviews shall be to determine the compliance of the Contractor's operations with the maintenance requirements, the terms of the Contract, and the policies and procedures of TDOT. The Contractor shall fully cooperate with these reviews. If deficiencies are found, TDOT shall inform the Contractor of this in writing. The Contractor shall take immediate remedial action to cure any deficiencies. No additional compensation will be due to the Contractor associated with such remedial actions. Payments may be withheld, or the Burn-In Period may be extended, if the Contractor fails to take immediate remedial action to cure any deficiencies.

The Contractor is required to maintain the devices uniformly and consistently throughout the Burn-In and Annual Maintenance Periods, meeting both TDOT and, as appropriate, the manufacturer's performance specifications, as well as respond to failures identified by TDOT. Continued poor performance of work or failure to perform shall cause the Contractor to be declared in default of the Contract. Failure to meet the maintenance requirements specified in this contract shall result in a written notice from TDOT. This information shall inform the Contractor of non-compliance, as well as the withholding of progress payments that will occur, or an extension of the Burn-In Period if non-compliance continues. Progress payments will be withheld under the following conditions.

1. Regarding Preventive Maintenance: If any devices are found to be behind schedule for the regularly scheduled maintenance procedures, all progress payments will be withheld until all devices are verified back on schedule.
2. Regarding Repair Maintenance: All repair maintenance requests should be responded to within the timeframes outlined. A response is defined as being on site and beginning to diagnose the problem. When the response times exceed the requirements on more than 2 requests during any given month, the current monthly progress payment will be withheld until the following month. Items where the failure to respond is beyond the control of the Contractor, will not be included in this calculation.
3. Regarding Maintenance Database: If database is not updated every Tuesday and is more than 1 week behind schedule, all progress payment will be withheld until database is current. If TEAMS is being used as the maintenance database, it shall be updated as maintenance is performed to timely track acknowledgement of maintenance tickets and completion of maintenance activities.

It is not the intent of TDOT to unfairly penalize the Contractor for events beyond their control such as acts of God, vehicle hits, severe weather conditions, major power failure, etc. Failure to perform either repair maintenance or preventive maintenance during such periods will not be used to penalize the Contractor, provided the Contactor returns to standard operations after such periods have ended.

The Contractor must ensure that all warranties remain valid. To achieve this, the Contractor shall perform all the preventive work specified by the manufacturer within the periods specified by the manufacturer for all equipment. If these tasks are covered by the standard preventive maintenance, then both conditions apply.

The Contractor shall provide vehicular equipment including but not limited to bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. An approved vendor as per the equipment specification requirements shall calibrate all electronic maintenance and measurement equipment.

The Contractor shall provide conveniently located secure premises to store all test equipment. The Contractor shall provide workbench facilities to enable diagnostic testing and remedial work.

24.13 Method of Measurement

24.13.1 Preventive Maintenance for System

Preventive Maintenance shall be measured on a lump sum basis. Preventive Maintenance shall include the labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work in accordance with the provisions of the Contract. Each device shall have at least one Preventive Maintenance cycle completed during Burn-In following the Preventive Maintenance Procedures detailed in the Project's Regional Maintenance Contract SP in APPENDIX B. Additional cycles may be required per specific device requirements in the Project's Regional Maintenance Contract SP in APPENDIX B.

24.13.2 Repair Maintenance During Burn-In Period

Repair Maintenance shall not be measured separately and shall be included in the bid price for the Burn-In Period. This shall include but not be limited to all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work in accordance with the provisions of the Contract.

For work items resulting from acts of God or other special requests from TDOT, the Contractor shall be compensated their hourly labor costs for such operations at the hourly rate bid for Unscheduled Maintenance Labor. This hourly rate includes but is not limited to all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. Hours shall be based on actual time on task plus a maximum of 2 hours travel time, or actual travel time if less than 2 hours. No further labor costs will be allowed. The bid price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work. The bid price per hour includes all labor charges regardless of the number of people at the site.

24.13.3 Unscheduled Maintenance Labor

During Burn-In, the Contractor shall be compensated their hourly labor costs for such operations at the hourly rate bid for Unscheduled Maintenance Labor only for work items resulting from acts of God or other special requests from TDOT. This hourly rate includes but is not limited to all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. Hours shall be based on actual time on task plus a maximum of 2 hours travel time, or actual travel time if less than 2 hours. No further labor costs will be allowed. The bid price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work. The bid price per hour includes all labor charges regardless of the number of people at the site.

24.14 Payment

Payment will be made under:

Item No.	Description	Unit
725-24.21	PREVENTIVE MAINTENANCE FOR SYSTEM	LS
725-24.25	UNSCHEDULED MAINTENANCE LABOR	HOUR

System Maintenance Requirements will be paid per each as follows:

1. Preventive Maintenance for System (for quarters authorized by TDOT) will be paid on a lump sum basis of 1/3rd of the contract unit price upon successful completion of a month of the Preventive Maintenance activity.
2. Unscheduled Maintenance Labor (where requested by TDOT) will be paid at the hourly rate upon completion and acceptance of a repair or modification.

25 PROJECT ACCEPTANCE

25.1 Description

This section specifies the minimum requirements for acceptance procedures and tasks that must be completed prior to project acceptance. These items include the project testing program, Burn-In Period, training, warranties, project submittals, system documentation, and as-built documentation.

25.2 Task Requirements

25.2.1 Project Testing Program

1. The project testing plan requirements and acceptance procedures are outlined in Section 2 of this SP725. Additional specific testing requirements are detailed in the individual SP725 sections.

25.2.2 Burn-In Period

1. The Burn-In Period requirements are outlined in Sections 2.5.7 and 24.13.2 of this SP725.

25.2.3 Training

1. The training requirements are outlined in Section 2.4 of this SP725. Additional specific training requirements are detailed in the individual SP725 sections.

25.2.4 Warranties

1. The warranties requirements are outlined in Section 2.6 of this SP725. Additional specific warranty requirements are detailed in the individual SP725 sections.

25.2.5 Project Submittal Program

1. The project submittal program requirements are outlined in Section 2.7 of this SP725. Additional specific submittal requirements are detailed in the individual SP725 sections.

25.2.6 System Documentation

1. The system documentation requirements are outlined in Section 2.8 of this SP725. Additional specific system documentation is detailed in the individual SP725 sections.

25.2.7 As-Built Documentation

1. Prior to the Conditional System Acceptance Test, all TDOT approved changes shall be incorporated by the Contractor into all submitted documents and drawings, including the project Plans. An electronic copy of the updated drawings shall be submitted to the Engineer to serve as the final as-built configuration drawings. In the project Plans, each drawing shall be identified under the sheet number block, with the words “AS-BUILT,” the date and the approval. The as-built drawings shall consist of a neatly marked-up set of plans using red linework and text in a PDF document. The drawing shall indicate the as-built location of all equipment including poles, cabinets, conduit, pull boxes, gates, etc., as well as deviations to details such as fiber optic splicing and terminations. As part of the as-built drawings, the Contractor shall use a hand-held GPS (1ft accuracy or better) unit to determine the GPS coordinates (in Decimal Degrees with 6 decimal places and a format approved by the Engineer) for all standalone devices, structures, and outside plant infrastructure including field devices, poles and sign structures, pull boxes, equipment cabinets, signs, etc. These coordinates shall be summarized in a GPS Coordinates Database in a Microsoft Excel table that indicates the following minimum information:

a. Device type

b. Device name and number (where applicable)

c. Roadway name

d. Roadway direction

e. Mile Marker to the nearest one tenth mile marker

f. Sheet number in Plans

g. GPS coordinates in Decimal Degrees with 6 decimal places

h. Demarcation information that includes what devices are fed from that location along with the utility provider and contact information

i. Provide GPS location and depth data for all conduit routings and bore pits. The data shall be provided at 20’ increments along the conduit path and at locations where the conduit line changes direction. The GPS data shall be accurate to within 6’ horizontal and 3’ vertical.

This information shall also be included in the equipment inventory and maintenance database described in this SP725.

2. The Contractor shall submit a PDF file (with markups created using digital entries) of each as-built sheet in a PDF format.

3. The Contractor shall also submit Shapefiles of the as-built system as documented in the GPS Coordinates Database as well as the fiber conduit, electrical conduit, and wireless paths. A separate Shapefile shall be submitted for each of the system components (each ITS device type, each pull box type, fiber conduit, electrical conduit, wireless paths, etc.) as well as a master file with all as-built information. All Shapefiles shall be in a format that can be referenced into MicroStation/ORD.

4. As-built documentation shall be prepared and submitted in the following 2 stages:

    a. Preliminary as-built documentation shall include all materials, devices, and infrastructure included in this contract. Preliminary as-built documentation shall be submitted and approved prior to requesting the Conditional System Acceptance Test.

    b. Final as-built documentation shall be an update reflecting any changes that occurred during the Burn-In Period. Final as-built documentation shall also include installation data forms provided by TDOT to the Contractor throughout the project that shall be completed by the Contractor. These forms require various information such as cable length IDs into and out of each pull box, site specific information, etc. Final as-built documentation shall be submitted and approved as part of the Final Systems Acceptance Testing and Inspection.

5. As part of the as-built drawings, the Contractor shall also submit a complete System Equipment Inventory of all equipment utilized on the project. The Contractor shall create and maintain the System Equipment Inventory as a Microsoft Excel database. The System Equipment Inventory shall include GPS coordinate information from the as-built documentation. As an alternate, the GPS Coordinates Database and the System Equipment Inventory may be combined in 1 relational database provided that all required data components are maintained.

As a minimum, the System Equipment Inventory shall include the following information about each equipment item:

a. Device/equipment item name

b. Pay item number

c. Location (roadway name, direction, nearest mile marker, and device ID)

d. Sheet number in Plans

e. GPS coordinates in Decimal Degrees with 6 decimal places

f. Make, model, and manufacturer part number

g. Serial number

h. Barcode equipment ID

i. Barcode location ID

j. Revision ID

k. Firmware ID

l. Purchase date

m. Installation date

n. Manufacturer contact information

o. Expiration date of manufacturer's warranty

6. The Contractor shall provide project submittals for as-built documentation in accordance with the requirements in Section 2.7 of this SP725. The project submittals for as-built documentation shall include but not be limited to the following:

    a. GPS Coordinates Database (template shall be submitted for approval)

    b. System Equipment Inventory (template shall be submitted for approval)

7. Beginning with the first activities of field construction, all as-built documentation including but not limited to updated drawings, completed installation data forms, GPS Coordinates Database, and System Equipment Inventory, shall be kept up to date on a weekly basis and shall be made available for review by the Engineer upon request.

25.3 Testing Requirements

1. General Requirements

    a. The Contractor shall conduct a project testing program for all materials specified in this section as required in Section 2.5 of this SP725. The project testing program for DMS shall include but not be limited to the additional specific requirements in this Subsection.

    b. All test results shall confirm physical and performance compliance with this SP725.

2. Bench Test Component (BTC)

a. The Contractor shall perform BTC on all materials specified in this section as they arrive from the factory. The goal of the BTC is to verify that the materials were not damaged during shipping. The BTC shall test or inspect the following components:

    i. External or internal visible damage.

    ii. Verify that all components function as intended, including running diagnostic tests as applicable.

    iii. Verify structural and other components have no damage and all loose parts are secured properly.

3. Bench Test System (BTS)

    a. The Contractor shall perform BTS on all materials specified in this section to verify that the materials are compatible and operationally interoperable with the communication equipment, TDOT ATMS software, and existing equipment. The Contractor shall refer to Section 2 of this SP725 for additional BTS requirements.

4. Stand Alone Test (SAT)

    a. The Contractor shall perform SAT on all materials specified in this section as they arrive from the factory. The goal of the SAT is to verify that the materials have been properly installed and commissioned according to the manufacturer requirements. The SAT shall include at minimum the following tests and inspections:

        i. Verify all components have been installed per manufacturer requirements.

        ii. Verify all items have been attached properly (as per recommendations and the Plans) to each other and any applicable structures.

        iii. Verify that grounding has been installed as required, power and communications have been connected as required, and installation follows NEC and other applicable codes/standards.

        iv. Verify that no components have internal or external damage.

        v. Verify that all components operate as intended and per manufacturer's specifications.

        vi. Witness operation of all electronic components, including fans, lights, and other accessories as applicable.

25.4 Warranty

All materials specified in this section (individually and as a system) shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. Devices shall carry a three-year manufacturer's warranty at minimum; such warranty shall be transferred to TDOT upon final acceptance of the project as per the requirements in Section 2.6 of this specification.

25.5 Method of Measurement

25.5.1 Burn-In Period

The Burn-In Period item shall be a lump sum item and shall include all labor, materials, tools, equipment, and engineering necessary to maintain the system as specified in Section 2.5.7. The Burn-In Period item

also includes all labor, materials, tools, equipment, and engineering necessary for all maintenance work as described in accordance with this SP725. The bid price for the Burn-In Period shall also include the labor and bar code labels for the bar code system described in Section 24.7. The Burn-In Period pay item is the only payment that will be made during the Burn-In Period with the exception of items described below.

25.5.2 As-Built Plans

As-Built Plans shall be a lump sum item and shall include all labor, equipment, materials, production and reproduction, and miscellaneous items needed to produce the as-built documentation as specified.

25.5.3 Training

The Training item shall be paid on an hourly basis and shall include all labor, equipment, materials, travel, facilities, production and reproduction, and miscellaneous items needed to conduct the training as specified.

25.5.4 Project Testing Program

Project testing shall be included in the cost of other pay items and will not be measured separately for payment, except for Burn-In Period as specified above.

25.5.5 Warranties

Warranties shall be included in the cost of other pay items and will not be measured separately for payment.

25.5.6 Project Submittal Program

Project submittals shall be included in the cost of other pay items and will not be measured separately for payment.

25.5.7 System Documentation

System documentation shall be included in the cost of other pay items and will not be measured separately for payment.

25.6 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-24.41	BURN-IN PERIOD	LS
725-24.55	AS-BUILT PLANS	LS
725-24.62	TRAINING	HOUR

Project Acceptance will be paid per each as follows:

1. As-built documentation will be paid on a lump sum basis as follows:

a. 90% of the contract unit price for approved as-built documentation prior to Conditional System Acceptance.

b. Final 10% of the contract unit price upon Final System Acceptance.

2. Training will be paid on an hourly basis as follows:

    a. 100% of the contract unit price upon completion of required training.

3. Burn-In Period will be paid on a lump sum basis as follows:

    a. 50% of the contract unit price upon successful completion of 90 calendar days of the Burn-In Period.

    b. Final 50% of the contract unit price upon Final System Acceptance.

APPENDIX A ABBREVIATIONS AND ACRONYMS

°C – Centigrade

°F – Fahrenheit

3GPP – 3G Peer to Peer

AAMA – American Architectural Manufacturers Association

AASHTO – American Association of State Highway and Transportation Officials

ABS – Acrylonitrile Butadiene Styrene Plastic Polymer

AC – Alternating Current

ACCY – Accessory (power)

ACI – American Concrete Institute

ACL – Access Control List

ADA – Americans with Disabilities Act

ADSI – Active Directory Service Interface

AES – Advanced Encryption Standard

AGC – Automatic Gain Control

AHRI – Air Conditioning, Heating & Refrigeration Institute

ALTOS – Manufacturer Product Reference

AM – Amplitude Modulation

ANSI – American National Standards Institute

AP – Application Profile

API – American Petroleum Institute

ARP – Address Resolution Protocol

ASCE – American Society of Civil Engineers

ASCII – American Standard Code for Information Interchange

ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers

ASN – Abstract Syntax Notation

ASN.1 – Abstract Syntax Notation – 1

ASSY – Assemblies

ASTM – American Society for Testing and Materials

ATMS – Advanced Traffic Management System

ATS – Automatic Transfer Switch

ATSC – Advanced Television Systems Committee

ATT – Communications Company

AV – Autonomous Vehicles

AVB – AV Bridging

AWG – American Wire Gauge

AWS – American Welding Association

BER – Bit Error Rate

BHMA – Builders Hardware Manufacturers Association

BICSI – Building Industry Consulting Service International

BIL – Breakdown Insulation Level

BNC – Binary Network Connector

BS – British Standard Institutions

BSC – Bare Solid Copper

BSM – Basic Safety Message

BSU – Base Station Unit

BTC – Bench Test Component

BTS – Bench Test System

CA – Manufacturer Product Reference

CAD – Computer Aided Design

CAN – Construction Advisory Notice

CAT – Community Access Television

CATV – Community Access Television

CBR – Constant Bit Rate

CCITT – International Telegraph and Telephone Consultative Committee, now being referred to as **ITU**

CCNA – Cisco Certified Network Associate

CCTV – Closed-Circuit Television

CE – Common Emitter

CFM – Cubic Feet Per Minute

CIF – Common Intermediate Format

CLD – Camera Lowering Device

CLI – Command Line Interface

CMX – Outdoor Ethernet Cable Rating

CO – Change Order

CODEC – Compressor/Decompressor (of Video files)

COM(M) – Communications

CORBA – Common Object Request Broker Architecture Protocol

COS – Class of service

CPU – Central Processing Unit

CRC – Cyclical Redundancy Check

CSA – Compliance Safety Accountability

CSAT – Conditional System Acceptance Testing

CSR – Combined Stress Ratio

DB – Decibel

DC – Direct Current

DCE – Data Circuit Terminating Equipment

DHCP – Dynamic Host Configuration Protocol

DI – Ductile Iron

DIN – Digital Input

DMS – Dynamic Message Sign

DNA – Manufacturer Product Reference

DNS – Domain Name System

DOT – Department of Transportation

DRAM – Dynamic Random Access Memory

DSP – Digital Signal Processing

DSRC – Dedicated Short Range Communication

DTE – Data Terminal Equipment

DVICE - Device

DVMRP – Distance Vector Multicast Routing Protocol

EA – Each

EE – End Entity

EIA – Electronics Industries Association

EIGRP – Enhanced Interior Gateway Routing Protocol

EIRP – Effective Isotropic Radiated Power

EMI – Electromagnetic Interference

EOP – Edge of Pavement

EOTL – Edge of Travel Lane

EOTW – Edge of Travel Way

EPA – US Environmental Protection Agency

EPDM – Ethylene Propylene Diene Monomer

EPS – Emergency Power Supply

EQUIP – Equipment

ESS – Environmental Sensor Station

ETH-BN – Ethernet Bandwidth Notification

ETL – Electrical Testing Laboratories

ETSI – European Telecommunications Standards Institute

EX - Ethernet

FAT – Factory Acceptance Test

FCAN – Full Capacity Above Normal

FCBN – Full Capacity Below Normal

FCC – Federal Communications Commission

FDD – Frequency Division Duplexing

FDS – Fog Detection System

FHWA – Federal Highway Administration

FIPS – Federal Information Processing Standard Publication

FLIR – Forward Looking Infrared

FNF – Flexible Net Flow

FO – Fiber Optic

FOCIS – Fiber Optic Connector Intermateability Standard

FOTP – Fiber Optic Test Procedures

Fps – Frames Per Second

FRP – Fiberglass-Reinforced Paneling

FSK – Frequency Shift Keying

FT – Foot

FTP – File Transfer Protocol

G.M. – Ground Mounted

GB – Gigabyte

GB/S – Gigabytes per Second

GBIC – Gigabit Ethernet Interface Card

GFCI – Ground Fault Circuit Interrupter

GH/GHz – Gigahertz

GIS – Geographic Information System

GMRP – Generic Multicast Registration Protocol

GOP – Group of Pictures

GPS – Global Positioning System

GR – Guardrail

GUI – Graphical User Interface

GVRP – Generic VLAN Registration Protocol

HAR – Highway Advisory Radio

HART – Highway Advisory Radio Transmitter

HDPE – High Density Polyethylene

HMI – Human Machine Interface

HOV – High Occupancy Vehicle

HSPG – Hub Single Point Ground

HTTP – Hypertext Transfer Protocol

HTTPS – Hypertext Transfer Protocol Secure

HVAC – Heating, Ventilation and Air Conditioning

IAB – Internet Activities Board

IANA – Internet Assigned Numbers Authority

IBC – International Building Code

ICC – Intelligent Cruise Control

ICEA – Insulated Cable Engineers Association

ICMP – Internet Control Message Protocol

ICS – Industrial Control Systems

ID – Identification

IEC – International Electrotechnical Commission

IEEE – Institute of Electrical and Electronic Engineers

IETF – Internet Engineering Task Force

IGEPAL – Manufacturer Product Reference

IGMP – Internet Group Multicast Protocol

IMSA – International Municipal Signal Association

IN – Inch

IP – Internet Protocol

IPCPS – IP Camera Positioning System

IR – Insulation Resistance

ISO – International Organization for Standardization

IT – Information Technology

ITE – Institute of Transportation Engineers

ITS – Intelligent Transportation Systems

ITSA – Intelligent Transportation Society of America

ITU – International Telecommunications Union

JPL – Jet Propulsion Laboratories

kAIC – one thousand amps interrupting current

Kbps – Kilobits per second

KHz – Kilohertz

km – Kilometer

KSI – Kilopound Per Square Inch

KV – Kilovolt

KVA – Kilovolt Amp

LAN – Local Area Network

LC – Lucent Connector

LCD – Liquid Crystal Display

LCN – Manufacturer Product Reference

LED – Light Emitting Diode

LF – Linear Feet

LHCP – Left hand circular polarization

LOS – Line of Sight

LR – Specification Reference

LRFD – Load and Resistance Factor Design

LS – Lump Sum

LT – Left

LU – Type of Conduit Body (Elbow)

LWRNG – Lowering

LX – Long Wavelength

MAC – Mandatory Access Control

MAP – Motorist Assistance Patrol

MAX – Maximum

MB – Megabyte

Mbps – Megabits per Second

MCB – Main Circuit Breaker

MCOV – Maximum Continuous Operating Voltage

MCTT – Multi Channel Test Tool

MD – Machine Direction

MDIX – Medium-Dependent Interface Crossover

MIMO – Multiple Input Multiple Output

MGB – Main Ground Busbar

MH/MHz – Megahertz

MIB – Management Information Base

MJPEG – Motion Joint Photographic Experts Group

MMFO – Multimode Fiber Optic

MPEG – Motion Picture Experts Group

MPH – Miles Per Hour

MPPS – Mega Packets Per Second

MS – Millisecond

MSEC – Millisecond

MTBF – Mean Time Before failure

MTP – Media Transfer Protocol

MTU – Maximum Transmission Unit

MUTCD – Manual on Uniform Traffic Control Devices

N.T.S – Not to Scale

NAB – National Association of Broadcasters

NC – Normally Closed

NEC – National Electric Code

NEMA – National Electrical Manufacturers Association

NESC – National Electric Safety Code

NETA – National Electrical Testing Association

NFPA – National Fire Protection Association

NHI – National Highway Institute

NHTSA – National Highway Traffic Safety Administration

NIST – National Institute of Standards and Technology

NMS – Network Management System

NO – Normally Opened

NOAA – National Oceanic and Atmospheric Administration

NPCA – National Precast Concrete Association

NPT – National Pipe Thread

NSF – National Science Foundation

NTCIP – National Transportation Communications for ITS Protocol

NTP – Network Time Protocol

NTSB – National Transportation Safety Board

NTSC – National Television System Committee

NWS – National Weather Service

OAM – Specific Ethernet Protocol

OBU – On Board Unit

OFS – Manufacturer Product Reference

O/H – Overhead

ONVIF – Open network Video Interface Forum

OSHA – Occupational Safety and Health Administration

OSP – Outside Plant

OSPF – Open Shortest Path First

OTDR – Optical Time Domain Reflectometer

OVDS – Over-height Vehicle Detection System

P – Power

PB – Pull Box

PC – Intel/Windows-based personal computer

PCB – Printed Circuit Board

PCI – Precast/Prestressed Concrete Institute

PDF – Portable Document Format

PE – Polyethylene

PF – Pound-Force

PICS – Profile Implementation Conformance Specifications

PIM – Protocol Independent Multicast

PLC – Programmable Logic Controller

PM – Preventive Maintenance

PMP – Point-to-Multipoint

PMPP – Point-to-Multipoint Protocol

POC – Point of Connection

POCSAG – Post Office Code Standardization Advisory Group

POE – Power Over Ethernet

PPM – Parts per Million

PPS – Packets Per Second

PPT – Puncture Propagation Tear

PSF – Pound Per Square Foot

PSI – Pounds Per Square Inch

PSWZS – Portable Smart Work Zone System

PT – Pan and Tilt

PTC – Positive Temperature Coefficient

PTP – Precision Time Protocol

PTU – Pan and Tilt Unit

PTZ – Pan Tilt and Zoom

PV – Photovoltaic

PVC – Polyvinylchloride

PVDF – Polyvinylidene Fluoride

PWM – Pulse Width Modulation

QoS – Quality of Service

RADIUS – Remote Authentic Dial-in User Server/Service

RAM – Random Access Memory

RDS – Radar Detection System

RF – Radio Frequency

RFI – Radio Frequency Interference

RG – Radio Guide

RGS – Rigid Galvanized Steel

RI – Resistor, Input

RIP – Routing Information Protocol

RJ – Registered Jack

RMON – Remote Networking Monitoring

RMS – Ramp Metering System

ROW – Right-of-Way

RP – Recommended Preference

RS – Recommended Standard

RSL – Received Signal Level

RSU – Road Side Unit

RT – Right

RTP – Real Time Transport Protocol

RTSP – Real Time Streaming Protocol

RUS – Rural Utilities Service

SAE – Society of Automotive Engineers

SAP – Session Announcement Protocol

SAT – Stand Alone Site Test

SCH – Schedule

SCMS – Security Credential Management System

SCTE – Society of Cable Telecommunication Engineers

SCU – Sign Controller Unit

SD – Secure Digital

SDI – Single Double Insulated

SDP – Session description protocol

SDR – Standard Dimension Ratio

SEI – Solid Electrolyte Interface

SFP – Small Form-Factor Pluggable

SFTP – Secure File Transfer Protocol

SIA – Security Industry Alliance

SIF – Standard Interchange Format

SJ – Hard Service

SM – Single Mode

SMFO – Single Mode Fiber Optic

SNMP – Simple Network Management Protocol

SNTP – Simple Network Time Protocol

SP/SP725 – Special Provision (specifically refers to this document)

SPD – Surge Protective Device

SPVU – Single Package Vertical Unit

SRAM – Static Random-Access Memory

SSD – Solid-State Drive

SSH – Secure Shell Protocol

SSL – Secure Socket Layer

SST – Sub-system Test

ST – Super Tension

STA. – Station

STMF – Simple Transportation Management Framework

STMP – Simple Transportation Management Protocol

STP – Shielded twisted pair

STS – Strategic Technology Solutions

SU – Subscriber Unit

SWD – Switching Duty

SWR – Standing Wave Radio

SZ – Reverse Oscillating

TACACS – Termination Access Controller Access Control System

TCIP – Transit Communications Interface Protocol

TCP – Transmission Control Protocol

TCP/IP – Transmission Control Protocol / Internet Protocol

TD – Tunnel Diode

TDMA – Time Division Multiple Access

TDOT – Tennessee Department of Transportation

TEES – Transportation Electrical Equipment Specifications

TELNET – Teletype Network Protocol

TFTP – Trivial File Transfer Protocol

THHN – Thermoplastic High Heat Resistant Nylon Coated

THWN – Thermoplastic Heat- and Water-Resistant Nylon Coated

TIA – Telecommunications Industry Association

TIM – Traveler Information Message

TIS – Traveler Information Service

TMC – Transportation Management Center

TOAD – Toggle Only Actuated Device

TP – Triple Pole

TS – Thermo Switch

TTMS – Travel Time Message Sign

TV - Television

TX – Transmitter

UDP – User Datagram Protocol

UDP/IP – User Datagram Protocol/Internet Protocol

UHF – Ultra-High Frequency

UL – Underwriter's Laboratory Incorporated

UNII – Unlicensed National Information Infrastructure

UPS – Uninterruptible Power Supply

USB – Universal Serial Bus

USDOT – United States Department of Transportation

UTP – Unshielded Twisted Pair

UV – Ultraviolet

VA – Volt Ampere

VAC – Volts Alternating Current

VBR – Voltage Breakdown

VDC – Volts Direct Current

VDS – Video Detection System

VHF – Very High Frequency

VLAN – Virtual Local Area Network

VPR – Voltage Protection Rating

VRRP – Virtual Router Redundancy Protocol

VSWR – Voltage Standing Wave Radio

VTP – VLAN Trunking Protocol

WAN – Wide-Area Network

WIM – Weigh In Motion

WRED – Weighted Random Early Detection

WWF – Welded Wire Fabric

XHHW – XLPE (Cross-Linked Polyethylene) High Heat-Resistant Water-Resistant

XLPE – Cross-Linked Polyethylene

XPIC – Cross Polarization Interference Cancellation

ZX – Extended Wavelength

APPENDIX B PREVENTIVE MAINTENANCE PROCEDURES

See Regional Maintenance SP below.

APPENDIX C SPARE PARTS

The following Spare Parts shall be kept on-hand by the Contractor and replenished as they are used.

Item Number	Description	Quantity

APPENDIX D LATEST DEVICE FIRMWARE

The latest supported device firmware is shown on the following pages.

APPENDIX E INSTRUCTIONS FOR ADDING SECTIONS/DOCUMENT MAINTENANCE

1. Go to end of section before desired new section, hit enter until new, empty line (no numbering)
2. Select "Heading 1" Style and enter section header in all caps
    a. If Appendix, use "Appendix Heading 1" instead
3. Hit enter, paste or type new information
4. Check or add headers using "Heading 2", "Heading 3" (or "Appendix Heading 2", "Appendix Heading 3")
5. Adjust line spacing before and after by right clicking and selecting "paragraph" or go to ribbon tab "Layout" and adjust in "Paragraph" section; note: expand the section or right click and select "paragraph" to uncheck "don't add space between paragraphs of the same style" to space out lists
6. To fix page numbering, select Heading 1 between automatic number and new text and go to ribbon tab "Layout", click "Breaks" and insert "Continuous Section Break"
7. If footer doesn't auto-update, open footer and select page number text, go to ribbon tab "Header & Footer", select "Page Number" and then "Format Page Number"; check the box for including header information (not checked for most appendices) and restart numbering at 1 if desired
8. Add new reference fields by selecting text to be replacing or placing cursor where reference should go and go to ribbon tab "References", then "Cross-reference" under "Captions" Section; use dialog box – typically show headers or numbered items and then insert header number or header text
9. Select all text in document with "ctrl" + "a", then use F9 to update all reference fields and table of contents; this should be done automatically upon saving and printing as well

Tips and Tricks:

1. Right click and select "Paragraph", "Indents and Spacing" tab, then uncheck "don't add space between paragraphs of the same style" to space out lists
2. In the same "paragraph" dialogue box, select "Line and Page Breaks" tab to find "Keep with next" and "keep lines together" check boxes; select an entire section you want to stay together on same page and check both of these boxes to force it to the next page; uncheck if you dislike how much white space is left on the previous page
3. Using the Navigation pane (hit "ctrl" + "f" or go to ribbon tab "View" and check "Navigation Pane" under "show" section), you can drag and drop headers to re-organize sections but back-check that everything moved properly please

APPENDIX F UNUSED/OUTDATED SPECIFICATIONS

~~26 FORWARD LOOKING INFRARED CAMERA SYSTEM~~

SECTION NOT USED

~~27 FIELD VIDEO ENCODER UNIT~~

SECTION NOT USED

28 TERMINAL SERVERS

28.1 Description

This section specifies the minimum requirements for Terminal Servers furnished and installed on this project. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, and test Terminal Servers.

The Terminal Server device, also commonly referred to as a Port Server device, will be used to communicate bi-directionally between IP-based Ethernet network systems and field devices that communicate or are controlled via a full-duplex serial interface.

28.2 Materials

Contractor shall provide all materials according to the requirements in the following sections.

All equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Prior to installation, the Contractor shall submit and receive approval from TDOT on a complete set of shop drawings of all the equipment and components listed within these Special Provisions and included as part of the installation.

The firmware pre-installed on the device shall meet the minimum version listed in APPENDIX D at the time of device installation in the field.

28.2.1 General Capabilities and Performance Requirements

The Terminal Server shall meet the following general requirements:

1. 10/100 Base-TX Ethernet port connection
2. RS-232/485 selectable or programmable serial connections
3. Baud rates up to 230 Kbps
4. TCP/IP protocol
5. SNMP protocol
6. HTTP protocol
7. Remote TELNET connection
8. ARP-Ping for IP address assignment
9. LED status for link and power
10. All terminal servers shall be mechanically and electrically interchangeable within the network.

28.2.2 Data Interface Requirements

The minimum data interface requirements include the following:

1. The Terminal Server shall support a minimum of 2 bi-directional serial communication channels over an Ethernet 10/100 Base-TX uplink.

2. Each Terminal Server shall have a minimum of 2 EIA-232/485 Serial interface ports. These ports shall be individually and independently configurable, directly by switching or over the network, to EIA-232/485 mode of operation as defined by the EIA for data format, data rate, and data structure (e.g., the number of bits, parity, stop bits, etc.). Each serial port shall support up to 230 Kbps.
3. Each serial port shall support IP addressing, and shall not use proprietary encapsulation methods, which would restrict the use of standards-based virtual COM port connectivity software.
4. The equipment shall provide the capability to establish an IP connection directly from a workstation to any device IP address.
5. Each Terminal Server shall have an Ethernet Interface (10/100Base-TX protocol, Full/Half-Duplex, Auto Sense (802.3), RJ-45).

28.2.3 Physical and Environmental Specifications

The minimum physical and environmental requirements include:

1. Each Terminal Server shall have the following ports:
    a. Network Ethernet Port: Minimum 1-10/100 Mbps RJ-45.
    b. Serial Data Interfaces: 2-232/485 9 pin ports.
2. Operate in a temperature range of -35°C to 74°C.
3. Operate in relative humidity of 5% to 95% non-condensing.
4. Maximum Dimensions: 8”W x 6”D x 3”H.
5. Provide external markings:
    a. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.
    b. The external markings shall include the product function name, model number, serial number, and manufacturer’s name.
6. Terminal Servers shall be shelf mountable or rack mountable. Shelf for the cabinet shall be provided if needed. Other mounting options may be submitted for review and approval by the Engineer.

28.2.4 Management Capabilities

The minimum management system requirements shall include:

1. Remote Management and Port Configurable.
2. SNMP compatible.
3. Local Configuration Port.
4. Port Configurable via Telnet.

28.2.5 Electrical

The minimum electrical/power requirements include:

1. 120 VAC.
2. External power supply unit is acceptable.

28.3 Installation Requirements

All equipment shall be installed according to the manufacturer's recommendations, the Plans, this SP725, and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
2. The Contractor shall furnish all tools, equipment, materials, supplies and manufactured hardware, and shall perform all operations and equipment integration necessary to provide complete, fully operational communications equipment as specified in this SP725, on the Plans, and/or in the contract documents. It is the responsibility of the Contractor to ensure DCE/DTE conflicts are addressed and that the equipment performs its required function when installed.
3. The terminal server power supply shall be connected to the UPS within the cabinet.
4. The Contractor shall provide TDOT with a written inventory of items received and the condition in which they were received. Once received, the equipment becomes the Contractor's responsibility. The Contractor shall provide all labor and equipment necessary to move inventory out of the designated storage facility and to transport it to the installation location. All equipment shall be installed according to the manufacturer's recommendations or as directed by the Engineer.

28.4 Testing Requirements

28.4.1 General Requirements

1. The Contractor shall conduct a project testing program for all materials specified in this section and as required in Section 2.5 of this SP.
2. All test results shall confirm physical and performance compliance with this SP.
3. The Contractor shall submit all test results documentation to the Engineer within 7 calendar days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 2.7.
4. Payment for all testing is included in the cost of the Terminal Server.

28.4.2 Factory Acceptance Test

FAT is not required for Terminal Server.

28.4.3 Bench Test Component

BTC is not required for Terminal Server

28.4.4 Bench Test System

BTS shall be performed in the presence of the Engineer. The BTS shall include the following tests and inspections:

1. Demonstrate the ability of the Terminal Server to communicate with the attached RDS's through the serial port.
2. Verify that the Terminal Server is compatible and supports operational interoperability with the communication equipment and TDOT ATMS software.

28.4.5 Stand Alone Site Test

SAT shall be performed in the presence of the Engineer. The SAT shall include the following tests and inspections:

1. Verify all components have been installed per manufacturer requirements.
2. Verify all items have been attached properly (as per manufacturer recommendations and the Plans) to each other.
3. Verify the Terminal Server has no internal or external damage.
4. Verify the Terminal Server has been properly connected to the UPS for continuous, conditioned power.
5. Verify the Terminal Server is protected by surge suppression.

28.5 Warranty

All materials specified in this section shall carry a minimum one-year manufacturer's warranty from the date of Final Acceptance against any imperfections in workmanship or materials. Warranties shall cover complete replacement at no charge for the equipment. Warranties shall be transferred to TDOT upon Final Acceptance of the project as per the requirements in Section 2.6 of this specification.

28.6 Measurement

The Terminal Servers will be measured in units of each and paid for at the contract price per each. The bid price shall include furnishing, installing, testing, warranties, full operation and configuring the Terminal Server in accordance with applicable Standards, Specifications, and requirements. The bid price shall also include the mounting hardware, Category 6 ethernet patch cord, serial port cables or connectors, power cable, power adapters, user manuals, and any and all other equipment required to complete installation of the unit. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

28.7 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-21.21	TERMINAL SERVER	EA

The Terminal Servers will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System, and Pre-Installation Test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.
3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.
4. Final 10% of the contract unit price upon Final System Acceptance.

~~29 FORWARD FIRING RADAR DETECTION~~

SECTION NOT USED

S T A T E **0 F** **T E N N E S S E E**

(Rev. 12-18-95) January 1, 2021

SPECIAL PROVISION

REGARDING

TEMPORARY TRAFFIC CONTROL (SIGNALIZATION)

Delete **Subsection 730.01** of the Standard Specifications and substitute the following:

730.01 - Description of Work - This work shall consist of furnishing, erecting, and maintaining all signalization equipment and materials installed in accordance with the provisions of the current edition of the "Manual for Uniform Traffic Control Devices for Streets and Highways", Federal Highway Administration, and these Specifications, or as specified by the plans or directed by the Engineer for the purpose of safely directing traffic through construction zones.

Material and equipment, while not required to be new, shall nevertheless, be in good condition and ready for use. If the Contractor elects to use a traffic signal controller that is not new, certification shall be submitted that the equipment has been tested to the original manufacturers' specifications and is in good working condition, and that all applicable NEMA environmental standards are met.

All equipment necessary for the satisfactory performance of this work shall be on hand and approved before the work will be permitted to begin. All construction requirements for this work shall be as prescribed in **Section 712 - Temporary Traffic Control.**

Delete **Subsection 730.03** of the Standard Specifications and substitute the following:

730.03-Submittal Data Requirements - Within 30 days after the issuance of the work order, the Contractor shall submit to the Engineer and to the Division of Materials and Tests one collated set of the manufacturer's descriptive literature and technical data which fully describes the types of signal equipment he proposes to use. A copy of the transmittal letter for this submittal shall be provided to the Engineer. Descriptive literature shall include the manufacturer, models, etc. and be adequate to determine if the equipment or material meets the requirements of the Plans and specifications. These sets of submittal data shall include a list of the materials submitted along with descriptive material for, but not limited to, the following items:

Controller
Cabinet and Exhaust Fan
Detectors
Signal Heads including Lamp Information and Mounting Hardware
Loop Wire and Loop Sealant
Shielded Detector Cable
Signal Cable
Cable for Span Wire, Guys, etc.
Pull Boxes
Conduit
Coordination Equipment
Wood Poles

In addition to the above, the Contractor shall submit to the Engineer a notarized letter certifying that all traffic signal materials listed in the submittal are in conformance with the Plans and Specifications.

If the signal equipment has been approved previously by the Department, a certified letter referencing the Contract and a statement confirming that the equipment has been tested in accordance with **Section 730.01,** may be submitted in lieu of the two (2) sets of the manufacturers descriptive material described above. The submittal sets shall also include detailed scale drawings of any non-standard or special equipment and of any proposed deviation from the Plans. If requested to do so, the contractor shall submit for approval sample articles of any materials proposed for use. The Department will not be liable for any materials purchased, labor performed, or delay to the work prior to such approval.

Add the following after the fifth paragraph of **Subsection 730.24**:

If polycarbonate signal heads are provided, they shall be the same in appearance as metal signals except the lenses, housings, doors and visors shall be molded of polycarbonate resin and shall withstand 70 ft-lb impact without fracture or permanent deformation. The color of the signal shall be Federal yellow and shall be homogenous throughout. Reflectors shall be "ALZAK" process coated aluminum or approved equal material and shall conform to the latest revised specifications of the ITE Technical Report No. 1.

Delete 6 (K.) under Controller Cabinets in **Subsection 730.25** and substitute the following:

K. All cabinet housing solid-state controllers shall be supplied with a signal conflict monitor which meets the NEMA standards. The signal conflict monitor (SCM) shall be wired to sample the following cabinet functions:

1. Each phase Red/Yellow/Green/Walk display.
2. Controller plus 24 volt output.

3. Controller Voltage Monitor function.

The following conditions shall be sensed by the monitor and the SCM shall place the cabinet in the Flash Mode:

1. Absence of an active AC input on a channel.
2. Green/Yellow both active on a channel.
3. Yellow/Red both active on a channel.
4. Green/Green active on conflicting channels.
5. Green/Walk active on conflicting channels.
6. Green/Yellow active on conflicting channels.
7. Absence of the 24 VDC required to operate the load switches.
8. Controller Voltage Monitor circuit indicates a controller malfunction.
9. Defeatable per channel operation that times the Phase Yellow Clearance interval. If the Phase Yellow Clearance is less than 3.0 seconds, the intersection shall be placed in the FLASH mode.

The SCM shall be wired in the cabinet in such a manner that the cabinet will provide ONLY FLASH operation if the SCM is not properly mounted.

The SCM shall be provided with front panel indicators to display the following:

1. AC power is active.
2. Channel active indicators.
3. Failed status.

   a. Plus 24 VDC I.
   b. Plus 24 VDC II.
   c. Conflict.
   d. Controller Voltage Monitor.
   e. Absence of Signal.
   f. Power Failure after conflict.

The SCM shall have a defeatable "Start in Flash Period" which shall be user adjustable over the range of 4-10 seconds. This circuitry shall guarantee a minimum flash operation period of the intersection when power is applied to the monitor.

The monitor shall be provided with a front-panel reset switch and power fuse.

The type of monitor required shall be as specified previously, but in no case will a cabinet be acceptable which has phase red/yellow/green/ or walk displays which are not monitored by the SCM.

The signal monitor sampling inputs shall be terminated at the point in the cabinet which is closest to the field termination point.

Add the following after the fourth paragraph of **Subsection 730.29**:

Microwave Vehicle Detector

Microwave vehicle detectors shall be self-contained units capable of emitting a low power microwave beam over one or more lanes of traffic. The microwave vehicle detector shall have the following requirements:

1. Shall have directional detection capability with a detection range of 5 to 50 meters (16 to 160 feet) measured from the detector over the approach traffic lane.
2. Shall have pan and tilt adjustability.
3. Shall have a detection delay of a minimum of one third of a second before an output is generated.
4. Shall be housed in an aluminum enclosure.

S T A T E **O F** **T E N N E S S E E**
(Rev. 08-29-19) January 1, 2015
City of Murfreesboro
Rutherford County

SPECIAL PROVISION

REGARDING

SECTION 730 – TRAFFIC SIGNALS

DESCRIPTION

730.01 Description of Work

This work consists of furnishing and installing all necessary materials and equipment to complete in-place traffic signal systems, modify existing systems, or both, all as shown on the Plans or the Standard or Special Details, and as specified in these Specifications. Unless otherwise shown on the Plans or specified in the Special Provisions, all materials shall be new.

Where existing systems are to be modified, incorporate the existing material into the revised system, salvage it, or abandon it as specified or as directed by the Engineer.

Furnish and install all incidental parts that are not shown on the Plans or specified herein, but that are necessary to complete the traffic signal or other electrical systems, or that are required for modifying existing systems, as though such parts were shown on the Plans or specified herein. Include the costs of such incidentals in bid price for other items. All systems shall be complete and in operation to the Engineer's satisfaction at the time of completion of the work.

GENERAL REQUIREMENTS

730.02 Regulations and Code

Ensure that all equipment provided conforms to NEMA Standards Publication, Traffic Control Systems, latest revision, or the Radio Manufacturers Association, whichever is applicable. In addition to the requirements of these Specifications, the Plans, and the Special Provisions, all material and work shall conform to the requirements of the NEC and the NESC; the Standards of ASTM, ANSI, ITE, and IMSA; the MUTCD; and other applicable local ordinances.

Wherever reference is made to the NEC, or the Standards mentioned above, consider the reference to mean the code or standard that is in effect on the date of advertising the bids or authorization for force account.

730.03 Submittal Data Requirements

Within 30 days after the issuance of the work order, submit to the Engineer, the Traffic Operations Division, and the local entity (city or county engineer), one collated set of the manufacturer's descriptive literature and technical data that fully describes the types of signal equipment proposed for use. In the descriptive literature, identify the

manufacturer and models and include sufficient information for the Engineer to determine if the equipment or material meets the requirements of the Plans and these Specifications. Include with these sets of submittal data a list of the materials submitted along with descriptive material for, but not limited to, the following items:

1. Controller
2. Cabinet and Exhaust Fan
3. Detectors
4. Signal Heads including Lamp Information and Mounting Hardware
5. Loop Wire and Loop Sealant
6. Shielded Detector Cable
7. Signal Cable
8. Cable for Span Wire, Guys, and similar features
9. Pull Boxes
10. Conduit
11. Coordination Equipment
12. Signal Communication Cable

Also include in the submittal sets detailed scale drawings of all non-standard or special equipment and of all proposed deviations from the Plans. Upon request, submit for approval sample articles of materials proposed for use. The Department will not be liable for any materials purchased; labor performed, or delay to the Work prior to such approval.

In addition to the above, submit to the Engineer a notarized letter certifying that all traffic signal materials listed in the submittal conform to the Plans and Specifications along with a copy of a statement from the maintaining agency that the system is acceptable to the agency. Any material substitutions requested by the maintaining agency shall meet minimum Department standards and shall be approved by the Department in writing prior to purchase or installation. The Department will not be liable for any materials purchased; labor performed, or delay to the Work regarding such approval.

Submit an electronic copy in PDF format of "Design" or "Shop" drawings, indicating the proposed dimensions and material specification for each of the supports and mast arms involved, to the Division of Structures for approval purposes within 30 days after the work order is issued. The Department will review these drawings at the earliest possible date, and will return the electronic copy marked "Approved for Fabrication," or "Returned for Revisions as Noted." Respond by taking appropriate action to ensure the earliest possible correction of these items so as not to delay the installation.

730.04 Mill Test Reports and Certification

Provide Mill Test Reports (MTR) or Certifications of Conformance to the Specifications for Materials and Design for all materials incorporated into the Work. Supply the following prior to acceptance of the structures:

1. MTRs for MAJOR structural items only, as identified in Table 730.04-1, shall include both physical and chemical descriptions of the material as supplied to the fabricator. When physical properties are altered during the fabrication, supplement the MTR covering chemical composition with certified test reports indicating the physical properties of this material after fabrication.

2. Certifications of Conformance to the Specifications for all remaining material not covered by MTR as identified in Table 730.04-1.

3. Certification that all welding was performed by operators qualified as follows: Steel welders to AWS and aluminum welders to ASME.

4. Certification of Conformance to the Specification for the Design of all components not completely dimensioned and detailed on the Standard Drawing.

Table 730.04-1: Required Mill Test Reports and Certifications

Component Materials	MTR	Certification
Tubes for arms and poles	X	
Base Castings	X	
Anchor Bolts	X	
Pole tops, misc. fittings, and hardware		X
Fabricated or cast-type arm connections		X
Galvanizing		X

730.05 Working Drawings

Provide within the controller cabinet and to the local maintaining agency an electrical schematic diagram of the cabinet and system wiring. Submit manufacturer's instructions for installation, maintenance, and operation of all equipment to the local maintaining agency and also place a copy within the controller cabinet. Place all such materials inside a plastic envelope mounted in the cabinet.

730.06 Guarantee

Guarantee the Traffic Signal System(s) installed under these Specifications, including all equipment, parts, and appurtenances in connection therewith, to the City or County and State against defective workmanship and materials for a period of not less than 1 year following the date the signal system is installed and made operational, except in no case shall this guarantee expire prior to 3 months after the final acceptance of the Project. Upon completion of the Project, turn over to the government agency responsible for maintaining the signal installation all warranties or guarantees on equipment and materials that are offered by the manufacturers as normal trade practice.

730.07 Training

Provide to the maintaining agency and/or the Department a training session on the controller and associated cabinet equipment to be supplied on the Project. The training session shall last for a minimum 4 hours unless the maintaining agency and/or the Department determines a lesser time is adequate. Train the user in the complete operation and programming features of all controllers. Provide this training prior to the acceptance of the Project at a facility agreed upon by the maintaining agency.

After the required training, certify to the Engineer that training has been completed.

This training requirement shall not apply if a training program meeting these criteria has been provided to the maintaining agency by this vendor and/or manufacturer on the equipment being bid within 18 months prior to the date of the invitation to bid. This requirement shall apply if the bidder is proposing new, upgraded, or modified equipment not covered in the previous training program.

MATERIALS AND INSTALLATION

730.08 Excavating and Backfilling

Perform excavation needed to install conduit, foundations, and other equipment, so as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavate trenches no wider than necessary to properly install the electrical equipment and foundations. Do not begin excavating until immediately before installing conduit and other equipment. Place the material from the excavation where it will cause the least disruption and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage.

Backfill the excavations and compact to at least the density of the surrounding material. Remove all surplus excavation material and dispose of outside the highway right-of-way, in accordance with **203.07**, or as directed by the Engineer.

After backfilling, keep excavations well-filled, and maintain in a smooth and well-drained condition until permanent repairs can be made.

At the end of each day's work, and at all other times when construction operations are suspended, remove all equipment and other obstructions from that portion of the roadway used by public traffic, and park a minimum of 30 feet from the edge of pavement unless otherwise protected by guardrail, bridge rail, or barriers installed for other purposes.

Perform excavation in the street or highway so as to restrict no more than one traffic lane in either direction at any time. Do not obstruct traffic during hours of peak flow unless otherwise approved by the Engineer. Incorporate construction signing in accordance with the MUTCD.

730.09 Removing and Replacing Improvements

Replace or reconstruct, with the same kind of materials as found on the Work, improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and all other improvements removed, broken, or damaged.

Before removing the sidewalk and pavement material, use an abrasive type saw to cut, to a minimum depth of 2 inches, the outline of all areas to be removed in Portland cement concrete sidewalks and in all pavements. Use any method satisfactory to the Engineer to cut the remainder of the required depth. Make cuts neat and true with no shatter outside the removal area.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, remove the entire square or slab and reconstruct the concrete as specified above.

Perform all work in accordance with these Specifications, or the applicable local ordinance, whichever is of a higher standard. Consider this removal and replacement work to be incidental to other items.

730.10 Foundations

Construct foundations for posts, standards, and cabinets of Class A Portland cement concrete.

Pour foundations for posts, standards, and pedestals after the post, standard, pedestal, or anchor bolts or reinforcing steel is in proper position. Form the exposed portions to present a neat appearance. Rest the bottom of concrete foundations on firm undisturbed ground.

Construct forms to be true to line and grade. Finish tops of footings for posts and standards, except special foundations, to curb or sidewalk grade or as ordered by the Engineer. Use rigid forms, securely braced in place. Place conduit ends and anchor bolts by means of a template until the concrete sets. Moisten both the forms and the ground that will be in contact with the concrete before placing concrete. Do not remove forms until the concrete has cured for at least 12 hours and hardened sufficiently to allow form removal without causing damage to the concrete.

Apply an ordinary surface finish to exposed surfaces of concrete. Wherever the edge of a concrete foundation or sidewalk section is within 18 inches of any existing concrete improvement, extend the sidewalk section to meet the existing improvement.

Where obstructions prevent the construction of planned foundations, construct a foundation satisfactory to the Engineer.

730.11 Anchor Rods

Furnish, with anchor-base type rods, anchor bolts meeting the requirements of ASTM F1554, grade as required by design. Fit each anchor bolt with two heavy hex nuts. Hot-dip galvanize all nuts and not less than 10 inches of the threaded ends of anchor bolts according to ASTM A153. The anchor bolts shall be capable of resisting at yield strength stress the bending moment of the shaft at its yield strength stress.

Set standards, posts, and pedestals plumb by adjusting the nuts before the foundation is finished to final grade. Do not use shims or similar devices for plumbing or raking. After plumbing or raking has been completed, cut off anchor bolts 1/4 inch above the top nut, and paint the exposed surface with rust protective paint.

Furnish all anchor bolts and nuts required for relocating existing standards and posts.

730.12 Pull Boxes

Construct and install pull boxes as shown on the Plans and the Standard Drawings or as directed by the Engineer. Additional pull boxes may be required where conduit runs are more than 150 feet long. The maximum spacing between pull boxes shall be 150 feet, unless otherwise directed by the Engineer. Install pull boxes wherever practicable out of the line of traffic. Set covers level with the pavement, or with the curb or sidewalk grade, or with the surrounding ground as required.

Place electrical conductors within pull boxes so as to be clear of the metal frame and cover.

Rest the bottom of the pull box firmly on a bed of crushed stone with a minimum depth of 12 inches below the bottom, and extending 6 inches beyond the outside edge of the pull box, unless otherwise directed by the Engineer.

A. Concrete Pull Boxes

Construct concrete pull boxes of a mixture of one part cement, two parts sand, and four parts gravel or 1-inch crushed stone with reinforcement placed as shown on the Standard Drawings. Reinforcement shall consist of welded wire reinforcement, 4 x 4 inches - No. 4/4 at 85 pounds per 100 square feet, meeting the requirements of **907.03**. Pull boxes may be poured in place or precast. The color of the pull box concrete material shall match the surrounding concrete color.

Install a cast iron frame and cover of the dimensions shown on the Drawings in each pull box. Provide castings of Class 30, meeting the requirements of **908.07**. The covers shall have a roughened top surface of 1/8 inch in relief. Provide notches for removing the cover. Inscribe the words “TRAFFIC SIGNALS” on top of the covers with letters 1-1/2 inches high and 1/8 inch in relief as shown on the Drawings.

The frame shall have a minimum weight of 42 pounds. The cover shall be of the “Extra Heavy” type with a minimum weight of 54 pounds.

B. Reinforced Plastic or Epoxy Mortar Pull Boxes

Ensure that pull boxes composed of reinforced plastic or epoxy mortar are designed and tested to temperatures of -50 °F and meet the requirements of the following: ASTM D543, ASTM D570, ASTM D790, and ASTM D635, and are based on a 30,000-pound single axle load over a 10 x 20 inch area. The top of the pull box shall consist of a concrete frame (ring) and cover. The color of the pull box concrete material shall match the surrounding concrete color. Inscribe the words “TRAFFIC SIGNALS” on top of the covers.

730.13 Transformer Base

Fabricate the transformer base from steel plate and sheet, and design it to harmonize with the shaft. Provide each transformer base with:

1. One 7-1/2 x 9 inch minimum handhole, with a cover secured with stainless steel fastening screws;
2. Four galvanized steel bearing plates to fasten the base to the anchor bolts;
3. Four galvanized steel bolts, nuts, and washers to fasten base and standard; and
4. One 1/2-inch, 13 UNC grounding nut welded to the inside of the base opposite the handhole opening.

Ensure that the strength of the transformer base is comparable with that of the shaft.

When a transformer base is required, no handhole will be required in the shaft.

730.14 Conduit

Furnish and install plastic and steel conduit in accordance with these Specifications and close conformity with the lines shown on the Plans or as established by the Engineer.

Threads shall be clean cut, straight, and true and of sufficient length to allow proper coupling. Do not use long running threads on any part of the Work. Protect threads in transit and during installation, and provide conduit with proper supports and protection during construction to prevent damage. Properly thread, ream, and cap all ends of pipe installed for future connections to prevent water and foreign matter from entering the conduit system. Provide threaded ends with approved conduit bushings.

Signal conduit shall be a minimum 2 inches in diameter, and detector conduit a minimum 1 inch in diameter, unless otherwise specified or directed by the Engineer. Conduit for service connections shall be 1 inch in diameter. Do not use conduits smaller than 1 inch in diameter unless otherwise specified, except grounding conductors at service points shall be enclosed in 3/4-inch diameter conduit. Larger-sized conduit may be used, at no additional cost to the Department, in which case it shall be for the entire length of the run with no reducing couplings allowed.

A. Materials

Provide conduits and fittings of the type as shown in the construction plans or as directed by the Engineer and as follows:

1. Steel Conduit

a. Rigid conduit and fittings shall be heavy-wall, hot dipped galvanized steel conforming to Federal Specification WW-C-581-d(3) and ANSI C80.1. It shall be galvanized inside and out and shall meet the requirements of ASTM A53. Each length shall bear the label of Underwriters Laboratories, Inc.

b. Flexible conduit shall be galvanized flexible steel meeting Federal Specification WW-C-581-d(3), ANSI C80.1 and UL Standard 6 with a minimum 40-mil thickness of polyvinyl chloride (PVC) coating conforming to ASTM D746.

2. Plastic Conduit. For plastic conduit, provide high impact PVC, Schedule 40 or Schedule 80.

3. High-Density Polyethylene (HDPE). Materials used for the manufacture of HDPE conduit and fittings shall be per ASTM F2160 and consist of a Standard Dimension Ratio (SDR) 9-11. No other substitutions shall be allowed unless directed by the Engineer. HDPE conduit can be used with preassembled cable and rope-in-conduit.

B. Installation

All bends shall be in strict compliance with the NEC.

Lay conduits to a minimum depth of 6 inches below subgrade but not less than 24 inches below pavement grade except when approved by the Engineer; conduit may be laid at a depth of not less than 24 inches below top of curb when placed in back of the curb. Place conduit runs for detectors parallel to existing or proposed curbs and not more than 18 inches behind the curb face unless other specified. Place steel conduit or Schedule 80 PVC conduit under existing pavements by approved jacking or drilling methods. Do not disturb pavements without the Engineer's approval. Where trenching is allowed in a traffic bearing area, use PVC conduit (Schedule 40) encased in concrete.

Conduits shall be continuous and extend from end point (i.e. pull box, foundation signal pole, pedestal pole, etc.) to another end point, or as directed by the Engineer. Conduit splicing shall not be permitted between end points.

After completing the installation of the conduit, test all conduits installed under the Contract with a mandrel having a diameter 1/4-inch smaller than the conduit and a length of 2 inches. Repair, to the Engineer's satisfaction, all conduits that will not allow passage of the mandrel; if repairs cannot be accomplished, remove and replace the conduit at no additional cost to the Department. After the mandrel test, scour all conduits with a stiff wire brush slightly larger in diameter than the conduit. Clear all conduits in the Engineer's presence.

Extend conduits terminating in anchor base standards and pedestals approximately 2 inches above the foundation and slope them toward the hand-hole opening. Conduits shall enter concrete pull boxes from the bottom and shall terminate not less than 2 inches or more than 4 inches above the bottom of the box and near the box walls to leave the major portion of the box clear.

Clean existing underground conduit to be incorporated into a new system by blowing with compressed air, or by other means approved by the Engineer.

730.15 Conductors

Furnish and install conductors in accordance with these Specifications and close conformity as shown on the Plans, or as directed by the Engineer.

Traffic Control Conductors shall be rated at 600 volts. The conductors shall be continuous run from traffic control device to traffic signal control cabinet unless approved by the Engineer. Run all conductors, except loop conductors and cables run along messengers, in conduit, except where run inside poles. Where signal conductors are run in lighting standards containing high voltage street lighting conductors, encase the signal conductors in flexible or rigid metal conduit. Where telephone circuits are introduced into controller foundations, encase the telephone conductors in flexible metal conduit and in conformance with the NEC.

Conductors for traffic loops shall be continuous AWG No. 14 XLP stranded wire to the detector terminals or spliced with shielded detector cable within a pull box, conduit, or pole base.

Detector cable shall be two conductor twisted pair shielded AWG No. 14 stranded meeting IMSA Specification No. ~~50-2~~ 51-7, Single Conductor Unshielded 600V XLPE Insulation / PE Tubed Jacket.

730.16 Cable

All signal cable shall conform to applicable IMSA Specification No. 19-1 or 20-1. Use stranded cable color coded AWG No. 14 for all signal and accessory circuits. Retain the same color identification for the entire length of a circuit run.

730.17 Wiring

1. Terminate all wiring to screw terminals using lugs.
2. No splices on signal conductor cable unless approved by the Engineer. If splices are approved, make all splices with solderless connectors, and insulate splices with weatherproof tape applied to a thickness equal to the original insulation.
3. Attach cables to messenger with non-corrosive lashing rods or stainless steel wire lashings.
4. All wiring within enclosed cabinets shall be neatly formed and harnessed and shall have sufficient length for access and servicing.

730.18 Service Connection

Coordinate service connection details and metering with the local utility as directed by the Engineer and in conformance with the City and County requirements. Obtain the necessary service for each installation.

730.19 Sealant

Provide sealant material selected from the Qualified Products List maintained by the Department's Material and Test Division for sealing saw-cuts. The sealant material shall resist the upward movement of loop and lead-in and shall exhibit stable dielectric characteristics, including a low permittivity and high dielectric strength. It shall bond to the roadway paving material, preventing entry of moisture, and shall remain flexible without melting through the anticipated temperature and weather conditions.

730.20 Strand Cable

Span cable for suspending signal heads between pole supports shall be 7-strand, Class A, copper-covered steel wire strand or greater, meeting the requirements of ASTM A460, with a minimum breaking strength as noted on the Plans. An acceptable alternate is 7-strand steel wire with a Class A zinc coating meeting the requirements of ASTM A475, with a minimum breaking strength as shown on the Plans.

Strand cable for messenger wire (other than span wire as specified above) and pole guy cable use shall be of the diameter(s) shown on the Plans and shall meet the requirements of ASTM A475 for zinc-coated steel wire strand, 7-strand Siemens-Martin Grade with a Class A zinc coating or greater.

A Figure 8 cable combining the messenger cable and conductor cable in an insulated jacket is an acceptable alternate to conductor cable lashed to a messenger cable.

730.21 Bonding and Grounding

Make metallic cable sheaths, conduit, transformer bases, anchor bolts, and metal poles and pedestals mechanically and electrically secure to form a continuous system, and ensure they are effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of not less than the same cross-sectional area as No. 6 AWG.

Furnish and install a ground electrode at each service point. Ground electrodes shall be one-piece lengths of copper weld ground rod not less than 8 feet in length and 1/2 inch in diameter, installed in accordance with the NEC. Ground the conduit and neutral as required under the NEC, except that grounding conductors shall be No. 6 AWG or approved equal, as a minimum. Enclose exposed ground conductors in 1/2-inch diameter conduit, and bond to the electrode with a copperweld ground clamp.

730.22 Field Test

Prior to completing the work, conduct the following tests on all traffic signal and lighting circuits in the Engineer's presence:

1. Test for ground in circuit.
2. Conduct a megger test on each circuit between the circuit and ground. The insulation resistance shall be not less than the values specified in Section 119 of the NEC.
3. Conduct a functional test to demonstrate that each part of the system functions as specified or intended herein.
4. Test all detector loops and leads before and after they are sealed in the pavement to ensure there are no shorts to ground in the system and to ensure that the loop plus lead-in inductance is within the operating range of the detector.

Replace or repair, in a manner approved by the Engineer, all faults in material or in the installation revealed by these tests. Repeat the applicable testing until no fault appears.

730.23 Inspection

After completion of the installation and before final acceptance of the Project, conduct a full operational check of the system under actual traffic conditions in the presence of the Engineer. The operational check shall cover a minimum time period of 30 calendar days. During this period, perform all necessary adjustments and replace all malfunctioning parts of the equipment required to place the system in an acceptable operational condition at no additional cost to the Department. Perform all work and furnish all materials required under these Specifications subject to the direct supervision, inspection, and approval of the Engineer. Provide the Engineer and authorized representatives free access to the work, and to all plants, yards, shops, mills, and factories where, or in which, articles or materials to be used or furnished in connection with such work are being prepared, fabricated, or manufactured. Provide full and sufficient information to determine that the performance of the work, the character of materials, and the quality of workmanship and materials meets the intent of these Specifications.

Only perform work in the presence of the Engineer or the Inspector appointed by the Engineer, unless permission to do otherwise has first been obtained. The Engineer may reject any work that is performed or constructed in the absence of the Engineer or Inspector, without such permission having been granted, either expressly or by implication.

The inspection of the work shall not relieve the obligation to properly fulfill the Contract as specified. If the Engineer finds a part of the work, or the materials used in the work, to be defective or unsuitable at any time prior to final acceptance, repair or replace such defective or unsuitable work or material.

Request the presence of an Engineer or Inspector in connection with the work under these Specifications at least 24 hours before such services will be required.

SIGNAL HEADS

730.24 Signal Heads

Signal heads shall meet the latest requirements published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE) for Adjustable Face Vehicle Traffic Control Signal Heads" and the National Electrical Code. The arrangement of traffic signal heads shall be mounted as shown on the Plans or as specified by the Engineer and be in accordance with the latest versions of the MUTCD and the TDOT Traffic Design Manual.

All circular indications shall use 12-inch lenses unless otherwise shown on the Plans. All arrow indications shall use 12-inch lenses. All new vehicle signal heads installed at any one intersection shall be of the same style and from the same manufacturer. All exposed metal signal housings, doors, visors, backplates and framework parts shall be painted with a powder coated finish and be in accordance to the MUTCD specifications. Suspensions for span wire mounting of multi-faced signal heads and signal head clusters (such as a 5-section signal head) shall include an approved swivel type balance adjuster for proper vertical alignment.

Signal head housings shall be cast aluminum and all associated parts/hardware shall be of non-corrosive material. In addition to these requirements, comply with the following:

A. Optical Units

Traffic signal indications shall be LED type and meet the Institute for Transportation Engineers (ITE) latest LED specifications. All LED indications shall have a five year warranty.

B. Signal Head Mounting and Mounting Brackets

Furnish signal heads that either have integral serrations or are equipped with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts. Provide signals with water-tight fittings.

Support bracket-mounted signal heads, as shown on the Plans, by mounting brackets consisting of assemblies of 1-1/2 inch standard pipe size. Ensure that all members are both plumb or level, symmetrically arranged, and securely assembled. Conceal all conductors within poles and mounting assembly. Secure each slip fitter to the pole.

C. Directional Louvers

Where shown on the Plans, furnish and install louvers in the hoods of the signal head sections designated.

Directional louvers shall have a snug fit in the signal hoods. Construct the outside cylinder and vanes from a non-ferrous metal or galvanized sheet steel. Louvers shall be painted with a powder coated finish.

D. Back Plates

Where shown on the Plans, furnish and attach back plates to the signal heads. All back plates shall be louvered and constructed of 3,003, half-hard, 0.051-inch minimum thickness aluminum sheet. Other materials such as plastic or fiberglass may be used where approved. In fabricating back plates, bend back the inside vertical edges, adjacent to the signal head, to form mounting brackets for attaching to the signal. Form back plates in two or more sections and bolt together, thus allowing for installation after signal heads are in place. Back plates shall have a dull black appearance in the front and back.

E. Wiring

Signal head leads shall be No. 18 AWG stranded with 221 °F thermoplastic insulation. Wire a separate white (common) lead to each socket shell; and wire a colored lead, corresponding to the color code shown on the Plans, to each socket terminal. Provide leads of sufficient length to allow connection to the terminal block specified. Provide each complete signal head with a minimum 4-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than 1/4-inch edge clearance to any portion of the stud. Exterior wiring shall have a 360-degree drip loop in advance of entering the head.

F. Pedestrian Signals

Pedestrian signal heads shall meet the latest requirements published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE) for Adjustable Face Pedestrian Signal Heads", the National Electrical Code and be compatible with NEMA standards. The arrangement of pedestrian signal heads shall be mounted as shown on the Plans or as specified by the Engineer and be in accordance with the latest versions of the MUTCD and the TDOT Traffic Design Manual. The pedestrian indications shall be LED symbols and in conformance with the Institute for Transportation Engineers (ITE) latest LED specifications. All LED indications shall have a five year warranty.

In addition, where pedestrian signal heads are provided, they shall:

1. Include a pedestrian change interval countdown display where the calculated pedestrian change interval is more than 7 seconds;
2. Include Accessible Pedestrian Signals and pedestrian pushbuttons complying with MUTCD Accessible Pedestrian Signals section;
3. Incorporate a locator tone meeting the requirements of the MUTCD Accessible Pedestrian Signals;
4. include a pedestrian pushbutton with tactile vibrating arrow button and audible sound.

The pedestrian countdown display shall conform to the latest FCC regulation on Emission of Electronic Noise.

The manufacturer must supply certification, which includes a copy of the test report by an independent technical laboratory as to the compliance with ITE specifications (where it applies). The report shall also indicate that the tests were performed only after the modules received a thirty (30) minute operational warm-up period immediately preceding the tests.

The housing door, door latch, and hinges shall be of aluminum or polycarbonate or approved equal. Hinge pins shall be stainless steel. Provide the door with a neoprene gasket capable of making a weather resistant, dust-proof seal when closed.

All pedestrian signal heads, mountings, outside of hoods, and pedestrian push button housings shall have a powder coated finish (if aluminum) or colored resin (if polycarbonate) in accordance to MUTCD specifications.

G. Signal Head Installation

Install signal heads and pedestrian signal heads with the faces completely covered until the entire installation is ready for operation.

CONTROLLERS – GENERAL

730.25 Controllers

Controller equipment shall be permanently marked with the manufacturer's name or trademark, part number, and serial number.
Controllers must meet the following applicable industry standards and amendments:

1. NEMA TS2 Controller ..... NEMA TS-2-2016
2. ATC Controller ..... AASHTO/ITE/NEMA ATC 5.2b
3. All NEMA TS2 and ATC controllers must provide functionality that meets or exceeds operational characteristics, including NTCIP support, as described in NEMA TS-2-2016.
4. NEMA TS2 Type 2 controllers shall be used when downward compatibility to existing TS1 cabinets is desired.

Except for replacing controllers in existing systems, all new installations must include controllers that capture high resolution event-based data elements to provide the automated traffic signal performance measures.

The manufacturer must supply certification of the conformance to the above requirements at the time of the bid.

In addition to the above requirements, the controller shall:

5. Have all timing values entered via a front panel mounted keyboard. This keyboard shall be an integral part of the controller unit.
6. Have an English language menu for programming or reading all controller features.
7. Continue to operate the intersection as values are inspected or altered.
8. Include the ability to upload and/or download the controller software operating system and user programmed database to or from external media (datakey, usb, sd card etc).
9. Support Flashing Yellow Arrow for Permissive Left-turn Movements applications.

Surge Protection Devices

The cabinet shall have Surge Protective Devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. Furnish SPDs to provide effective defense against high transient voltages caused by lightning discharges or other sources. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet. The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker. SPDs must meet the following minimum requirements:

1. AC power SPD:
    a. Must be UL 1449 4th Edition Listed
    b. Parallel connected device
    c. UL Nominal Surge Rating (In): 20kA
    d. UL Short Circuit Current Rating (SCCR): 150kA minimum
    e. Surge current rating: 50kA per phase minimum
    f. Visual status indication
    g. Remote signalization contacts for monitoring purposes
    h. 10 year manufacturer's warranty minimum

2. DC power SPD:
    a. Must be UL 1449 4th Edition recognized
    b. Parallel connected device
    c. UL Nominal Surge Rating (In): 10kA minimum
    d. Must provide protection between all +/-/Gnd connections
    e. Surge current rating: 20kA per phase minimum
    f. Visual status indication
    g. Remote signalization contacts for monitoring purposes
    h. 10 year manufacturer's warranty minimum

3. Data and communication SPD:
    a. Must be UL 497B listed
    b. 10 year manufacturer's warranty minimum

4. Signal and interconnect cable field wiring terminal SPD:
    a. Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.

b. Withstand a surge current of 1000A with an 8 by 20 μs waveform six times (at 1 second intervals between surges) without damage to the suppressor.
c. 10 year manufacturer's warranty minimum

5. Loop lead-in cable field wiring terminal SPD:

a. Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges
b. Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges
c. Withstand repetitive 400A surges with an 8 by 20 μs waveform without damage
d. 10 year manufacturer's warranty minimum

All SPDs must be installed according to the SPD manufacturer's instructions and not affect the operation of equipment. SPD leads must be kept as short and straight as possible.

CABINETS – GENERAL

730.26 Cabinets

Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. The label should be placed on the inside of the main door using a water resistant method. The label must be visible after installation.

Cabinets shall be provided as a complete unit and have all terminals and facilities necessary for traffic signal control as shown on the plans and shall meet at a minimum, the following requirement:

NEMA TS2 Controller Cabinet ..... NEMA TS 2 2016

The manufacturer must supply certification of the conformance to the above requirements at the time of the bid. Cabinets shall also be in accordance with the latest version of the TDOT Traffic Design Manual.

Two paper copies of the cabinet wiring diagram shall be provided with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan. Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires. A heavy duty, resalable plastic bag must be mounted on the backside of main cabinet door for storing cabinet documentation.

House the controller in a rigid, weatherproof cabinet, constructed, finished, and equipped as follows, and as shown on the Standard Details:

1. **Material.** Provide weather-tight cabinets fabricated from aluminum sheet or cast aluminum alloy with a minimum 0.125-inch thickness. All welds on fabricated cabinets shall be internal and continuous; spot welding is not acceptable. Painting of cabinets is only required if the final finish presents an unsightly appearance or as specified in the plans.

2. **Doors.** Type III, IV, and V cabinets shall have a hinged front opening door that shall include substantially the full area of the front of the cabinet. Equip the door with a positive hold fast device to secure the door in at least two open positions: one position at approximately 90 degrees and the other at 120 degrees or more. The holdfast device shall be easily secured and released without the use of tools. Equip doors for Type II, III, IV, and V cabinets with a switch compartment, and provide the manual switches, specified in **730.26..6.k**, with a hinged front opening auxiliary door. Each door shall have a gasket to provide a weatherproof seal when closed.

Provide the main door with a No. 2 pin-tumbler cylinder lock, and the auxiliary door with a standard police sub-treasury lock. Provide four keys for each lock.

Provide a switch which is to be tied to the cabinet light so that cabinet light will be on when the door is open and off when the door is closed.

3. **Cabinet Mounting.** Mount cabinets as shown on the Plans or Standard Details.

4. **Ventilation.** Unless otherwise specified, provide ventilation as follows:

   a. On all cabinets housing controllers, mount a screened, rain-tight vent, 1-1/2 inches in diameter or larger, on the cabinet top.

   b. Provide screened or filtered inlet ventilation openings, equal to or greater in area than top vents, located in the bottom or lower back side of Type I and II cabinets or around the lower 8 inches portion of Type III cabinets.

   c. Construct the vents so as to project within the cabinet no more than necessary to provide for lock nuts and gaskets to retain the vent.

   d. Locate vents so as to not interfere with the mounting of controller equipment.

5. **Cabinets with Exhaust Fans.** Exhaust fans shall consist of an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per minute. Mount the fan in a rain-tight housing attached to the top of the controller cabinet.

   The fan shall be controlled by a thermostat having a temperature differential between turn-on and turn-off of 15 °F (-0, +5 °F), adjustable for turn-on through a minimum calibrated range of from 100 °F to 150 °F.

   Whenever a fan is to be installed, provide the air inlet filter and filter holder shown in the Standard Details, or approved equal. Internally seal other air inlets. Provide exhaust fans in all cabinets that house controllers, with the exception of flasher controllers.

6. **Auxiliary Equipment.** With the exception of cabinets used in special applications (Type I and II), provide all cabinets with the following:

   a. Substantial shelves or brackets to support controller and auxiliary equipment.

   b. Panel for terminals arranged for adequate electrical clearance. Panels should be located in the cabinet as described below:

- Detectors	Lower left wall
- AC power	Lower right wall
- Auxiliary/police switches	Door
- Load switch bay	Back wall

   c. The cabinet shall include an LED light and GFI duplex receptacle which can be used when the main circuit breaker is off.

   d. Control panel assembly consisting of:

      1. Power supply connections made to a 30-ampere circuit breaker mounted on the cabinet separate from the signal terminal panel. The circuit breaker shall be a magnetic trip type, having an interrupting capacity of at least 2,000 amperes at 125 volts AC. The circuit shall trip between 101% and 125% of rated load, with an inverse time delay characteristic

provided. Instantaneous tripping shall occur at ten times the nominal rating. All controllers shall be internally fused.

2. Service line surge protection
3. Electrical service termination point sized to accept No. 4 AWG copper wire
4. Ground fault receptacle
5. Porcelain lamp receptacle to accept a standard traffic signal lamp. If LED lenses are utilized, they shall be dimmable and switchable to reduce glare at night time.
6. Circuit breakers in accordance to the National Electric Code for:
   (a) Main power input to provide all power associated with normal operation.
   (b) Flasher power input to provide all power associated with flash operation.
   (c) Service power to provide power for the lamp and duplex receptacle and cabinet light.
7. Copper ground bus (minimum of 12 positions).

e. Flasher mechanism independent of controller. The cabinet shall be wired for and include a NEMA flasher mounted on the back panel. All cabinets shall have a two-circuit flasher. The flasher shall have output indicators mounted on the front of the flasher case and shall be rated at a minimum of 15 amperes.

f. General purpose relays, where required to perform specified functions. All relays external to the controller or appurtenances shall meet NEMA standards. In addition:

   1. Flash transfer relays shall be of heavy-duty type and have a minimum contact rating of 10 amperes. Contacts shall be of silver material to reduce contact pitting.
   2. Unless otherwise specified, each cabinet shall include six (6) flash transfer relays.
   3. Flash transfer relays shall support Flashing Yellow Arrow for Permissive Left-turn movement applications.

g. Type II, III, IV, and V cabinets, when specified as housing for traffic actuated controllers, with two or more insulated terminal blocks mounted within the housing, one or more for terminating each field wire.

h. A minimum of 12 available bare ground positions tied to AC Common Return.

i. Earth (driven) ground tie point to terminate a single No. 4 AWG copper ground.

j. A tie point to tie all ground systems within the cabinet to a single reference point. All grounds (AC - return, Chassis, and Logic Ground) must be referenced to a single ground point at the electric service.

k. A panel (police subpanel) shall contain the following:
   1. A main power switch, which shall be wired to remove all cabinet power when in the Off position.
   2. An Automatic Flash switch, which shall be wired as follows:
      (a) The Flash position shall cause the cabinet to provide Flash Operation. The controller shall continue to operate, and Stop Time shall be applied to the controller.
      (b) Auto/Manual switch to activate Manual Control Enable.
      (c) Manual control pushbutton switch with self-coiling cord. Cord shall attach to a 2 position terminal strip via fork type connector
      (d) Upon return from Flashing to Automatic, the controller shall initialize in the Start-Up Display condition as programmed in the controller, typically major road phases.
   3. A panel mounted inside the main door shall contain the following switches:
      (a) A technician Stop-Time switch to apply Stop Time to each controller ring.

(b) An Interval Advance switch, enabled only by the Stop Time switch, to be momentary pushbutton switch to apply Interval advance to the timer.
(c) A Signal On-Off switch, which shall remove the AC power applied to the signal heads for normal operation while the controller continues to operate.
(d) Individual phase vehicle and pedestrian detector test switches to be miniature toggle of the On-Off Momentary type to place:
    i. No Call - Call provided by detectors
    ii. Locked detector call
    iii. Momentary detector call

Insulate or shield switch terminals on back of main cabinet door so that no live parts are exposed.

Leads from the terminal block to the auxiliary door switches shall be no less than No. 18 AWG stranded, with TW plasticized polyvinyl chloride or nylon insulation enclosed in an insulating loom, and shall be of sufficient length to allow full opening of the main cabinet door.

l. The cabinet shall be wired with the appropriate number of load switches to accommodate vehicular and pedestrian phasing according to plans. At a minimum, cabinets shall include 16 load switch bases. The load switch wiring shall support Flashing Yellow Arrow for Permissive Left-turn Movement applications.

m. All cabinet wiring shall be neatly routed and labeled, laced and permanently secured. All cable shall be secured to the panel, where practical. There shall be no holes drilled through the cabinet walls to mount panels or secure cables.

n. All terminals in the cabinet shall be of the barrier type. The following field connector terminals shall be provided:
    1. Four (4) signal output positions per load switch bay (R-Y-G-FL).
    2. Ten (10) positions per phase for vehicle loop detector harness.
    3. One position per phase for pedestrian detector inputs.

o. Cabinets shall have SDLC communication between the controller, MMU, Detector Rack, Radar Detector (if applicable) and Video Detection (if applicable).

p. Cabinets should have an electrical outlet (Non GFI) that has 120 VAC from the OUTPUT side of the Main Power Surge unit.

q. Cabinets shall support Flashing Yellow Arrow for Permissive Left-turn Movements applications.

r. All cabinets shall be supplied with a Malfunction Management Unit (MMU) and shall meet at a minimum, the following requirement:

NEMA TS2 Malfunction Management Unit ..... NEMA TS 2 2016

The manufacturer must supply certification of the conformance to the above requirements at the time of the bid.

According to NEMA TS2 the MMU shall be able to detect the presence of voltage on conflicting on conflicting field connection terminals, the absence of proper voltages on all the signal field connection terminals of a channel, and shall be capable of monitoring for the presence of satisfactory operating voltages within the Controller Unit (CU) and the MMU itself. The MMU shall be able to operate as a Type 16 with sixteen channels or as a Type 12 with twelve channels (compatible with NEMA TS1 cabinets.

The MMU should have an Ethernet port.

730.27 Auxiliary Equipment for Traffic Signal Controllers

Furnish and install the following auxiliary equipment in each cabinet for traffic actuated controllers.

A. Load Switches

Provide each cabinet complete, with the necessary number of NEMA load switches and Flash Transfer relays necessary to affect the specified signal sequence and phasing. Load switches shall:

1. Meet NEMA standards.
2. Have front-face mounted LED indicators to indicate the "On" condition of both the Input and Output circuits.
3. Use replaceable "cube" type circuitry or encapsulated discrete component construction. No unencapsulated discrete component constructions are acceptable.

B. Time Clock Switches

Where shown on the Plans, provide time clock switches of solid state circuitry, continuous duty, with a 7-day cycle clock operating from the 120-volt AC service line. Provide switching for a minimum of one independent output and ensure the time of day selection is adjustable to within 1 minute of the desired time. Provide a battery backup system that can maintain time keeping and memory a minimum of 24 hours after power interruption. Furnish an omitting device as an integral part of the time switch to allow the switching operation to be skipped for any preselected day or days of the week. The time clock shall automatically compensate for daylight savings time changes. When the time clock is supplied as an internal component of the controller, supply the clock feature to provide for the selection of Maximum Green II on time of day, day of week, week of year basis. Time clocks shall meet NEMA environmental specifications.

When required in the traffic signal plans, the auxiliary equipment listed below shall meet the following requirements:

A. Uninterruptable Power Supply (UPS)

The UPS shall power the traffic signal cabinet in the event of a power failure for a minimum of 3 hours.

UPS assemblies should include off-the-shelf deepcycle AGM batteries. Loss of utility power, transfer from utility power to battery power, and transfer back to utility power must not interfere with normal operation of connected equipment. In the event of UPS failure or battery depletion, connected equipment must be energized automatically upon restoration of utility power. Removal and replacement of the UPS must not disrupt the operation of the equipment being protected.

All harnesses necessary to connect and operate the system must be included. All connectors must be keyed to prevent improper connection.

UPS assemblies shall be installed in accordance with the manufacturer's recommendations.

An UPS operation and maintenance manual shall be provided in the cabinet where the UPS is installed with cabinet wiring schematics, electrical interconnection drawings, parts layout and parts lists.

The UPS shall include a manufacturer's warranty covering defects for a minimum of three years (5 years for the external batteries) from the date of final equipment acceptance. The warranty must include provisions for providing a replacement UPS within 10 calendar days of notification for any UPS found to be defective during the warranty period at no cost to the maintaining agency.

B. Communications

Wireless shall consist of installing a Wireless Network Communications Link with all necessary hardware in accordance with the plans and standard drawings to provide a data link between field devices (i.e. Traffic Signal Controllers).

Each link shall consist of Master ODU (Out Door Unit, Antenna) connected to a data switch within one of the signal cabinets and a Slave ODU connected to a data switch within the other signal cabinet. Each ODU is aligned to face the opposing ODU. The cable length between the ODU and its associated data switch may not exceed 300 feet.

The Wireless Network Communications Link components at each of the linked traffic signal cabinets shall include an ODU, a LPU (Lightning Protection Unit), power supply mounting hardware, and CAT 5e cabling. The ODU is pole mounted per manufacturer's specifications. The LPU and power supply are mounted within the traffic signal cabinet. CAT 5e cable is installed between the ODU and LPU.

For the applicable frequency spectrum of the radios being deployed, perform a spectrum analysis to ensure no competing equipment in the area. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. Typically, if the ODUs can be mounted with clear line of sight between them, this is sufficient to ensure proper operation. If this is not possible, it may be determined that a repeater station is necessary to complete the intended link. Provide the test results to the ENGINEER for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The ENGINEER will approve final locations of the ODUs and any necessary repeater stations.

Install each ODU in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the ODU manufacturer's recommendations. Secure the ODU mounting hardware to the pole and route the CAT 5E cable such that no strain is placed on the RJ-45 connectors. Align each antenna/radio to be perpendicular to the ground (using bubble level) and to face the opposing radio.

C. Fiber optic cables

Multi-mode type fiber optic cable shall be 50 µm core diameter, with at least 12 fibers per cable unless otherwise specified in the plans. Single-mode type cable shall be between 8-9 µm core diameter, with at least 12 fibers per cable unless otherwise specified. A fiber optic drop cable shall be a minimum of 6 fibers (each type) and be fusion spliced into the trunkline in a splice enclosure either aerially or in a pull box. 50ft. of slack shall be provided, either lashed to a span aerially, or coiled in a pull box for underground installations. Termination panels shall be provided with sufficient size to provide for a neat installation, and enough panel space to accommodate the specified number of fibers for termination. ST connectors shall be used unless otherwise specified. Any necessary jumpers shall be provided for installed equipment.

MISCELLANEOUS TRAFFIC SIGNALS

730.28A Flashing School Signals

When shown on the Plans, provide flashing school signals that conform to the following:

1. The signal shall produce two alternate flashing lights within the marginal limits of a school speed limit sign. Details of the sign construction shall be as shown on the Plans. Sign colors shall conform to the MUTCD and be constructed of materials complying with these specifications.

2. The two LED lenses shall be yellow in color and a minimum of 8 inches in diameter. The LED lenses shall be part of a weather-proof and water-tight optical unit. The LED lenses shall meet the same requirements

for vehicular signal head LED lenses. Mount the lenses in the sign using a molded endless rubber gasket with the sign being mounted to the signal case.

3. Provide a two circuit type flasher unit to provide alternating equal on-off operation. The flashing mechanism shall produce between 50 and 60 flashes per minute through two 120-volt, 60-cycle AC, 15-ampere circuits. The flasher shall be of solid state construction.

4. Provide accessible constant AC+ terminal for conducting illuminating speed limit.

5. Wire the unit for external circuits.

6. The signal shall be actuated by time switch meeting **730.27**. Locate the timing device in a remote mounted control cabinet.

7. Where an illuminated speed limit indication is shown on the Plans, the numeral message shall be illuminated in Portland Orange in a rectangular lens and illuminated only during the period when the signal produces two alternately flashing amber lights.

In addition, the Time Clock Unit/Switch used for Flashing School Signals shall be a programmable module that allows a user to define the time and day that the school speed zone flasher assembly will initiate and terminate flashing operation. The module shall be installed within the pole-mounted signal cabinet provided as part of project. The time clock shall be compatible with the cabinet's wiring relays and termination panels and the battery power supply system. The time clock switch provided shall also have the following features/capabilities outlined below:

1. Daylight Savings Time shall be a user-programmable setting, in addition to having automated compensation per TDOT specifications.

2. The unit shall provide a minimum 12-character, multi-line alpha-numeric LCD back-lit display capable of displaying all programming parameters.

3. The unit shall be capable of being programmed manually (using an integral keyboard pad) or programmed externally using an optional software program via a laptop computer and cable connection (compatible software program is a separate and distinct item from the time switch unit, and if required, will be separately specified and noted in list of estimated project quantities).

4. Unit shall provide automatic Leap Year compensation.

5. The time clock switch shall be capable of up to minimum 24-hours of capacitive back-up operation, 48 hours desirable, in the event of power interruption.

6. Unit shall be compatible with the supplied solar powered power system / battery unit

7. Time clock switch shall be capable of being programmed for one (1) Normal / Main program, and an additional minimum of 12 Exception periods /programs allowing holiday, vacation and custom skip plans. The exception programs will allow for the Normal / Main program to be skipped or allow for flasher operation on alternative schedules (i.e. early release days, summer school, etc).

8. Unit shall conform to TDOT standard specification subsection 730.27 – Auxiliary Equipment for Traffic Actuated Controller – Time Clock Switches except as superseded herein.

9. Unit shall have non-volatile program memory to allow retention during power loss.

730.28B Solar Power Flashers

When required, the solar power flasher equipment listed below shall meet the following requirements:

1. Solar panel and mounting equipment shall be installed on cantilever pole shaft as illustrated on layout detail sheet and as directed by manufacturer instructions.

2. Solar power unit assembly shall include all required mounting equipment, wiring/cables, battery supply, battery charging unit and other ancillary equipment necessary to operate the solar panel and properly charge the battery. The photovoltaic array shall include mounting bracket assembly to permit adjustment of the array to optimal sun exposure. The photovoltaic module shall be mounted and aligned per manufacturer recommendations to maximize solar exposure.

3. Battery unit shall meet manufacturer specifications required to operate and power L.E.D. signal displays and continuous time clock switch operation. Battery shall be compatible with cabinet equipment, including the time clock switch and the flasher signal displays. Battery unit shall meet minimum environmental and performance specifications required for system operation as recommended by solar panel and time clock switch manufacturers.

4. Solar panel and battery supply shall be of a size and power rating necessary to provide required power to time switch clock and flasher signal displays. Obtain the power load requirements from the solar power equipment manufacturer and provide as required. On a typical school day, it should be expected that the flasher system will operate up to four (4) hours per day with the time clock continuously operating to maintain its clock timer. Provide a solar system sizing report from the manufacturer indicating the power supply requirements of the proposed system required to meet the expected power demand.

5. The photovoltaic modules shall be warranted for a minimum of five (5) years from date of installation.

6. The battery system shall be a gelled-electrolyte type battery with capacity to provide a minimum of five (5) days continuous operation of the flasher assembly without charging. Batteries shall be field replaceable. Batteries shall have prorated warranty of a minimum of five (5) years from date of installation.

730.28C Portable Traffic Signals

Portable Traffic Signals (PTS) consists of furnishing, installing and configuring a complete PTS system that may be used in construction zones or in other temporary signal locations. The work will be at various sites throughout the state of Tennessee and will consist of providing all labor, materials, equipment and incidentals necessary to make functional the PTS in accordance with these specifications.

The PTS shall be trailer or cart mounted units that provide for easy transportation and quick setup and deployment. There shall be 2 unit options and each unit shall be self-contained.

1. Type 1 units are typically used for long term projects (i.e. projects 5 days or longer in duration) and shall include 2 signal heads per trailer with an upper signal head mounted on an overhead mast arm that can be extended over the travel lane, and a lower signal head mounted on the vertical upright of the trailer.

2. Type 2 units are typically used for short term projects (i.e. projects 4 days or shorter in duration) and shall include 1 signal head that is mounted on the vertical upright of the trailer or cart. Cart-mounted units shall be successfully crash tested to NCHRP 350 TL-3, or equivalent MASH standards. If the project duration is extended beyond 4 days, then Type 1 units should be substituted in lieu of the Type 2 units for all PTS within the signal system.

The PTS shall be MUTCD Compliant and utilize standard ITE signal heads, and adhere to the ITE Specifications and Standards for Vehicle Traffic Control Signal Heads, Light Emitting Diode (LED) Circular Signal Supplement. The unit shall be solar powered and communicate via a wireless or hardwire connection. The unit shall include all the major components listed below or be able to perform the functions of these components. The major components

of the unit shall include but are not limited to the trailer or cart, telescoping mast arm (on Type 1 units only), signal head(s) and back plates, traffic signal controller with operating software, solar charging system with batteries, input and output devices, flasher units, conflict monitor, relays, communications system and other equipment required for the safe operation and installation of the unit.

The PTS signal heads and all applicable components of the PTS shall meet the physical display and operational requirements of conventional traffic signals as specific in the MUTCD.

1. For Type 1 units, each unit shall contain 2 signal heads with an upper signal head mounted on an overhead mast arm that can be extended over the travel lane with a minimum clearance of 17 feet measured from the bottom of the signal head unit to the road surface. The lower signal head shall be mounted to the vertical upright of the trailer at a minimum height of 8 feet from the bottom of the signal head unit to the road surface. The signal heads shall also include black back plates that can be easily removed. The signal heads shall have the ability to be rotated 180 degrees to face in the opposite direction and shall have the ability to rotate and lock in approximately 10 degree increments to position the signal head for the optimum visibility to motorists.

2. For Type 2 units, the signal head of the unit shall be mounted to the vertical upright at a minimum height of 8 feet from the bottom of the signal head unit to the road surface. The signal head shall also include black back plate that can be easily removed. The PTS shall be easily rotated to position the signal head for optimum visibility to motorists.

The PTS shall include a solid-state controller with operating temperature range of -40ºF to +180ºF and compliance with NEMA TS-5 Performance Standard. The controller or programming module shall have an easy to read front panel indicator display. The display shall be backlit and have the capability to facilitate programming and display the currently operating program for each vehicular approach. The controller shall be capable of operating the PTS system in a fixed time, traffic actuated, or manual control mode. Each PTS in a connected system shall have the capability to serve as either the master or slave signal. Each PTS shall include a Conflict Monitor Unit (CMU), or Malfunction Management System (MMS) to ensure phase conflicts do not exist during operation.

1. A minimum of 5 automatic time-of-day timing plans within a 24-hour period should be available in fixed time mode. The operating system should have the ability to control a minimum of 4 traffic phases with programmable cycle time adjustments and user adjustable red, amber, minimum green and maximum green times. The operating system shall also have the capability of facilitating standby modes of red, red flash and yellow flash.

2. The system shall also have the ability to operate in vehicle actuation mode when vehicle detection detectors are used. The operating system shall have the capability to allow the PTS to be connected to and controlled by a standard NEMA controller.

3. The system shall have the capability to be configured and controlled remotely using a handheld wireless remote control with the capability of being operated at a distance up to ¼ mile from the master.

4. The system shall have the capability of remote monitoring for reporting, at a minimum, signal location and status, battery voltage and system defaults. The remote monitoring shall have capability to alert designated individuals if a fault condition occurs.

5. The operating system shall include password protection to prevent unauthorized programming.

The PTS shall communicate with all other PTS within the signal system via license-free wireless 900 MHZ radio link communications. The radio units shall maintain communications at a minimum distance of 1 mile. The radio system shall conform to the applicable Federal Communications Commission (FCC) requirements, including FCC 90.17, and all applicable state and local requirements. The PTS shall be in direct communication at all times either by wireless or hardwire connection to provide for the required conflict monitor.

The system shall also have the ability to operate in vehicle actuation mode when vehicle detection detectors are used. For Type 1 units, the PTS detector shall be a high-definition, multi-beam, microwave radar stop bar detector for each vehicular approach. The Type 1 radar detector shall have a minimum range of 140 feet and shall be mounted at a minimum height of 17 feet measured from the top of the road surface. For Type 2 units, the PTS detector shall be a radar detector for each vehicular approach. The Type 2 radar detector shall have a minimum range of 140 feet and shall be mounted and have complete radar detection functionality at a minimum height of 8 feet measured from the top of the road surface.

The PTS shall be equipped with a solar power array, charging unit and battery system. For Type 1 units, the number and size of batteries shall be sufficient to operate the signal for a minimum of 21 days at 70 degrees without additional charging or assist from the solar array. An on-board battery charger shall be compatible with both the solar array and with a 120V AC power source. The solar panel array shall provide for a minimum of 440 watts of solar collection capability. For Type 2 units, the PTS shall have batteries sufficient to operate the signal for a minimum of 5 days at 70 degrees without additional charging or assist from a solar array. All instrumentation for the electrical system and battery compartment shall be mounted in a lockable weatherproof enclosure. Solar panels shall be secured to the mounting brackets for theft prevention. All wiring for the unit shall be protected against weather and damage.

The trailer or cart, and all mounted components, shall conform to the wind loading requirements (90 mph minimum) as described in the AASHTO Standard Specifications for Highway Signs, Luminaries and Traffic Signals. The wind load calculations shall be completed by an independent third-party, and stamped by a U.S. Registered Professional Engineer. The trailer or cart shall be made of structural steel and shall include 4 leveling/stabilizer jacks capable of lifting the trailer or cart a minimum of 6 inches. The trailer or cart shall be equipped with a hydraulic or electric lift system sufficient for 1 person to be able to raise and lower the vertical upright and/or horizontal mast arm to and from the operating position. For Type 1 or 2 units, the trailer or cart shall be equipped to provide legal and safe transport on the public highway system at speeds up to 55 mph. All exterior metal surfaces, except signal heads and back plates, shall be powder-coat painted highway safety orange.

The PTS work shall meet the following general requirements:

1. Be responsible for locating the PTS in the appropriate location based on MUTCD and ITE standards for visibility to motorists and for safe operation.

2. Be responsible for providing all hardware, software, communications equipment and licenses to operate a complete PTS system.

3. Be responsible that all PTS equipment is installed according to the manufacturer's recommendations including wireless or hardwire connections.

4. Be responsible for transport, setup, configuration, operation and monitoring of the PTS throughout the entire project. The Engineer shall approve all timing and settings that are used for operation of the signal.

5. As directed by the Engineer, it may be necessary to relocate the PTS during the project. The cost of the relocation shall be included in the PTS price bid.

DETECTORS

730.29 Detectors

Provide detectors, of the type shown on the Plans, to actuate signal phases of traffic actuated controllers. Provide ample lightning protection to provide effective defense against high transient voltages caused by lightning discharges or from other sources. The lightning protection unit must withstand repeated 400-ampere surges on a 9 x

20 microsecond waveform. Also, the unit must be a two-stage device capable of clamping a minimum of one hundred 300-ampere surges to 25 volts within 40 nanoseconds for surge applied across the two detector leads.

A. Inductive Loop Detection System

Inductive loop detector units (loop amplifiers) shall meet at a minimum, the following requirement:

NEMA TS2 Inductive Loop Detector Units ..... NEMA TS 2 2016

Loop amplifiers may be single or multi-channel and shall be of the totally self-contained type.

All loop amplifiers shall be of the type to provide both "Extended" and "Delayed" outputs.

The loop detector amplifier shall be full automatic, requiring no adjustments to effect operational ability other than setting of the operating frequency and sensitivity. The amplifier shall:

1. Sense any legal motor vehicle traveling at speeds up to 65 miles per hour.
2. Have both a “Pulse” and “Presence” Output:
   a. Pulse output shall generate an output of 125 ±25 millisecond output for each vehicle entry.
   b. Presence output shall provide a continuous output for up to 60 minutes as long as a vehicle is within the detection zone.
3. Provide at least four user selectable sensitivity ranges.
4. Be supplied with at least three frequency ranges for crosstalk minimization.
5. Have a front-face mounted indicator to indicate active output of the internal relay. This indicator shall indicate the presence of:
   a. Normal Output
   b. Delayed Output
   c. Extended Output
6. Have a front-panel mounted “Reset” switch that when pressed shall cause the unit to completely re-tune itself.
7. Have Delayed or Extended timing features with the following ranges:
   a. Delayed output of 0 to 30 seconds in 1-second increments.
   b. Extended output of 0 to 10 seconds in 1/4-second increments.
8. Have internal diagnostics to determine the operational ability of the loop. These diagnostics shall determine if a loop is opened or shorted, and shall provide a visible indication of such condition. Additionally, if such a condition occurs, the amplifier unit shall default to a “constant” output.
9. Provide solid state output, which shall be “off” to provide an output.
10. Have all delay functions wired to the associated plan phase green to inhibit that function during controller phase green.
11. Be able to operate with loop lead-in lengths of at least 2,000 feet.
12. Provide audible call output.

Comply with the details of the detector loop installation as shown on the Plans or Standard Drawings.

B. Video Detection System (VDS)

When specified in the plans, the equipment shall consist of all items necessary to provide a complete functional video detection system that process images and provide detection outputs to the traffic signal controller. The VDS shall be capable of the following:

1. Be capable of NEMA TS2 operation.
2. Be waterproof and weather resistant.
3. Provide user-defined detection zone programming via a graphical user interface (GUI) and any necessary equipment for future programming. The configuration database shall have the ability to be stored on removable data storage external to the video card.
4. Display programmable detection zones and detection activations overlaid on live video inputs. It shall detect vehicles in real time as they travel across each detection zone.
5. Have a minimum of 24 programmable detection zones per camera.
6. Shadow rejection without special hardware.
7. Non-impaired operation under light intensity changes.
8. Maintain operation during various weather conditions (e.g. rain, fog, snow).
9. Anti-vibration, 5% rejection based on image change.
10. Ability to select direction of flow parameters.
11. Ability to properly detect directionally.
12. Ability to configure presence, pulse, extend and delay outputs.
13. Ability to set up a minimum of six detection zones per camera view to count the number of vehicles detected and stores the information for retrieval.
14. Variable focus providing a minimum of 4 to at least 40 degree horizontal field of view.
15. Store detection zones in non-volatile memory.
16. Have no splices between the processors and the cameras.
17. Provide LED indicators to show active detection.
18. Have an internal heater to assure proper operation of the equipment during low temperatures.
19. Have surge ratings as set forth in NEMA specifications.
20. Have a two-year warranty and updates of all software shall be available without charge during the warranty period.

C. Radar Vehicle Detection System (RVDS)

When specified in the plans, the equipment shall consist of all items necessary to provide a complete functional RVDS that process high-definition, multi-beam radar electromagnetic waves and provide detection outputs to the traffic signal controller.

RVDS shall be capable of NEMA TS2 operation.

The RVDS shall consist of the following components:

1. Radar sensor (1)
2. Detector rack interface module (1)
3. Power and surge protection panel or module (1) (cabinet interface devices that combine one or more of the above components shall be acceptable as well).
4. All associated equipment required to setup and operate in a field environment including software, serial and ethernet communication ports, cabling, electrical connectors and mounting hardware.

The RVDS shall be capable of the following:

1. The RVDS shall be able to operate in all types of weather conditions including: rain, snow, sleet, ice, fog and windblown dust.
2. Lightning and surge protection will be provided for power connections and communications links to the radar RVDS.
3. Provide a "fail safe" operation that triggers when communication between the radar vehicle sensor and the interface module is broken. Contact closure from the interface module will occur on all programmed detector channels associated with the affected radar sensor when the failsafe is triggered and will remain in this state until communication is re-established between the interface module and the radar vehicle sensor.
4. Comply with all applicable Federal Communications Commission (FCC) requirements. The manufacturer will provide documentation of compliance with FCC specifications.
5. Shall maintain frequency stability without the use of manual tuning elements by the user.
6. Shall provide a minimum of 4 separate RF channels selectable by the user to avoid interference with other devices working on the same frequency.
7. The communication port(s) shall support a communication speed that will not introduce excessive latency between when a vehicle is detected and the contact closure in the traffic signal cabinet.
8. The interface modules that utilize the detector rack must operate at 12V or 24V DC. Shelf mounted interface modules must operate within a range of 89V to 135V AC, 60 Hz single phase. Power to the RVDS radar sensor must be from the transient protected side of the AC power distribution system in the traffic control cabinet in which the RVDS is installed.
9. RVDS documentation shall include a comprehensive user guide as well as quick reference guide(s).
10. Shall have the ability to configure presence, pulse, extend and delay outputs.

D. Wireless Magnetometer Detection System (WMDS)

When specified in the plans, the equipment shall consist of all items necessary to provide a complete functional wireless magnetometer detection system that process changes to earth magnetic field and provide detection outputs to the traffic signal controller.

WMDS shall be capable of NEMA TS2 operation.

The WMDS shall consist of the following components:

1. In-pavement sensors
2. All wireless communication equipment needed to establish communication links to the controller cabinet.
3. Interface modules compatible with NEMA TS-2 V2.06b cabinet detector rack.
4. Surge protection for the WMDS and system software for set-up and monitoring of the WMDS.

The WMDS shall be capable of the following:

1. Detecting a variety of vehicle types including motorcycles, automobiles and large trucks. The system must allow the user to select sensitivity levels that adjust the amount of hysteresis to the magnetic field needed to achieve contact closure to the assigned detector channel. Magnetometer sensitivity level adjustments must allow for different levels of vehicle detection.
2. The ability to configure presence, pulse, extend and delay outputs.

3. WMDS equipment failure such as: the sensor, communications link, access point radio, repeater radio (if used) or interface module, shall result in constant vehicle call "fault state" on the affected detector channel to the traffic controller.
4. Detection accuracy must be comparable to properly operating inductive loops.
5. Provide real-time vehicle detection (within 150 milliseconds (ms) of vehicle arrival). Once detection is achieved by the sensor, the traffic controller must receive contact closure to the assigned detector channel within the 150 ms time frame.
6. The in-pavement sensor must operate on batteries without the need for underground power or communication cable connections to the unit.
7. The average operating life span of the sensor under battery power must be a minimum of 10 years.
8. The interface module must provide 2 or 4 detector channels. Sensors must be assignable to the available detector channels on the interface module using software provided with the WMDS.
9. The front face of the module shall identify detector channel 1 and detector channel 2. Each must use an LED to indicate contact closure on the channel. When vehicle detection is achieved, the LED will be on and contact closure applied to the detector channel. During periods of no vehicle detection the LEDs will be in an off state and no contact closure will be applied to the detector channel.
10. The interface module will use an LED indication to indicate a "fault state" with the WMDS. When the fault state is active contact closure will be applied to the appropriate detector channel.

E. Pedestrian Push Buttons

Where shown on the Plans, furnish and install pedestrian push buttons of substantial tamper-proof construction. They shall consist of a direct push type button and single momentary contact switch in a cast metal housing. Operating voltage for pedestrian push buttons shall not exceed 24 volts.

Provide a weatherproof assembly, constructed to prevent electrical shocks under any weather condition.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the standard or post to which it is attached to provide a rigid installation.

Unless otherwise specified, install the push button and sign on the crosswalk side of the pole.

Pedestrian push buttons shall have a transient protection that meets NEMA specifications.

730.30 (Reserved)

730.31 (Reserved)

TRAFFIC SIGNAL SUPPORTS

730.32 Cantilever Signal Supports

This Subsection applies to the manufacture of steel poles and mast arms for the support of traffic signals. The height of poles, shaft dimensions and wall thickness shall meet the design requirements and mounting height of traffic signals as set forth in these Specifications and shown on the Plans. The Plans indicate bracket arm lengths.

Furnish poles consisting of a straight or uniformly tapered shaft, cylindrical or octagonal in cross-section, having a base welded to the lower end and complete with anchor bolts. All castings shall be clean and smooth with all details well defined and true to pattern. Steel castings shall conform to ASTM A27, Grade 65-35. Gray iron castings shall conform to ASTM A126, Class A.

All mast arms shall be compatible with the poles in material, strength, shape, and size.

A. Anchor Base

Secure an anchor base of one-piece cast steel or steel plate of adequate strength, shape, and size to the lower end of the shaft. Place the base so as to telescope the shaft, and weld at the top and bottom faces with continuous fillet welds so that the welded connection develops the full strength of the adjacent shaft section to resist bending action. Provide each base with a minimum of four holes to receive the anchor bolts. Provide cast steel bases with removable cast iron covers for anchor bolts and tapped holes for attaching covers with hex head cap screws.

Provide a welded frame handhole, 5 x 8 inches minimum and located with a clear distance above the base of no less than the pole diameter, "D". Weld a 1/2-inch 13 UNC grounding nut to the inside of the pole at a point readily accessible for wiring.

B. Shaft

Fabricate shafts from the best, hot-rolled basic open hearth steel. The shaft shall have only one longitudinal electrically welded joint and may have electrically welded intermediate transverse full penetration circumferential joints, at intervals of not less than 10 feet. The shaft shall be longitudinally cold-rolled to flatten the weld and increase the physical characteristics so that the metal will have minimum yield strength of 48,000 pounds per square inch. Where transverse full penetration circumferential welds are used, the shaft fabricator shall furnish to the Engineer certification that: (1) all such welds have been radiographed and ultrasonically tested by an independent testing laboratory using a qualified Nondestructive Testing (NDT) technician and (2) the NDT equipment has been calibrated annually.

Fit the shaft with a removable pole cap, a J-hook wire support welded inside near the top, and a flange plate assembly to match that welded to the butt end of the mast arm.

C. Mast Arms

Provide mast arms fabricated and certified in the same manner as the upright shafts and that have the same physical characteristics.

The mast arms shall meet the design requirements necessary to support rigidly mounted traffic signals as shown on the Plans. All arms shall include a removable cap at the tip, grommeted wire outlets, and signal hanger assemblies of the type and number shown on the Plans, and a flange plate welded to the butt end to provide a rigid connection to the mast. The assembly shall be constructed so that all wiring can be concealed internally.

Connect mast arms to the upright pole at a height necessary to provide a minimum clearance of 16 feet 6 inches and a maximum clearance of 19 feet under the traffic signal heads. Install separate signal heads to provide the same clearance.

D. Finish

Galvanize steel poles, mast arms, and hardware in accordance with ASTM A123.

Galvanize all steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, after fabrication in accordance with ASTM A123, or A153 or A385, as applicable.

730.33 Steel Strain Poles

Provide steel strain poles consisting of a uniformly tapered or equivalent upright shaft fitted with a removable pole top, J-hook wire support and 45-degree wire inlet near the top, a span wire clamp, a 5 x 8 inch handhole with reinforced frame and cover, bent anchor bolts, and all other accessories needed to make a complete installation. The pole and all of its component parts shall be designed to support tethered traffic signals of the type and number shown on the Plans, suspended from a span wire assembly. Fabricate and certify the poles as specified for the upright shafts in **730.32**.

Determine the shaft length required to meet field conditions and vertical clearances of signal heads over the roadway. The signal head clearance shall be a minimum of 16 feet 6 inches and a maximum of 19 feet. Fasten the span wire no closer than 1 foot 6 inches from the top of the pole.

Unless otherwise specified, provide all strain pole traffic signal supports with a one-piece anchor type base, fabricated from drop forged or cast steel of sufficient cross-section to fully develop the ultimate strength of the poles. Fasten the base to the pole with a welded connection that develops the full strength of the pole. Provide the base with a minimum of four holes of sufficient size to accommodate the proper size anchor bolts that are capable of resisting at yield strength stress, the bending moment of the shaft at its yield strength stress. Provide removable cast iron covers for the anchor bolts.

The shaft shall be fabricated from material providing minimum yield strength of 48,000 pounds per square inch after fabrication.

Galvanize the steel poles and hardware in accordance with ASTM A123.

Galvanize all steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, after fabrication in accordance with ASTM A123, or A153 or A385, as applicable.

730.34 Pedestal Support Signal Poles

Provide pedestal poles consisting of one upright pole with suitable base and other accessories or hardware as required making a complete installation.

All poles shall be made of one continuous piece from top of base connection for the entire height of the pole. The cross-section shall be either cylindrical or octagonal and may or may not be uniformly tapered from butt to tip.

The cross-section at the tip shall have a 4-1/2 inch outside diameter.

A. Type "A" Pedestal (Aluminum)

Pedestals shall be of uniform octagonal or cylindrical cross-section of the tubular tapered type fabricated of one full length sheet.

Bases shall be octagonal or square in shape, of the ornamental type fabricated of cast material. Provide a handhole in each base.

Caps shall be of the nipple or tenon type mounting fabricated of cast material.

Furnish bases with four steel anchor bolts of sufficient size and length to securely anchor the base to the concrete footing. Weld the shaft to the cast metal base. Refer to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (current edition).

Type A pedestal shaft shall be fabricated from aluminum tubing 6063-T4 heat treated to T-6 temper after fabrication, and meeting ASTM B221.

Type A anchor base shall be made of sand-cast aluminum alloy 356-T6 meeting ASTM B26 - SF 70A-T5 specifications.

B. Type "B" Pedestal (Steel)

Pedestals shall be fabricated from a 4-1/2 inch (outside diameter) seamless steel pipe.

Bases shall be octagonal in shape of the ornamental type fabricated of cast or malleable iron and shall have minimum height of 12 inches. The top opening of the base shall be threaded to receive the shaft. Provide a handhole in each base.

Furnish bases with four steel anchor bolts of sufficient length to securely anchor the base to the concrete footing.

730.35 Wooden Pole Signal Supports

A. General

Provide wooden poles of the class and length shown on the Plans and that meet **917.11**. Set poles to the depth shown on the Plans, and fit them with all the necessary hardware to make the installation complete.

The signal head clearance shall be 16 feet 6 inches minimum and 19 feet maximum. Fasten the span wire at least 2 feet below the top of the pole.

B. Guying Components

Guy clamps shall be steel, 3-bolt type, 6 inches in length, and of the proper strand size to fit the wire used. The clamp bolts shall have upset shoulders fitting into the clamp plate. Substitution of the cable grip is subject to the Engineer's approval.

Attach guy wire to the pole with a 5/8-inch diameter x 12-inch length single strand angle-type eye bolt with 2 x 2 inch square cut washers; lock washer, and square nut.

Instead of the eye bolt specified above, an angle single strand eye of drop forged steel may be used, fastened on threaded end of span wire eye bolt.

Sidewalk guy fittings shall consist of 2-inch inside diameter standard galvanized steel pipe of required length with malleable iron pole plate and guy clamp. Fasten the pole plate to the pole with a 3/8-inch thru bolt and 1/2-inch lag screws.

All guying components and hardware shall be galvanized in accordance with ASTM A123 or A153.

Anchors for guys shall be of the pressed steel four-way expanding fluke type or of the steel or malleable iron sliding plate type. The minimum unexpanded diameter shall be 8 inches, and the minimum expanded area shall be 110 square feet. Coat anchors with a black asphaltic paint.

Guy anchor rods shall be drop-forged steel, 3/4-inch diameter and 7-foot minimum length, threaded, of the single thimble eye type, with a square anchor bolt nut.

730.36 Pole Location

Install all signal support poles at the locations shown on the Plans or where directed by the Engineer.

COMPENSATION

730.37 Method of Measurement

Measurement for traffic signals will be on a per item basis for each item to be furnished and installed, as specified herein and shown on the Plans.

With regard to items for signal head assemblies, each item to be furnished, installed, or both furnished and installed shall be distinguished with a code number as follows:

1. The first digit is the number of faces per assembly.

2. The second digit will indicate the number of 12-inch lenses per assembly (including arrow lenses).

3. The third digit is the quantity of 8-inch lenses per assembly.

4. The letter "A" indicates an arrow lens and the digit following the "A" indicates the number of 12-inch arrow lenses per assembly.

5. The letter "H" or "V" indicates the arrangement of arrow signal lenses to be horizontal or vertical with respect to solid ball indications.
   EXAMPLE:
   1 5 0 A 2 H
   Digits indicate the following:
   1 = one face
   5 = five 12-inch lenses
   0 = zero 8-inch lenses
   A2 = two 12-inch arrow lenses
   H = Arrow lenses placed horizontally with respect to circular indications

A. Removal of Signal Equipment

The Department will measure items of equipment or material designated or required for removal on a per each intersection basis. Removal and salvage of all signal heads, poles, control equipment, cabinets, span wire, cable, and similar features to be performed at an intersection shall be included as a unit cost per each intersection. This includes the cost of stockpiling salvable equipment for pick-up by or delivered to the appropriate agency, as noted in the Plans.

Signal Head Assembly (includes Pedestrian Signal Heads)

The Department will measure signal heads of the type shown on the Plans by the individual assembly complete in place, per each. This item shall include the signal heads, terminals, lamps, attachment hardware, cable connection, and testing.

Pull Box

The Department will measure each pull box of the type required as one complete unit, installed, per each. This item includes the pull box, excavation, backfilling, crushed stone base, and other incidental items as called for in the Plans or Standard Drawings.

Electrical Service Connection

The Department will measure Electrical Service Connections on a per each signal installation basis. This item includes the electrical service supplied to the weatherhead by the local utility, all necessary materials, including an electrical meter base and disconnect pedestal, and labor for connection of the electrical service from the

controller to the weatherhead, the wiring of the controller and detectors, and all incidentals necessary to render a complete and operable system.

Signal Cable

The Department will measure the length of Signal Cable of each size (number of conductors) installed in linear feet to the nearest foot from point to point along the routing for each cable.

The Department will make horizontal measurements by center to center measurement from:

1. Pole to pole
2. Pole to signal head (when terminating in a signal head)
3. Pull box to pull box
4. Pull box to pole
5. Pull box to pole-mounted or base-mounted controller

For cable inside mastarms, the Department will measure from center of vertical support to signal head where cable terminates.

The Department will make vertical measurement by one of the following:

1. For cable inside poles or conduit risers, the distance from ground level to the point of attachment of the span wire.
2. For cable inside mast arm supports, the distance from ground level to the mast arm connection.
3. For cable to pole-mounted controller,
    a. From ground level to bottom of controller.
    b. From bottom of controller to point of attachment of span wire.
4. For cable to pole-mounted signal head or pushbutton,
    a. From ground level to bottom of signal head or pushbutton
    b. From bottom of signal head or pushbutton to point of attachment of span wire.

The Department will make no additional allowance for slack length, length inside equipment or supports (except as noted), length for the required 360-degree drip loop, and similar instances requiring additional length of cable.

Span Wire

The Department will measure Span Wire Assembly, Tether Wire Assembly, and Messenger Cable by type in linear feet to the nearest foot. The measurement will be made from center to center of poles. These items include attachment hardware, strain insulators, and other hardware shown in the Plans as part of the assembly. The Department will make no additional allowance for slack length and other instances requiring additional length of wire.

Steel Conduit Riser Assembly

The Department will measure conduit riser assemblies per each for each size conduit riser installed on the outside of a pole, as shown on the Plans. This item includes conduit, weatherhead, condulet, fittings, nuts, washers, banding, clamps, grounding, and other items necessary for installation.

Conduit

The Department will measure conduit in linear feet to the nearest foot for each size and type of conduit installed.

The Department will measure underground conduit along the conduit by one of the following:

1. From the face of curb to the center of a pull box, pole or controller foundation,
2. From center to center of pull boxes,
3. From center to center of a pull box and a pole or controller foundation, or
4. From center to center of pole foundations or pole foundation and controller foundation.

The Department will add:

1. 1 foot to the above measurements for each entry to a pull box or pole foundation and each exit of a pull box or pole foundation.
2. 3 feet to the measurement for each capped extra entry (conduit stub) or exit to a pull box or pole foundation installed, as shown on the Plans.
3. 3 feet to the measurement for each connection between underground conduit and above ground riser.
4. 3 feet to the measurement for each entry or exit to a foundation for a base-mounted controller.

This item includes trenching, backfilling, sealing, capping, fittings, bushings, banding, grounding, and other accessories and hardware required for installation of the conduit system.

Vehicle Loop Detector (Amplifier)

The Department will measure vehicle detector loop amplifier per each unit, including the cable and associated hardware necessary to electrically connect the amplifier to the controller and loop lead in.

The Department will measure two and four channel card rack type amplifiers per each unit, including the cable, card rack(s), and associated hardware necessary to electrically connect the amplifiers to the controller and loop lead-ins.

Shielded Detector Cable

The Department will measure the two-conductor shielded detector cable installed between the controller cabinet and the loop detector wires in linear feet to the nearest foot.

The Department will make horizontal measurements (overhead and underground) by one of the following:

1. From center to center of pull boxes,
2. From center to center of pull box and pole,
3. From center to center of poles, or
4. From center to center of pull box or pole and controller foundation.

The Department will make vertical measurements by one of the following:

1. From ground level to the point of attachment of span wire, inside pole or conduit riser,
2. From the bottom of controller cabinet to the point of attachment of span wire, or
3. From ground level to the bottom of controller.

The Department will make no additional allowance for slack length, length inside equipment or supports (except as noted), splices, and similar instances requiring additional length of cable.

Saw Slot

The Department will measure the length of saw slot for installation of detection loop and lead wiring in linear feet to the nearest foot. Measurement for detection loops in the traffic lanes will be made based on the loop size shown on the Plans (the nominal length plus the nominal width) times 2. The Department will make no additional allowance for saw overruns to obtain full depth of saw slot or diagonal cuts to prevent sharp bends in the loop wire. The Department will measure saw slot for detection loop leads from the conduit entry at the face of curb or edge of pavement and along the route of the lead-in to the detection loop.

This item includes backing rods, or polyethylene foam sealant, loop sealant, and all other incidentals necessary to render a complete and operable system.

Loop Wire

The Department will measure the length of loop wire for installation of detection loops and lead-ins in linear feet to the nearest foot. Measurement will be made from the pull box or pole to the detection loop, around the loop the required number of turns and back to the pull box, pole, or point of splice. The Department will make no additional allowance for slack length, length inside equipment or supports, splices, and similar instances requiring additional length of wire.

This item includes electrical connections, testing, and all other incidentals necessary to render a complete and operable system.

Controller

The Department will measure controllers as one complete unit, installed, per each. This item includes all auxiliary equipment shown the Plans to provide signalization control as shown on the Plans, and all hardware, including the cabinet (and cabinet foundation, if base-mounted), necessary for installation.

Wood Pole

The Department will measure Wood Poles, of the type and size shown on the Plans, per each, installed.

Guying Device

The Department will measure Guying Devices, of the type shown on the Plans, per each, installed. This item includes the guy wire, anchor, clamps, and all other components shown on the Plans necessary for installation.

Steel Strain Pole

The Department will measure Steel Strain Poles of the type and size shown on the Plans, per each, installed. This item includes the pole, foundation, anchor bolts, grounding, and all other hardware shown on the Plans necessary for a complete installation.

Cantilever Signal Support

The Department will measure Cantilever Signal Supports, of the type and size shown on the Plans, per each, installed. This item includes the vertical pole shaft, mast arm, foundation, anchor bolts, grounding, and all other hardware shown on the Plans necessary for a complete installation.

Service Cable

The Department will measure two conductor power service cables, of the type and size shown on the Plans, in linear feet to the nearest foot, installed. Horizontal runs will be measured center to center of poles. Vertical runs will be measured from the ground to the weatherhead inside a pole or conduit riser, or from the ground to the

bottom of the controller, or from the bottom of the controller to the weatherhead. This item includes all necessary attachment hardware. The Department will make no additional allowance for slack length or other instances requiring additional length of cable.

Pedestrian Pushbutton with Sign

The Department will measure Pedestrian Pushbutton with Sign as one complete unit, in place, per each. This item includes the pushbutton, sign, mounting hardware, wiring of pushbutton, testing, and all other incidentals necessary for a complete installation.

Pedestrian Signal Display with Pushbutton and Sign

The Department will measure Pedestrian Signal Display with Pushbutton and Sign as one complete unit, in place, per each. This item includes the signal heads, terminals, lamps, cable connections, pushbutton, sign, all attachment hardware, testing, and other incidentals necessary for a complete installation.

Portable Traffic Signal

The Department will measure Portable Traffic Signal, of the type shown on the Plans or as directed by the Engineer, per each, installed. This item includes the all of the software and hardware necessary for a complete installation.

730.38 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Traffic Signal	Lump Sum
Removal of Signal Equipment	Each
Signal Head Assembly (Description)	Each
Install Pull Box (Description)	Each
Electrical Service Connection	Each
Signal Cable – (Description)	Linear Feet
Span Wire Assembly (___ pounds min. break strength)	Linear Feet
Tether Wire Assembly – __" Diameter	Linear Feet
Messenger Cable – __" Diameter	Linear Feet
Riser Assembly (Description)	Each
Conduit __" Diameter (Type)	Linear Feet
Vehicle Detector (Description)	Each
Shielded Detector Cable	Linear Feet
Saw Slot	Linear Feet
Loop Wire	Linear Feet
Controller (Description)	Each
Wood Pole (Description)	Each
Guying Device (Description)	Each
Steel Strain Pole (Description)	Each
Cantilever Signal Support (Description)	Each
Service Cable	Linear Feet
Pedestrian Pushbutton with Sign	Each
Pedestrian Signal Display with Pushbutton and Sign	Each
Portable Traffic Signal (Type)	Each

The unit price to be paid includes the cost of furnishing and installing, complete in place, each of the various types of equipment required by the Summary of Quantities shown on the Plans. Total payment is full compensation for all materials, labor, equipment, and incidentals necessary to produce a completely operative and finished installation of a traffic signal or traffic signal system as shown on the Plans and as specified herein, including restoration of pavements, sidewalks, and appurtenances damaged or destroyed during construction and tests. All additional materials and labor not specifically shown or called for, which are necessary to complete the traffic signal installation or traffic signal system described, will be considered incidental to the system and no additional allowance will be made.

S T A T E **O F** **T E N N E S S E E**

(Rev. 01-08-2015) January 1, 2021
(Rev. 09-06-2016)
(Rev. 06-26-2017)
(Rev. 10-02-2019)
(Rev. 09-25-2020)
(Rev. 10-09-2020)
(Rev. 09-30-2021)
(Rev. 09-25-2024)

SPECIAL PROVISION

REGARDING

RIGHTS-OF-WAY MOWING

Description. This work shall consist of mowing of the rights-of-way for vegetation control in accordance with the Plans, Specifications, and as directed by the Engineer. A mowing cycle shall be one complete mowing of the areas along state highways and interstates designated within this contract and shall be completed within twenty (20) working days that are suitable for mowing.

Definitions.

Continuous Mowing Operation. A Continuous Mowing Operation is an operation conducted for a minimum of five (5) hours per day over a twenty (20) working day cycle, which consists of one or more mechanical mowers working independently or in coordination to cut vegetation on state rights-of-way deemed Mowable Acres by the Engineer.

Working Day. A calendar day, exclusive of State recognized holidays, which weather or other conditions not under the control of the Contractor, will permit a continuous mowing operation with the normal working force engaged in performing the controlling item or items of work which are normal to progress at the time, as determined by the Engineer.

Mowable Acres. All areas within rights-of-way where mechanical mowers and finish mowers can cut vegetation and safely traverse slopes without significant damage to existing ground.

Mowing. The work associated with cutting or trimming vegetation primarily consisting of, but not limited to, grasses and invasive weeds to provide a consistent and aesthetically pleasing standing vegetation height of four (4) inches.

Swath Mowing. The work associated with cutting one fifteen (15) foot wide swath of vegetation parallel to the edge of pavement on each shoulder and one fifteen (15) foot wide swath of vegetation parallel to the edge of pavement in each direction within the median. For medians less than sixty (60) feet, the entire median will be mowed (see sheet 7 for Typical Mowing Diagram).

Mechanical Mower. A commercial quality piece of equipment which is capable of mowing vegetation in excess of two (2) acres per hour at least five (5) hours per day.

Finish Mower. A commercial quality piece of equipment specifically designed to address mowing of vegetation around roadside obstacles or areas not accessible to conventional mowers in an attempt to prevent damage and provide a consistent vegetation height by means other than a mechanical mower. The cost associated with this work shall be included in the unit price bid for mowing 806-01, swath mowing 806-02.13, or sidewalk finish mowing 806-02.14. Finish mowers do not meet the requirements for mechanical mowers as described in this special provision and cannot be utilized for continuous mowing operations on state highways or interstates.

Hand Trimming. The work associated with cutting or trimming vegetation in proximity to roadside obstacles or in areas not accessible to mechanical mowers in an attempt to prevent damage and provide a consistent vegetation height by means other than a mechanical mower.

Roadside Obstacles. Items located within the right of way, both natural and man-made which may include but are not limited to trees, signposts, delineator posts, light posts, steel beam guardrail, and associated posts, cable barrier rail, barrier walls, retaining walls, utility poles, catch basins, fallen rock, bridge end abutments, mailboxes, established/planted trees and shrubs, landscaped beds, and wildflower areas.

General. All mowing operations shall be performed to the satisfaction of the Engineer. Standing vegetation shall be cut to a height of four (4) inches while maintaining a consistent vegetation profile within all mowing limits adjacent to the roadway. The Contractor shall mow only those areas that are designated as mowable acres, including, if present, a minimum of five (5) feet up the back slope from the bottom of the ditch, and five (5) feet behind all guardrails as shown in The Typical Mowing Diagram on sheet 7. The actual dimensions and mowing limits shall be discussed at the pre-construction conference. Vegetation including small trees, shrubs, and bushes with a stem diameter of up to two (2) inches which are inside of and encroaching upon the established mowing limits shall be cut by the Contractor using a mower or hand trimming methods as directed by the Engineer. Areas that were recently cleared or chipped will be included in mowable acres. Extreme care shall be taken not to damage the trees, plants, and shrubs, which are designated by the Engineer to remain. Hand trimming may be required as directed by the Engineer for areas of vegetation inside the designated mowable acres which are not accessible to mechanical mowers. As work progresses, mowing and trimming shall be conducted in such a manner to provide a consistent standing vegetation height in all mowing limits adjacent to the roadway (see sheet 7 for Typical Mowing Diagram). The Contractor shall mow as close as practicable to all roadside obstacles. Hand trimming is required atop earth berms, within all rip rap areas, and around all roadside obstacles.

Guardrail and cable barrier rail located on interstates will be sprayed by TDOT personnel except for those located in the following counties: Davidson, Hamilton, Knox, and Shelby. Spraying by TDOT does not relieve the Contractor from hand trimming if needed. The Contractor shall not apply herbicides on state rights-of-way.

The Department reserves the right to perform spot mowing with its own forces on all State right-of-way as necessary. Minor quantity adjustments may be made due to the Tennessee Department of Transportation's Wildflower Program, Adopt a Plot Program, designated research areas, environmental no-mow areas, and Adopt A Highway Program.

Time and Frequency Mowing. A notice to begin work will be issued to the Contractor at least five (5) working days prior to the date the mowing cycle is to begin. Work shall begin on the date specified in the notice. Mowing operations shall proceed in the same route sequence as performed during litter operations. The contractor shall submit a planned mowing sequence, hand trimming sequence, and schedule to the Engineer for approval before each mowing cycle begins. Any deviations from the approved mowing sequence or schedule may be allowed at the discretion of the Engineer. A failure to begin mowing operations on the date specified in the notice will result in the assessment of liquidated damages (see SP108B). The mowing cycle shall be twenty (20) working days suitable for mowing unless otherwise documented in the Special Notes.

The number of mowing cycles will be indicated in the General Notes but may be increased by one mowing cycle to coincide with extreme weather conditions or for departmental needs. Also, the Engineer may require a partial mowing cycle at certain locations.

Mowing shall be performed during daylight hours, Monday through Friday. Work may be allowed on Saturday at the discretion of the Engineer. If the approved mowing schedule is not maintained, the Engineer may require work to be performed on Saturday and/or Sunday. If work is performed on Saturday and/or Sunday, the Contractor will be charged a Working Day.

Mowing Operations. Work shall begin for each mowing cycle on the date specified in the notice to begin work. Once a mowing cycle begins, the Contractor shall maintain a Continuous Mowing Operation until the mowing is complete. A mowing cycle will be considered complete when all mowing and hand trimming is completed to the satisfaction of the Engineer. Hand trimming shall be performed in the same sequence as mowing operations.

Hand trimming is to be completed within the twenty (20) working day cycle. Failure to complete hand trimming within five (5) working days of the termination of mechanical mowing represents a failure to maintain a continuous mowing operation.

When mowing within twelve (12) feet of the edge of pavement or shoulder, mechanical mowers shall not discharge vegetation and debris toward the roadway. When mowing is required in proximity to the roadway, any vegetation or debris deposited on the roadway as a result of the mowing operation will be removed immediately from the edge of pavement to the edge of pavement, or between curb and gutter, whichever applies. Any cost associated with the removal of vegetation clippings, foreign objects, or gravel that is deposited on the roadway, the shoulder, or in a curb and gutter section as a result of the mowing operation shall be included in the unit price bid for Mowing, Item No. 806-01, Swath Mowing, Item No. 806-02.13, or Sidewalk Finish Mowing, Item No. 806-02.14.

Swath mowing shall follow as closely as practical to the boundary between the shoulder of the roadway and the point at which vegetation begins. In cases where a continuous swath cannot be maintained on ramps, at bridges, and when encountering assets of the state, the swath shall deviate away from the edge of pavement then terminate, or the swath shall deviate away from, then back to the edge of pavement in as tight a space as practical. Any vegetation that cannot be cut by the mower between the edge of pavement and the edge of the swath shall be cut using hand trimming, and the cost shall be included in the unit price bid for Swath Mowing, Item No. 806-02.13. All interchanges and ramps shall be mowed completely during a Swath mowing operation.

The Contractor shall mow in the direction of traffic when less than thirty (30) feet from the paved surface.

Equipment. Prior to beginning work, the Contractor shall provide the Engineer with a schedule of equipment which will be used to accomplish work under the terms of the contract. The Contractor shall certify to the Engineer that the equipment to be used on this project is suitable for mowing along public highways. All equipment used for mowing operations shall be utilized as described by the manufacturer's recommendations and maintained in safe operating conditions. Mowing on slopes that exceed the equipment manufacturer's specifications shall not be allowed. Any equipment that the Engineer determines to be unsuitable for use or hazardous to highway users shall not be used. The Contractor shall provide sufficient equipment and accessory items necessary for efficient operation and the completion of the mowing cycle in the designated time. Any special equipment requirements will be noted in the General Notes. Zero-turn mowers are considered finish mowers and can be utilized for mowing around roadside obstacles but do not meet the requirements for continuous mowing operations under the terms of this special provision. The cost associated with this work shall be included in the unit price bid for Mowing, Item No. 806-01, Swath Mowing, Item No. 806-02.13, or Sidewalk Finish Mowing, Item No. 806-02.14.

All rotary mowers must be equipped with safety chains to prevent damage to property caused by flying debris propelled out from under the mower. No disc-type mowers will be allowed. Chains shall be a minimum of 5/16 inch in size, and links spaced side by side around the mower's front, sides, and rear. Chains shall be spaced at no less than twelve (12) strands of chain per foot and shall be laced horizontally one row from the bottom with 1/4" steel cable secured by cable clamps on each end. When sitting on level ground, at a level deck height of seven (7) inches, the chains shall be long enough to drag the ground. Flaps or semi-rigid guards will not be allowed as a substitute for chains. Maximum cutting widths for rigid frame rotary mowers shall be l20 inches (10 ft.). Maximum cutting widths for all other mower types shall not exceed 180 inches (15 ft.) without the approval of the Engineer.

Safety Requirements. Mechanical mowers and finish mowers shall be equipped so as to conform to prevailing Occupational Safety Health Act (OSHA) Standards, including flashing amber lights and slow-moving equipment emblems.

The Contractor shall comply with OSHA standards, including the use of Class 3 reflective shirts or vests at all times.

Notification to the Engineer shall be made immediately of any personal injury, accidents involving the contractor's equipment, or accidents involving the motoring public.

While equipment is not in use, it shall be parked or stored off the pavement or shoulder of the highway in an inconspicuous place more than thirty (30) feet from the edge of pavement or as directed by the Engineer. Under no circumstances shall mechanical mowers or finish mowers be parked or stored in medians. When batwing mowers are being moved from one site to another under their own power with the mowers raised, the mower shall be disengaged.

Handheld, pushed, or riding trimmers using string or blades are not considered mechanical mowers and cannot be considered as part of a continuous mowing operation under the terms of this special provision.

The Contractor shall be required to have a mechanical leaf blower on site to address any vegetation or debris deposited on state routes. The cost associated with this work shall be included in the unit price bid for Mowing Item No. 806-01 or Swath Mowing Item No. 806-02.13.

The Contractor shall be required to have the company name and phone number on all tractors and work zone support vehicles on the left and right sides in a location that is visible to the public. The lettering for the company name and phone number shall consist of a reflectorized material with a minimum height of three inches (3") or five inches (5") in height if non-reflectorized.

Equipment Cleaning. The Contractor will be required to clean any piece of equipment moved into Tennessee if the equipment is moving from an area infested with invasive species of concern listed below:

- Cogon Grass

Prior to moving equipment into Tennessee, the Contractor shall notify the Engineer of the location of the equipment's most recent operation. The Contractor shall not move any equipment that last operated in an area infested with an invasive species of concern into Tennessee without having cleaned such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds. If the Contractor cannot verify the location of its most recent operation, then the Contractor shall assume that the location is infested with invasive species of concern.

Prior to moving from an area identified as infested with invasive species of concern to, or through Tennessee, the Contractor shall clean such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds, and shall notify TDOT prior to moving any equipment subject to the cleaning requirements set forth above. The Contractor shall advise TDOT of its cleaning measures and make the equipment available for inspection. TDOT shall have two (2) days, excluding weekends and state holidays, to inspect and approve for use of equipment after it has been made available. After a satisfactory inspection, the Contractor may move the equipment as planned. Equipment shall be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. The Contractor shall not be required to disassemble equipment.

Traffic Control. The Contractor shall maintain traffic and all traffic control devices for mobile mowing operations according to the requirements contained herein, the State of Tennessee's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD) defined under the Rules of Tennessee Department of Transportation Chapter 1680-3-1, and the Standard Specifications. Although Traffic Control may be included in the cost of other items, the Contractor will be responsible for submitting certifications per Materials & Tests Division Standard Operating Procedures. Under no circumstances shall a mower cross the pavement edge line without complying with Mobile Operations requirements found in the MUTCD.

Warning Signs. The Contractor shall furnish portable signs in accordance with the "Manual on Uniform Traffic Control Devices" to notify the traveling public of the operations of mowing equipment. The Contractor shall place these signs along the highway during the operation of mowers and remove them immediately after the operation ceases. Signs at the beginning point shall be 48" by 48" in size; diamond-shaped with black letters on an orange background with a black border with eight-inch high letters. These signs shall be dual-mounted, one on each shoulder, for both directions of travel.

Damage to Property. The Contractor shall carry on the operation in such a manner that does not damage the existing ground areas, trees, shrubs, guardrails, utilities, delineators, or other structures. The Contractor shall not mow during wet conditions where turf damage or ruts would occur. In the event damage occurs to the right-of-way because of mowing operations, the Contractor shall replace or repair, at their own expense, in like kind, and as directed by the Engineer. Notify the Engineer immediately when any property damage occurs. If damaged property resulting from the Contractor's operations has to be repaired or replaced by the Department, the cost of such work shall be deducted from monies due to the Contractor.

The Contractor shall take all necessary precautions to prevent damage to passing vehicles and to both public and private property. This shall include roadside obstacles, vehicles and any other property which may be damaged by the mowing operation. Payment for work may be withheld until the damaged property has been repaired or replaced.

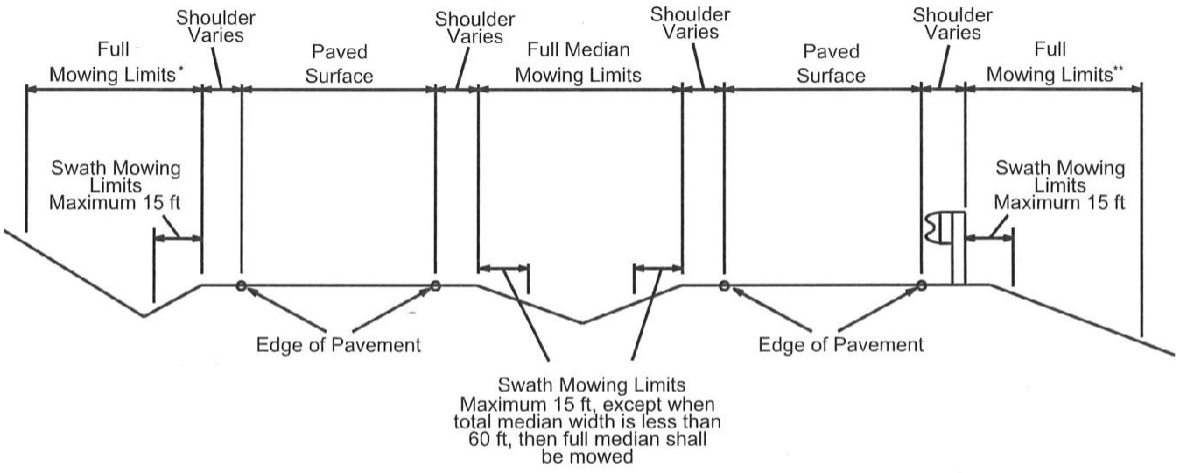
The Contractor shall respond to all claims of damage from the public within seventy-two (72) hours after notification of damage. Failure to settle claims for damages in a timely manner may result in actions by the Department to preclude the Contractor from performing work on future projects.

Additional Work. The Contractor may be required to mow in areas not specifically detailed in the General Notes under the direction of the Engineer. Additional work shall be limited to the counties and systems which are designated in the General Notes. Payment for additional work will be made at the contract unit price for Mowing, Item No. 806-01, Swath Mowing, Item No. 806-02.13, or Sidewalk Finish Mowing, Item No. 806-02.14.

Method of Measurement. Mowing shall be measured by the acre based on the quantities shown in the General Notes for each mowable area. Each mowing cycle or partial cycle will be measured separately. A mowing cycle includes the mowing of all tabulated areas shown in the General Notes one time.

Basis of Payment. The accepted quantities of mowing will be paid for at the contract unit price per acre. All costs for traffic control as defined above shall be included in the unit bid price for Mowing, Item No. 806-01, Swath Mowing, Item No. 806-02.13, or Sidewalk Finish Mowing Item No. 806-02.14).

TYPICAL MOWING DIAGRAM
(NOT TO SCALE)



NOTES:

* Cut a minimum of 5 ft up the back slope from the bottom of the ditch, or as directed by the engineer.

** Cut a minimum of 5 ft behind all guardrail, or as directed by the engineer.

S T A T E **O F** **T E N N E S S E E**

(Rev. 6-20-22) January 1, 2021
(Rev. 9-7-22)

SPECIAL PROVISION

REGARDING

EQUAL EMPLOYMENT OPPORTUNITY

Electronic Code of Federal Regulations (e-CFR):
23 CFR 230 Chapter 1 Subchapter C Appendix A to Subpart A

Specific Equal Employment Opportunity Responsibilities

General

a) Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal employment opportunity as required by Executive Order 11246 and Executive Order 11375 are set forth in Required Contract Provisions (Form PR-1273 or 1316, as appropriate) and these Special Provisions which are imposed pursuant to Section 140 of Title 23, U.S.C., as established by Section 22 of the Federal-Aid Highway Act of 1968. The requirements set forth in these Special Provisions shall constitute the specific affirmative action requirements for project activities under this contract and supplement the equal employment opportunity requirements set forth in the Required Contract Provisions.

b) The contractor will work with the Tennessee Department of Transportation and the Federal Government in carrying out equal employment opportunity obligations and in their review of his/her activities under the contract.

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

Equal Employment Opportunity Policy

The contractor will accept as his operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability and to promote the full realization of equal employment opportunity through a positive continuing program:

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

Equal Employment Opportunity Officer

The contractor will designate and make known to the Tennessee Department of Transportation contracting officers an equal employment opportunity officer (hereinafter referred to as the EEO Officer) who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of equal employment opportunity and who must be assigned adequate authority and responsibility to do so.

Dissemination of Policy

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

   1) Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's equal employment opportunity policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.

   2) All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the contractor's equal employment opportunity obligations within thirty days following their reporting for duty with the contractor.

   3) All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer or appropriate company official in the contractor's procedures for locating and hiring minority group employees.

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

1) Notices and posters setting forth the contractor's equal employment opportunity policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

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

Recruitment

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

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

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

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

Personnel Actions

Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability. The following procedures shall be followed:

a) The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b) The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c) The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d) The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with his obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of his avenues of appeal.

Training and Promotion

a) The contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

b) Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event the Special Provision Regarding Training Program Requirements is provided under this contract, this subparagraph will be superseded as indicated therein.

c) The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

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

Unions

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

a) The contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

b) The contractor will use best efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability.

c) The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the Tennessee Department of Transportation and shall set forth what efforts have been made to obtain such information.

d) In the event the union is unable to provide the contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to their race, color, religion, sex, sexual orientation, gender identity, national origin, age or disability, making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees). In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the Tennessee Department of Transportation.

Subcontracting

a) The contractor will use his best efforts to solicit bids from and to utilize minority group subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of minority-owned construction firms from the Tennessee Department of Transportation.

b) The contractor will use his best efforts to ensure subcontractor compliance with their equal employment opportunity obligations.

Records and Reports

a) The contractor will keep such records as are necessary to determine compliance with the contractor's equal employment opportunity obligations. The records kept by the contractor will be designed to indicate:

   1) The number of minority and non-minority group members and women employed in each work classification on the project.

   2) The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women. (Applicable only to contractors who rely in whole or in part on unions as a source for their work force),

   3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees, and

   4) The progress and efforts being made in securing the services of minority group subcontractors or subcontractors with meaningful minority and female representation among their employees.

b) All such records must be retained for a period of 3 years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the of the Tennessee Department of Transportation and the Federal Highway Administration.

c) The contractors will submit an annual report to the Tennessee Department of Transportation each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form PR 1391. If on-the-job training is being required by "Training Special Provision," the contractor will be required to furnish Form FHWA 1409.

d) The contractor and subcontractors will be required to complete other reports as instructed by the Engineer.

e) Current estimates may be withheld by the Engineer when reports are not received within the above specified time limits.

S T A T E **O F** **T E N N E S S E E**

(Rev. 6-20-22) January 1, 2021

SPECIAL PROVISION

REGARDING

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION

TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246)

Electronic Code of Federal Regulations (e-CFR):
41 CFR 60-4.2 -- Solicitations

1) The Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Specifications" set forth herein.

2) The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

County	Goals for Female Participation in each Trade
All Counties	6.9

County	Goals for Minority Participation for each Trade
Lincoln	11.2
Hamilton, Marion, Sequatchie	12.5
Bledsoe, Bradley, Grundy, McMinn, Meigs, Monroe, Polk, Rhea	8.6
Carter, Hawkins, Sullivan, Unicoi, Washington	2.6
Greene, Hancock, Johnson	3.2
Anderson, Blount, Knox, Union	6.6
Campbell, Claiborne, Cocke, Cumberland, Fentress, Grainger, Hamblen, Jefferson, Loudon, Morgan, Roane, Scott, Sevier	4.5

County	Goals for Minority Participation for each Trade
Montgomery	18.2
Davidson, Cheatham, Dickson, Robertson, Sumner, Williamson, Wilson, Rutherford	15.8
Bedford, Cannon, Clay, Coffee, Dekalb, Franklin, Giles, Hickman, Houston, Humphreys, Jackson, Lawrence, Lewis, Macon, Marshall, Maury, Moore, Overton, Perry, Pickett, Putnam, Smith, Stewart, Trousdale, Van Buren, Warren, Wayne, White	12.0
Shelby, Tipton	32.3
Benton, Carroll, Chester, Crockett, Decatur, Dyer, Fayette, Gibson, Hardeman, Hardin, Haywood, Henderson, Henry, Lake, Lauderdale, McNairy, Madison, Obion, Weakley	26.5

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted). If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and nonfederally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in CFR Part 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from Project to Project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3) The Contractor shall provide written notification to the Director of Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation.

U.S. Department of Labor – Regional Office
Office of Federal Contract Compliance Program
61 Forsyth Street, Room 7B75
Atlanta, GA 30303

The notification shall list the name, address, and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.

S T A T E **O F** **T E N N E S S E E**

(Rev. 9-7-22) January 1, 2021

CERTIFICATION REGARDING

DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

PRIMARY AND LOWER TIER COVERED TRANSACTIONS

The prospective Primary and/or Lower Tier participant certifies, by signing and submitting this proposal, to the best of its knowledge and belief, that it and its principals:

Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal, State or local department or agency.

Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.

Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in the preceding paragraph of this certification; and

Have not within a three- year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

Are not a corporation that has been convicted of a felony violation under any Federal law within the two-year period preceding this proposal; and

Are not a corporation with any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Where the prospective Primary and/or Lower Tier participant is unable to certify to any of the statements in this certification, such prospective participant should attach an explanation to this proposal.

(Exceptions to the above are to be submitted on a separate sheet with the bid proposal)

For any exception noted, indicate to whom it applies, initiating agency, and dates of action. Providing false information may result in criminal prosecution or administrative sanctions.

S T A T E **O F** **T E N N E S S E E**

(Rev. 5-1-95) January 1, 2021

SPECIAL PROVISION

REGARDING

LABOR (STATE PROJECTS ONLY)

The contractor will be required to comply with the provisions of Title 12, Chapter 4, Part 4, Tennessee Code Annotated, relative to payment of prevailing wages and also the following rules and regulations as established by the Tennessee Department of Labor:

(1) Classify all laborers and mechanics conformably with schedule of classification in the contract.

(2) Apprentices may be employed only under a bona fide apprenticeship program, registered with the Bureau of Apprenticeship, U.S. Department of Labor.

(3) Wages rates must be posted in a prominent place on the site of construction and must be made available to all mechanics and laborers employed on the project at all times.

(4) Pay all laborers and mechanics unconditionally and not less often than once each week the full wages earned.

(5) Pay hourly rates which are not less than those listed for the class of labor being employed.

(6) Pay overtime compensation as required by any applicable federal or state laws, rules or regulations.

(7) Make no deductions from wages other than those authorized by law.

(8) The contractor shall submit each week in which any contract work is performed a certified copy of all payrolls to the contracting agency. The address and social security number of each employee shall be shown the first time the employee appears on a payroll, and on any subsequent payroll when the employee's address changes.

The certifications will affirm that the payrolls are correct and complete, that the wage rates contained therein are not less than those determined by the Commissioner of Labor, and that the classifications set forth for each laborer and mechanic conform with the work performed. The contractor will make his employment records available for inspection by representatives of the contracting agency and the Department of Labor and will permit such representatives to interview employees during working hours on a project.

Failure to submit payrolls within one week or to resubmit corrected payrolls within one week after notification may be reason to withhold progress payments.

The rates of pay for each classification of labor employees on this project as set out by the Labor Department of the State of Tennessee and made a part of this proposal contract, shall remain unchanged for the life of this contract.

Watchman and clerical employees are not to be covered by the Wage Scale, therefore, may be paid at or above the National Wage and Hour Law Rates.

S T A T E **O F** **T E N N E S S E E**

(Rev. 9-7-22) January 1, 2021

SPECIAL PROVISION

REGARDING

NON-DISCRIMINATION IN EMPLOYMENT

Bidders are cautioned as follows:

By signing this bid, the bidder will be deemed to have signed and agreed that all persons, firms or corporations supplying goods, material, equipment or service of any kind to the State of Tennessee will not discriminate against any employee or applicant for employment on the basis of race, color, religion, sex, sexual orientation, gender identity, national origin, age or disability and further, that while under contract with the State will show proof upon request that all employment practices including, but not limited to, promotion, rates of pay, transfers, recruitment, recruitment advertising, terminations, layoffs and training and apprenticeship programs are not discriminatory in nature.

Each contractor shall be required to post in conspicuous places, available to all employees and applicants for employment, notices of non-discrimination.

S T A T E **O F** **T E N N E S S E E**

(Rev. 01-06-23)
(Rev. 01-05-24)
(Rev. 01-03-25)

January 1, 2021

SPECIAL PROVISION

REGARDING

TENNESSEE DEPARTMENT OF TRANSPORTATION

2025 MINIMUM WAGE SCALES FOR FEDERAL-AID CONSTRUCTION

& 2025 MINIMUM WAGE SCALES FOR STATE FUNDED CONSTRUCTION

This Contract contains "Tennessee Department of Transportation 2025 Minimum Wage Scales for State Funded Construction", Tennessee Department of Labor Decision No. T-40293, dated January 1, 2025 and "Tennessee Department of Transportation 2025 Minimum Wage Scales for Federal Aid Highway Construction", U. S. Department of Labor Decision No. TN20250147 (dated January 3, 2025).

The Contractor is required to pay the greater of the two (2) rates for each classification.

Note: Minimum Wage Scales for Federal-Aid Heavy Construction are on file with the Department, and will be included in all applicable Contract Proposals

S T A T E O F T E N N E S S E E

TENNESSEE DEPARTMENT OF TRANSPORTATION

2025 MINIMUM WAGE SCALES FOR STATE FUNDED CONSTRUCTION

January 1, 2025 **Tenn. DOL Decision No. T-40293**

CLASSIFICATION (ENGLISH)	CLASSIFICATION (SPANISH)	Basic Hourly Rates	Craft No.
Blaster	**Proveedor do Explosivos**	28.16	**1**
Bricklayer	**Ladrillero**	20.30	**2**
Carpenter / Leadsperson	**Carpintero o Lider**	25.70	**3**
Class "A" Operators	**Operador Clase A**	29.81	**4**
Class "B" Operators	**Operador Clase B**	27.04	**5**
Class "C" Operators	**Operador Clase C**	29.07	**6**
Class "D" Operators	**Operador Clase D**	27.71	**7**
Concrete Finisher	**Terminador de Cemento**	25.58	**8**
Drill Operator (Caisson)	**Operador de Perfordora**	43.02	**9**
Electrician	**Electricista**	37.70	**10**
Farm Tractor Operator (Power Broom)	**Operador de Tractor de Rancho**	19.94	**11**
Ironworkers (Reinforcing)	**Herrero**	27.79	**12**
Ironworkers (Structural)	**Herrero de Estructura**	24.05	**13**
Large Crane Operator	**Operador de la Grua**	32.51	**14**
Mechanic (Class I) Heavy Duty	**Mecanico Clase 1**	32.38	**15**
Mechanic (Class II) Light Duty	**Mecanico Clase 2**	30.38	**16**
Painter / Sandblaster	**Pintor o Lajador**	37.54	**17**
Skilled Laborer	**Obrero Diestro**	25.38	**18**
Survey Instrument Operator	**Operador de Agrimensor**	35.87	**19**
Sweeping Machine (Vacuum) Operator	**Operador de Barredora**	25.99	**20**
Truck Driver (2 axles)	**Camionero (2 ejes)**	26.63	**21**
Truck Driver (3/4 axles)	**Camionero (3 o 4 ejes)**	25.38	**22**
Truck Driver (5 or more axles)	**Camionero (5 o más ejes)**	29.74	**23**
Unskilled Laborer	**Obrero no Diestro**	22.46	**24**
Worksite Traffic Coordinator	**Coordinar de Trafico en el Lugar de Trabajo**	28.70	**25**

CLASSIFICATION **CRAFT NO.**

SKILLED LABORER: **18**

Air Tool Operator, Asphalt Raker, Chain Saw Operator, Concrete Mixer Operator (less than 1 yard), Concrete Rubber, Edger, Fence Erector, Form Setter (Steel Road), Guardrail Erector, Mechanic's Helper (Tire Changer or Oiler), Mortar Mixer, Nozzleman or Gun Operator (Gunite), *Pipelayer, Sign Erector

CLASS "A" OPERATORS: **04**

Backhoe/Hydraulic Excavator (3/4 yard and over), Crane (less than 20 tons), End Loader (3 yards and over), Motor Patrol (Finish

CLASS "B" OPERATORS: **05**

Backhoe/Hydraulic Excavator (less than 3/4 yard), Bull Dozer or Push Dozer, End Loader (less than 3 yards), Motor Patrol (Rough), Tractor (Crawler/Utility), Scraper, Shovel, Trenching Machine

CLASS "C" OPERATORS: **06**

Asphalt Paver, Concrete Finishing Machine, Concrete Paver, Scale, Spreader (Self-Propelled), Concrete Grinder, Asphalt Milling Machine, Boring Machine (Horizontal)

CLASS "D" OPERATORS: **07**

Bobcat, Central Mixing Plant, Concrete Pump, Concrete Saw, Curb Machine (Automatic or Manual), Dozer or Loader (Stockpile), Drill (Piling), Mulcher or Seeder, Rock Drill (Truck Mounted), Roller (Asphalt), Roller (Compaction Self-Propelled), Soil Stabilization Machine, Tractor (Boom & Hoist), Bituminous Distributor Machine, Pump, Track Drill, Striping Machine,

LARGE CRANE OPERATOR: **14**

Means one who operates boom-type equipment equal to or greater than 20 tons to hoist and move materials, raise and lower heavy weights and perform other related operations; may oil, grease or otherwise service and make necessary adjustments to equipment as needed; and may perform other related duties. (Note: The equipment is used for such work as pouring concrete and setting steel. This work is subject to strict inspection and must conform closely to specifications. The equipment may also be used for other miscellaneous tasks for which crane or stick-type equipment is required which may include hoist operations and pile driving operations.)

***Skilled Laborer - Pipelayer Classification:**

Means one who lays, connects, inspects and tests water lines, force mains, gas lines, sanitary or storm sewers and drains, underground telephone and electric ducts or other utilities manufactured from clay, concrete, steel, plastic, cast iron pipe or other similar materials; may smooth bottom of trench to proper elevation by scooping with a shovel; receives pipe lowered from top of trench; inserts spigot end of pipe into bell end of last laid pipe; adjusts pipe to line and grade; caulks and seals joint with cement or other sealing compound; may connect threaded or flanged joint pipe; may assemble and place corrugated metal or plastic pipe; and may perform other related duties.

Additional Information :

Prevailing Wage Act (T.C.A., §§ 12-4-401 through 12-4-415). Effective January 1, 2014.
https://www.tn.gov/content/dam/tn/workforce/documents/Contact/PrevailingWageAct2014.pdf

For the Classification of Covered Workers (Rule 0800-03-02-.02), see the Tennessee Department of Labor and Workforce Development Prevailing Wage Commission Rules : https://www.tn.gov/content/dam/tn/workforce/documents/pwc/Prevailing_Wage_Rules.pdf

Wage Rates : https://www.tn.gov/workforce/employees/labor-laws/labor-laws-redirect/wages-breaks/prevailing-wage.html

Poster Page : https://www.tn.gov/workforce/general-resources/major-publications0/major-publications-redirect/posters-redirect/required-posters.html

Note: Adobe Acrobat Reader is required to download & print. If you do not have this software a link is provided at the bottom of the Poster Page for a free download.

Tenn. Dept. of Labor & Workforce Development (Labor Standards Division) : (844) 224-5818

APPENDIX C

DESIGN-BUILD CONTRACT FORMS
APPENDED TO BOOK 2 (DESIGN-BUILD CONTRACT)

Form Name	Form Designation
Attestation Regarding Personnel Used in Contract Performance	Form AT
Conflict of Interest Disclosure Statement	Form COI
Contract Payment and Performance Bond	Form CP&PB
Lobbying Certificate	Form LC
Technical Proposal Signature Page	Form TPSP

DESIGN-BUILD
RFP CONTRACT BOOK 3
PROJECT SPECIFIC INFORMATION

TENNESSEE DEPARTMENT OF TRANSPORTATION

Interstate 24

Interchange at Epps Mill Road/Buchanan Road; Epps Mill Road, From west of Capital Way to SR-2 (US-41)

Rutherford County, Tennessee

CONTRACT NUMBER: DB2505

TN TDOT Department of Transportation

OCTOBER 2025

TABLE OF CONTENTS

Page

1. GENERAL 1
1.1 PROJECT DESCRIPTION 1
1.2 PROJECT GOALS 3
1.3 DEPARTMENT-PROVIDED MATERIALS 4
1.4 ON-THE-JOB/APPRENTICESHIP TRAINING 4
2. PROJECT MANAGEMENT 5
2.1 ORGANIZATIONAL STRUCTURE AND STAFFING PLAN 5
2.2 CRITICAL PATH METHOD (CPM) SCHEDULE 6
2.3 QUALITY MANAGEMENT PLAN 7
2.4 ENVIRONMENTAL COMPLIANCE PLAN 9
2.5 SAFETY AND HEALTH PLAN 9
2.6 PUBLIC RELATIONS AND PUBLIC INFORMATION PLAN 9
2.7 RECORDS MANAGEMENT PLAN 10
3. ROADWAY 11
3.1 STANDARDS AND REFERENCES 11
3.2 DESIGN REQUIREMENTS 11
3.3 DRAINAGE 14
3.4 PAVEMENT MARKINGS 16
3.5 SIGNING 16
3.6 TRAFFIC SIGNALS 17
3.7 LIGHTING 17
3.8 GROUND SURVEY 18
3.9 PAVEMENT DESIGN 18
4. STRUCTURES 19
4.1 BRIDGES 19
4.2 RETAINING WALLS 20
5. INTELLIGENT TRANSPORTATION SYSTEMS (ITS) 21
5.1 FIELD INVESTIGATIONS 21
5.2 DESIGN REQUIREMENTS 21
5.3 ADDITIONAL REQUIREMENTS 22
5.4 SUBMITTAL REQUIREMENTS 22
6. GEOTECHNICAL 23
6.1 NOTIFICATION REQUIREMENTS 23

6.2 GEOTECHNICAL REPORTS 24
7. RIGHT-OF-WAY 25
7.1 ACQUISITION SERVICES REQUIREMENTS 25
7.2 TITLE REPORTS AND CLOSINGS 26
7.3 APPRAISAL AND APPRAISAL REVIEWS 28
7.4 ACQUISITION, RELOCATION ASSISTANCE, AND PROPERTY MANAGEMENT 29
8. UTILITIES 33
8.1 UTILITY INVESTIGATIONS 33
8.2 GENERAL REQUIREMENTS 33
8.3 COORDINATION RESPONSIBILITIES 34
8.4 COMPENSABLE UTILITIES 35
8.5 ADDITIONAL REQUIREMENTS 36
8.6 CONSTRUCTION REQUIREMENTS 36
9. ENVIRONMENTAL 37
9.1 ENVIRONMENTAL BOUNDARIES 37
9.2 STATE OR FEDERAL ENDANGERED/THREATENED SPECIES 38
9.3 OTHER NATURAL RESOURCES 39
9.4 GPS/GIS DATA COLLECTION 39
9.5 MITIGATION OF STREAMS AND WETLANDS 40
9.6 PERMITTING 41
9.7 TENNESSEE ENVIRONMENTAL EVALUATION REPORT (TEER) DOCUMENT 48
9.8 DISPOSAL OF MATERIALS 48
9.9 EROSION PREVENTION AND SEDIMENT CONTROL (EPSC) 48
9.10 DEPARTMENT INSPECTIONS 50
10. CONSTRUCTION REQUIREMENTS 52
10.1 CONSTRUCTION SERVICES 52
10.2 ACCEPTANCE OF MATERIALS 52
10.3 MAINTENANCE DURING CONSTRUCTION 53
11. TRAFFIC CONTROL / PAVEMENT MARKING SCOPE OF WORK 54
11.1 GENERAL REQUIREMENTS 54
11.2 TEMPORARY LANE / ROAD CLOSURES 55
11.3 TEMPORARY MARKINGS 56
11.4 TEMPORARY SIGNAGE 56
11.5 CHANGEABLE MESSAGE SIGNS 56
11.6 QUEUE PROTECTION DEVICES 56

11.7 CHANGEABLE DETOUR AND CONSTRUCTION SIGNAGE 56
11.8 CONSTRUCTION WORK ZONE 56
11.9 PAVEMENT EDGE DROP-OFF TRAFFIC CONTROL 56
12. NEARBY DEVELOPMENTS 57
12.1 PROJECT SPRING AT SR-2 57
12.2 DEVELOPMENT NEAR EPPS MILL ROAD AND CAPITAL WAY 57
13. APPENDIX A: PAVEMENT DESIGN 58

1. GENERAL

This **Contract Book 3 (Project-Specific Information)** contains the requirements and conditions by which the Design-Builder shall design and construct the Project, except for any portions of the work that may be stipulated within this **Contract Book 3 (Project-Specific Information)**to be performed by the Tennessee Department of Transportation (TDOT, or "the Department").

The order of precedence of **Contract Book 3 (Project-Specific Information)** with the other contract documents is described in **Contract Book 2 (Design- Build Contract)**. TDOT will utilize electronic contracts for this project.

The Definition of Terms corresponding with this **Contract Book 3 (Project-Specific Information)** can be found in the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction* and/or *Design-Build (DB) Standard Guidance*:

https://www.tn.gov/content/dam/tn/tdot/alternative-delivery/design-build/Design-Build_Standard-Guidance_2022-04-28.pdf .

All work shall be completed in accordance with the version of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction in effect 30 days prior to the Proposal due date, unless specifically stated herein.

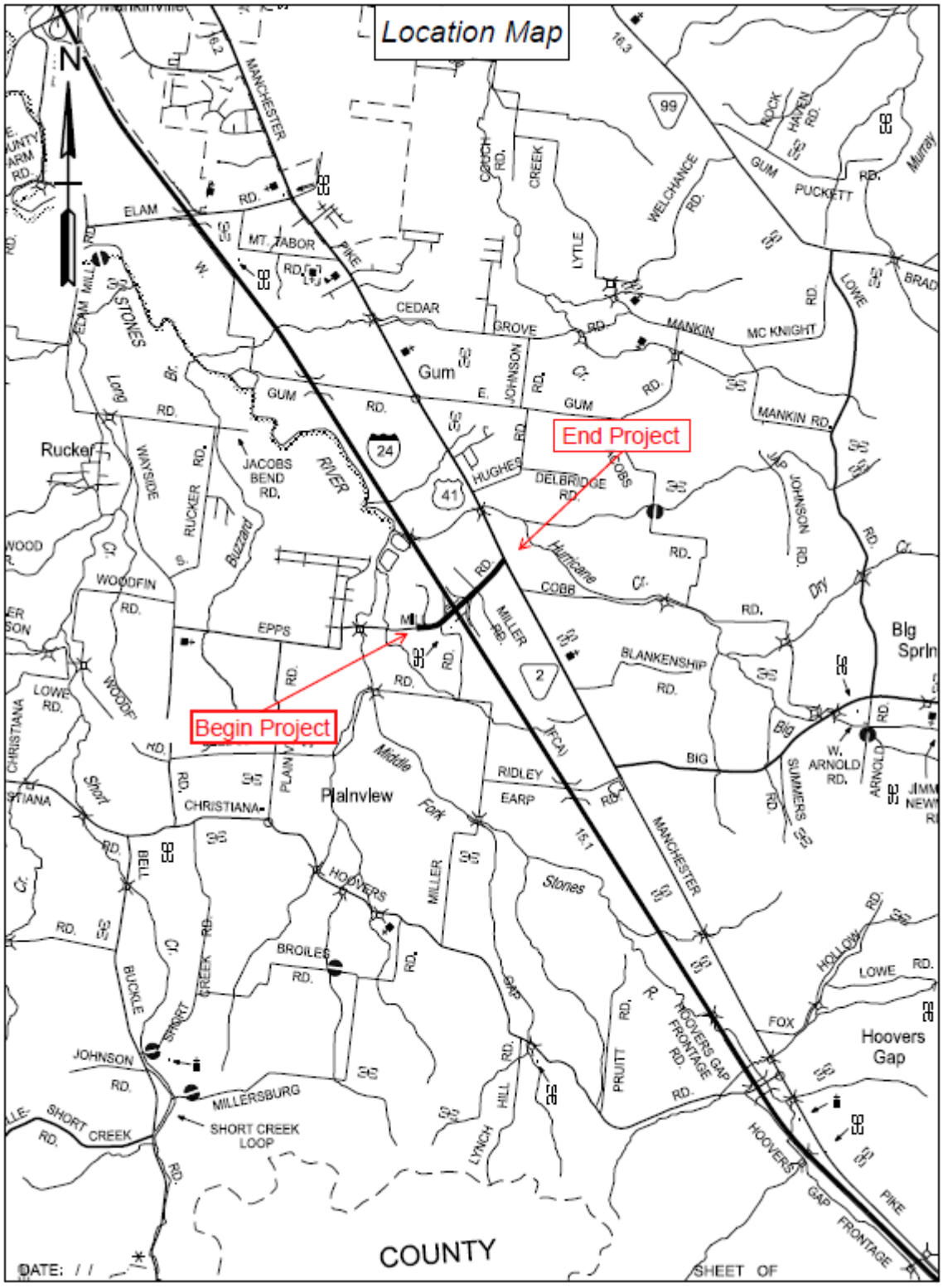
1.1 PROJECT DESCRIPTION

The Design-Builder shall verify existing survey and perform all necessary survey updates, design and construction services to construct (roadway and structures) I-24 Interchange at Epps Mill Road/Buchanan Road (the "Project").

The Project shall include the design and construction of the widening of Epps Mill Road from just past Capital Way (L.M. 0.86) to State Route 2 (US-41) (L.M. 0.00) and ramp improvements at the interchange (Exit 89) with Interstate 24 (I-24). The area within the ramp terminals will be full-access controlled and the area outside of the ramp terminals will be partial-access controlled. The Project replaces the existing Epps Mill Road bridge over I-24 and realigns Epps Mill Road for the bridge construction staging. The project also includes realignment of Epps Mill Road at the intersection with SR-2 as depicted on the Functional Plans.

The bridge (ID 75I000240041) over I-24 is twenty-eight (28) feet wide and is a two-span 300 ft. long haunched steel welded plate girder bridge with a sufficiency rating of 75.0. The bridge is approaching its end of service life and will be replaced as part of this project.

An overview of the project is shown in the figure below.



The Design-Builder's general responsibilities with respect to the scope of work for the Project shall include without limitation the following, as more particularly described within this **Contract Book 3 (Project-Specific Information)**:

- Widening Epps Mill Road from just past Capital Way (L.M. 0.86) to State Route 2 (US-41) (L.M. 0.00);
- Realigning Epps Mill Road
- Improving ramps at the Epps Mill Road interchange (Exit 89) with Interstate 24 (I-24);
- Providing a minimum 45-mph design speed for the Epps Mill Road to I-24 westbound on-ramp (Ramp 1);
- Providing a minimum 40-mph departure design speed for the I-24 eastbound to Epps Mill Road off-ramp (Ramp 2);
- Providing a minimum 35-mph design speed for the Epps Mill Road to I-24 eastbound on-ramp (Ramp 3);
- Providing a minimum 40-mph departure design speed for the I-24 westbound to Epps Mill Road off-ramp (Ramp 4);
- Constructing a new bridge to replace the existing Epps Mill Road bridge over I-24;
- Extending acceleration and deceleration lanes on I-24 at the Epps Mill Road Interchange ramps;
- Widening State Route 2 for a dedicated left and right turn lane at the intersection with Epps Mill Road;
- Realigning Miller Road to intersect Epps Mill Road perpendicular and across from the new I-24 eastbound ramp terminals;
- Removing and replacing all existing guardrail that does not meet current standards.;
- Resurfacing all existing asphalt pavement within the project limits;
- Modifying existing drainage structures and installing proposed drainage improvements;
- Installing new full interchange lighting;
- Installing new ITS components;
- Replacing existing and installing new signage as shown in the roll plots; and
- Replacing control access fence.

1.2 PROJECT GOALS

The Project's primary purposes are to provide present and future congestion relief, and address deficiencies of the existing interchange. The following goals have been established for the Project (not listed in any specific order):

- Provide a design and construction approach that minimizes inconvenience to the traveling public.
- Optimize cost efficiency through design and construction innovation to complete the Project within the allocated budget.

- Provide a management system or approach that ensures the requirements of the project will be met or exceeded.
- Minimize project delivery timeframes through streamlining the design and construction process and mitigating potential delays through proactive planning and coordination to obtain final project acceptance no later than September 30, 2029.

1.3 DEPARTMENT-PROVIDED MATERIALS

All documents have been published on the Department's project website:

https://www.tn.gov/content/tn/tdot/alternative-delivery/design-build/db2505.html

The Design-Builder shall acknowledge that materials furnished by the Department are preliminary and provided solely to assist the Design-Builder in the development of the project design. The Design-Builder shall be fully responsible for the accuracy and completeness of all work performed under this contract. The Design-Builder shall be fully liable and hold the Department harmless for any additional costs and all claims against the Department which may arise due to errors, omissions and negligence of the Design-Builder in performing the work required by this contract.

The Design-Builder is responsible for verifying all information provided by the Department.

1.4 ON-THE-JOB/APPRENTICESHIP TRAINING

On-the-Job/Apprentice Training is not required on this Project.

2. PROJECT MANAGEMENT

The Design-Builder shall prepare and administer a Project Management Plan (PMP) containing the Design-Builder's approach to managing the design and construction activities of the Project in accordance with the **DB Standard Guidance** and the specific requirements defined herein..

The PMP shall contain, at a minimum, the following component parts:

- Organizational Structure and Staffing Plan
- Design Quality Management Plan (DQMP)
- Construction Quality Management Plan (CQMP)
- Safety and Health (S&H) Plan
- Environmental Compliance Plan (ECP)
- Critical Path Method (CPM) Schedule
- Public Relations and Public Information Plan (PIP)
- Records Management Plan
- Other plans as specified by the **Design-Build Contract**

Within 30 Days of Contract Award, the Design-Builder shall meet with the Department at the Post-Award Meeting to discuss development of the components of the PMP for Review and Acceptance by the Department prior to the start of any Work.

The Design-Builder shall use the Project Understanding and Approach, and the Project Management and Approach submitted with the Proposal as a foundation to prepare the PMP component plans. The Design-Builder shall implement all elements of the PMP.

2.1 ORGANIZATIONAL STRUCTURE AND STAFFING PLAN

The Design-Builder shall prepare an Organization Structure and Staffing Plan for the purpose of ensuring that appropriate qualified staff are employed by the Design-Builder to perform the Work and are able to carry out the Work in a manageable and safe manner.

The plan shall identify the Key Personnel and key management staff including the Key Personnel level 1 and level 2 identified in the Statement of Qualifications (SOQ) and on the Response Category 2 form.

The Design-Builder shall provide an organizational chart that graphically represents the hierarchy and functional interaction of the Key Personnel, and indicates the functional responsibilities of each. The organizational chart shall be part of the PMP.

The organization shall be monitored and the chart updated and provided to the Department when changes to the Design-Builder's organizational chart occur.

Staffing Requirements

The Design-Builder shall provide to the Department, within 15 calendar days after the initial Notice to Proceed (NTP), a list of the contacts (and contact details) of Key Personnel on site and Key Personnel on call who are available 24 hours per day during the executions of the Work.

Any licenses or certifications that are required to meet the requirements of the Request For Qualifications (RFQ) and RFP shall be in place by the time the first NTP is issued.

2.2 CRITICAL PATH METHOD (CPM) SCHEDULE

The Design-Builder shall prepare a cost-loaded CPM Schedule, in accordance with Chapter 3 of the *DB Standard Guidance* and the requirements herein, for review at the Post-Award Meeting.

The Design-Builder shall use the preliminary CPM Schedule submitted with the Proposal as a foundation to prepare a Project CPM Schedule and shall submit it to the Department for Review and Acceptance. Acceptance of the initial Project CPM Schedule by the Department shall be a condition of starting any Work. The Design-Builder shall submit an updated Project CPM Schedule on a monthly basis for the Department's Review and Acceptance. Failure to submit an updated Project CPM Schedule may result in the withholding of progress payments.

The Design-Builder shall provide a narrative with each CPM Schedule submittal, which shall include:

- A detailed description of the status of the Project and changes to the CPM;
- Identification of strategies for mitigation of Project risks or issues impacting the CPM Schedule describing constraints and discussing contingencies;
- How the proposed project phasing and sequence of work and allocation of resources enables the Design-Builder to progress the work to achieve the contractual completion dates;
- How the phasing ensures timely deliveries of materials to achieve the CPM Schedule milestones;
- Identification of categories of work performed by Design Builder's own direct labor force and those performed by Subcontractors; and
- Pay Item activities and all work included in the Pay Item activities corresponding to totals as reflected on the Schedule of Items.
- Cost-loaded CPM: Cost loading activities shall be distributed appropriately. Individual activities shall be cost loaded. Level of effort cost loading shall not be used unless approved by the Department.

The Design-Builder shall include all Design Reviews submittals and any resubmittals in the CPM Schedule in order for the Department to appropriately allocate resources for performing the reviews and to track and document any possible schedule impacts.

TDOT Review Time

The Design-Builder shall allocate ten (10) Business Days (excluding State holidays) in the CPM Schedule for activities requiring the Department's Review and Acceptance, or Review and Comment.

Monthly progress payment requests and CPM updates are due five (5) business days prior to estimate cutoff date.

Number of Plan Review submittals shall be limited to two (2) at any given time.

Schedule and Cost Controls

The Design-Builder shall develop procedures for schedule and cost control on the Project, including the cost control and schedule management system to be used to control and coordinate the cost and schedule of the work.

The cost-control approach shall include a description of the proposed approach for calculating progress performance for preparing the monthly payment requests using the Pay Item activities, Schedule of Items and CPM Schedule.

The Design-Builder shall include a procedure for re-scheduling of its work to achieve schedule recovery objectives and how these objectives will be enforced with its work force and subcontractors.

Liquidated Damages for Failure to Meet Completion Deadline

The Design-Builder shall complete the Project within the time limitations set forth in **Contract Book 2 (Design-Build Contract)** and Special Provision 108B.

If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, a sum shall be deducted from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, if such completion is delayed.

The Liquidated Damages shall be **$8,000 per Calendar Day*.** This is also the Time Value used for calculation of selection and for failure to complete the work on time. It shall be calculated as followed:

If the Project is NOT completed in time "B", then the following amount will be deducted from the monies due the Design-Builder as:

(Actual Time Charged – B) x **$8,000/Calendar Day**

Any Liquidated Damages shall be addressed, not as a penalty, and computed as they occur with a separate item number subtracting from monies due the Design-Builder.

** Calendar Day amounts are applicable when the Contract Time is expressed on the Calendar Day or fixed date basis.*

2.3 QUALITY MANAGEMENT PLAN

The Design-Builder shall prepare a Quality Management Plan (QMP) in accordance with Section 2.5 of the **DB Standard Guidance** and the requirements herein.

The QMP shall consist of a:

- Design Quality Management Plan
- Construction Quality Management Plan

Design Quality Management Plan

The Design Quality Management Plan (DQMP) shall describe the quality roles and responsibilities of the Design-Builder's design quality management team and procedures for implementing the design

work in accordance with Chapter 5 of the *DB Standard Guidance*. The DQMP shall describe the design development, submittal and design review process for preparation of final signed and sealed construction plans used to construct the proposed improvements. The processes and procedures in the DQMP shall be developed in accordance with TDOT's *Design Guidelines* and Chapter 5 of the *DB Standard Guidance* for the Department's Review and Acceptance prior to starting any design work.

The DQMP shall include quality control and quality assurance procedures for ensuring the quality of the design work and conformance with the requirements in the *DB Standard Guidance***,** including design-quality checks and certifications, and independent Design Reviews prior to submittal for the Department's Review and Acceptance.

The Design-Builder shall provide all Design Documents and perform Design Reviews in accordance with the Design Review schedule established in the Critical Path Method (CPM) Schedule, and in accordance with Contract requirements.

The Design Manager shall be responsible for design QC and ensuring the design submittals and design reviews are performed in accordance with the DQMP and the Contract Documents. The Design-Builder shall provide a Design Quality Manager (DQM) to perform quality assurance activities and audits of the QC activities and QC program. The DQM shall be independent of the production work and shall certify to the Design-Builder and the Department that the design Work Product conforms to the requirements of the Contract Documents.

Construction Quality Management Plan

The Construction Quality Management Plan (CQMP) shall describe the quality roles and responsibilities of the Design-Builder's construction quality management team and procedures for implementing the construction work in accordance with Chapter 7 of the **DB Standard Guidance**. The CQMP shall be submitted for the Department's Review and Acceptance prior to starting any construction work.

Although the Department will provide Construction Engineering and Inspection (CEI) and Quality Assurance Testing, the Design-Builder is responsible for ensuring the quality of the work and shall prepare procedures in the CQMP for quality control of materials and how the Design-Builder plans to inspect the project to ensure compliance with the Contract Documents.

The Design-Builder shall be responsible for QC during construction and ensuring that QC testing and inspections are performed in accordance with the CQMP and the Contract Documents. The Design-Builder shall provide a Construction Quality Manager to oversee, manage, certify and perform construction quality assurance and audit activities. The CQM shall independently review the submittals for the Department, and upon completion shall certify to the Department that the information is accurate and complete. The CQM shall certify that all Work Product has been checked and/or inspected by the CQM's quality staff, and that all work complies with the Contract Documents. The CQM shall also certify to the Department that the CQMP and all measures, protocols, and procedures provided therein, are functioning properly and are being followed.

The Design-Builder shall guarantee and provide full cooperation in relation to CEI, audits, reviews, request for information etc.

2.4 ENVIRONMENTAL COMPLIANCE PLAN

The Design-Builder shall prepare an Environmental Compliance Plan (ECP) in accordance with Section 2.5.4 of the *DB Standard Guidance*.

2.5 SAFETY AND HEALTH PLAN

The Design-Builder shall prepare a Safety Plan in accordance with Section 2.5.5 of the *DB Standard Guidance*.

2.6 PUBLIC RELATIONS AND PUBLIC INFORMATION PLAN

The Design-Builder shall comply with Section 7.4.5 of the *DB Standard Guidance* and address the following project-specific requirements:

Internal and External Communications

The Design-Builder shall describe the internal and external communication process between the Design-Builder and the Department, the Department's staff, external stakeholders, third parties and the public affected by the work.

The Design-Builder shall provide all information required for communication purposes. The communication activities are mainly intended for the Department and Department staff (internal stakeholders) but shall also focus on neighboring public and communities, companies and organizations, emergency services, Rutherford County, environmental agencies and other external services.

The focus on the construction communication shall support the following goals:

- Ensure the entire project is executed in the least disruptive and positive manner possible for the Department.
- Maintain the best possible long-term relations with all relevant external stakeholders.
- Ensure the work is performed in the most effective and efficient way.

Project Website

The Design-Builder shall coordinate with the Department and provide Project-related information to the Department for Review and Acceptance including:

- Contact information;
- Project maps;
- Current Project activities and progress;
- Timing of road and interstate ramp closures and openings;
- Recommended route alternatives during closures, with maps;
- Newsletters and meeting materials; and

- Calendar of, and announcements for, meetings and special events.

Liaison With the Media

Unless otherwise specifically authorized in writing by the Department, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project without the Department's prior written authorization. The Design-Builder shall require this clause within all Subcontractors agreements.

2.7 RECORDS MANAGEMENT PLAN

The Design-Builder shall describe procedures for managing and maintaining Project record documents in accordance with Sections 5.2.11 and Chapter 7 of the ***DB Standard Guidance*** and the project-specific requirements herein.

The Department will perform a combination of Audits, Reviews, Inspections etc. to assess whether the Design-Builder's integrated project management is functioning properly and determine whether its records and information are reliable and up to date.

The Tennessee-licensed Professional Engineer in charge of the development of the Project plans shall place their seal, including signature and date, on the right side of the title sheet. All plans sheets shall contain the seal, including signature and date, of the Professional Engineer in charge of its development. Certified digital signatures shall be required for all plan submittals (refer to the TDOT *Design Guidelines*).

The As-Built Plans and the Design-Builder Specifications following construction completion shall incorporate any changes to the Readiness-for-Construction Design Review Plans and Specifications, changes made during construction as well as all utility locations within ROW as described in the *DB Standard Guidance***.**

Upon completion of the Project, the Design-Builder shall provide the TDOT Region 3 Alternative Delivery Office a transmittal letter, an electronic copy (CAD and signed PDF's) of the As-Built drawings, and final foundation type, including footing elevations and lengths of individual piles, prior to final payment of funds to the Design- Builder. In addition, the Design-Builder shall provide TDOT Structures Division a final as-built set of plans for all structures (bridges, walls, foundations, etc.). The Plans shall be delivered electronically via a cloud-based platform as agreed to by the Department. Bridge Plans and design calculations shall not be bundled and must be sent as individual files labeled "Bridge Plans Only" and "Bridge Design Calculations Only," respectively, for each bridge on the Project.

3. ROADWAY

3.1 STANDARDS AND REFERENCES

The Design-Builder shall design and construct the Project to adhere to the latest edition of the following standards in effect 30 days prior to the Proposal due date.

- TDOT Roadway Standard Drawings
- TDOT Roadway Design Guidelines and Instructional Bulletins
- TDOT Roadway Design CADD Standards
- TDOT Survey Manual
- TDOT Bridge Design Manual
- TDOT Pavement Design Guidelines
- TDOT Drainage Manual
- TDOT Traffic Design Manual
- TDOT Design Procedures for Hydraulic Structures
- The Department-accepted AASHTO Policy on Geometric Design of Highways and Streets
- AASHTO Roadside Design Guide
- AASHTO Guide for Design of Pavement Structures
- Manual on Uniform Traffic Control Devices (MUTCD)
- Open Roads Designer (ORD) shall be used in development of 3D parametric modeling to provide model-centric design deliverables. The Design-builder shall use ORD in accordance with requirements and guidelines provided on the Department's website (https://www.tn.gov/tdot/state-engineering-technical-training/tdot-cadd-support/ord-resources.html).

3.2 DESIGN REQUIREMENTS

Horizontal and Vertical Alignments

The proposed horizontal and vertical alignments shall be designed and constructed to meet or exceed the following:

- Epps Mill Rd.
    - Functional Classification: Urban Major Collector
    - Terrain Classification: Rolling
    - Termini:
        - The western terminus of the project is just west of Capital Way and shall taper from the existing 2-lane section to the proposed 3-lane section of Epps Mill Rd.

        - The eastern terminus of the project shall tie to State Route 2 (US-41)(Manchester Pike).
    - Maximum Grade: 4.0%
    - Design Speed: 40 mph
    - Posted Speed: 30mph
- Interchange
    - Maximum Grades:
        - Ramps: 5.0%
        - Interstate 24: Match existing
    - Design Vehicle: WB-67
    - Vertical Clearance: 16'-6" minimum over the ultimate number of lanes and shoulders of Interstate 24 described in Section 3.2 for the bridge over Interstate 24.
- State Route 2 (US-41)
    - Functional Classification: Rural Arterial
    - Terrain Classification: Rolling
    - Termini:
        - The northern terminus of the project is approximately 560' north of the proposed intersection with Epps Mill Road and shall taper from the existing 2-lane section to the proposed 3-lane section of State Route 2 (US-41).
        - The southern terminus of the project is approximately 580' south of the proposed intersection with Epps Mill Road and shall taper from the existing 2-lane section to the proposed 3-lane section of State Route 2 (US-41)(Manchester Pike).
    - Maximum Grade: 4.0%
    - Design Speed: 60 mph
    - Posted Speed: 55mph

Low points on sag curves shall not be located on bridges or pavement at bridge ends.

All other proposed ramps shall be designed and constructed to match the design speeds shown on the Functional Plans.

Ramps with 2 or more lanes shall be 12 ft. wide. One-lane ramps shall be 16 ft. wide.

Ramp 3 (Epps Mill Road to I-24 eastbound): Inside shoulder shall be 6 ft. (4-ft. stabilized); Outside shoulder shall be 8 ft. (6-ft. stabilized).

Ramps 1 (Epps Mill Road to I-24 westbound), 2 (I-24 eastbound to Epps Mill Road), and 4 (I-24 westbound to Epps Mill Road): Inside shoulders shall be 6 ft. (4-ft. stabilized); Outside shoulders shall be 12 ft. (10-ft. stabilized).

Vertical clearance for all alignments (entire roadway width including the full shoulder width, and future I-24 lanes as shown in the Functional Plans) and all existing overhead structures along I-24 and Ramps shall have a minimum 16 ft., 6 in. minimum vertical clearance. The 16 ft., 6 in. minimum clearance shall be maintained during all construction phases of the project. This requirement shall include all

temporary roadway surfaces used during construction. The Design-Builder shall submit plans as outlined in the TDOT *Design Guidelines* to the TDOT Structures Division for Grade Approval.

The Design-Builder shall be responsible for preparation of final signed and sealed construction plans used to construct the proposed improvements. They shall be prepared in accordance with TDOT's *Design Guidelines* and the previous design standards referenced in this section.

If the Design-Builder wishes to change the horizontal or vertical alignment or deems that additional ROW is needed outside of the secured ROW, they will be responsible for any and all additional environmental technical studies and completion of the re-evaluation of the TEER document, ROW appraisals and acquisitions, utilities coordination/relocation and any permits necessary.

The ramp construction and closures shall be phased in accordance with Special Provision SP108B. Access to all side roads shall be maintained throughout the duration of construction.

The Design-Builder shall identify the need for any special roadway design details (i.e. any special drainage structures, rock embankment, special guardrail, retaining walls, concrete barrier designs, etc.) and shall provide special design drawings to the Department for Review and Acceptance.

The geometric configurations of all roadway components shall be designed to provide adequate drainage and prevent hydroplaning (during construction and when complete). Cross slopes shall be in accordance with the requirements of the roadway typical section as shown in the Functional Plans. Design-Builder to provide hydraulic calculations (including spread calculations) to the Department.

All proposed slopes associated with the roadway shall be 2:1 or flatter and shall be sodded. For slopes steeper than 2:1, the Design-builder shall obtain TDOT concurrence on the slope protection.

All permanent and temporary safety appurtenances (sign supports, guardrail, barrier rail, impact attenuators, etc.) shall meet current TDOT standards and shall have all required Department certification documents.

Deviations and Exceptions

All proposed modifications require an Alternative Technical Concept (ATC) subject to Department approval. The Design-Builder shall not request more than eight (8) ATCs.

Deviations from the Functional Plans horizontal alignment (greater than 10.0 feet) will require an ATC with Department approval. The Design-Builder is responsible for any impacts resulting from deviations from the Functional Plans.

No design exceptions shall be allowed.

Guardrail and Barriers

The proposed guardrail, including any anchor system, shall be installed prior to opening traffic. All existing guardrail, within the construction limits, that does not meet current standards shall be upgraded to meet current standards. Guardrail shall be removed and replaced in accordance with the TDOT Standard Drawings and the latest edition of TDOT *Standard Specifications*.

All permanent and temporary safety appurtenances (sign supports, guardrail, barrier rail, impact attenuators, etc.) shall meet current TDOT standards and shall have all required Department certification documents.

All existing and new guardrail, guardrail attachments to bridge ends and/or concrete barriers, and end terminals within the project limits shall be MASH-compliant TL-3 and be on the Department's Qualified Products List (QPL).

The Design- Builder shall construct concrete barrier walls in accordance with the S-SSMB series of TDOT Standard Drawings.

Required guardrail and concrete barrier locations shall conform to the TDOT *Design Guidelines*, TDOT Standard Drawings, and/or the AASHTO *Roadside Design Guide*.

3.3 DRAINAGE

The Design-Builder shall analyze, design, and construct the entire stormwater management system within the Project limits, including bridges, stormwater conveyances (open-channel and closed-conduit), stormwater inlets, and stormwater collection systems in accordance with the Department's *Drainage Manual*.

- All stormwater runoff that flows through the Project, whether originating within or outside of the Project limits, must be accounted for in the design of the drainage system.
- The analysis, design, and construction of all components of the stormwater management system shall address the interim conditions during design and construction of the Project.

Drainage Design Requirements

The Design-Builder shall analyze, design, and construct the entire stormwater management system within the Project limits, including bridges, stormwater conveyances (open-channel and closed-conduit), stormwater inlets, and stormwater collection systems in accordance with the Department's *Drainage Manual*.

- All stormwater runoff that flows through the Project, whether originating within or outside of the Project limits, must be accounted for in the design of the drainage system.
- The analysis, design, and construction of all components of the stormwater management system shall address the interim conditions during design and construction of the Project.

The Design-Builder shall use a 50-year design storm for all new (and existing to remain) storm sewer systems in accordance with the Department's *Design Manual*.

- For any structure with a Q_{50} that exceeds 500 cfs, the Design Procedures for Hydraulic Structures shall be followed.
- All drainage systems shall be designed to convey the 50-year storm without overtopping of any existing or proposed drainage or transportation elements.

The Design-Builder shall design culvert and pipe outfalls, channels, and ditches (including special ditches) within the Project limits in accordance with requirements of the Department's *Drainage Manual*.

- Appropriate energy dissipation devices shall be designed at culvert outlets to prevent scouring and appropriate channel linings shall be designed such that erosion within and downstream of the channels and ditches is minimized.

- Energy dissipation devices shall be designed to fit within the proposed ROW.

The Design-Builder shall provide erosion control for construction of the Project per the guidelines specified in the Department's *Drainage Manual* and this Book 3.

The Design-Builder shall design the drainage system to accommodate construction staging. Spread requirements for temporary traffic control may be reduced to a 5-year storm event, however permanent conditions must meet the requirements of the Department's Drainage Manual. The design shall include temporary erosion control, sediment basins, and other Best Management Practices (BMPs) needed to satisfy NPDES, local municipality, and other regulatory requirements.

The design of stormwater management facilities shall be compatible with existing or any known proposed improvements to drainage systems on adjacent properties and shall preserve existing drainage patterns wherever possible.

If existing drainage patterns must be altered due to a temporary or permanent aspect of the design, the Design-Builder shall provide documentation of any/all impacts to upstream/downstream and/or adjacent properties and/or road crossings for Department's Review and Approval prior to alteration of existing drainage patterns. Survey data shall be collected for all upstream/downstream/adjacent properties that are impacted, such as road crossing information, structure damage elevations, and channel cross sections (at a minimum), and shall be used in support of hydraulic calculations for the offsite drainage systems. Engineering analyses and certifications shall be provided to the Department for Review and Approval prior to performing the alteration.

The Design-Builder shall inspect and verify that existing drainage systems to remain are clean, operable, and structurally adequate. Any repairs, replacements, debris removal, and/or deficiencies shall be corrected by the Design-Builder.

The Design-Builder shall analyze existing storm drainage systems to remain, culverts (boxes and cross pipes), and open channels within the Project Limits that are impacted by the Design Documents.

The Design-Builder shall replace or supplement any pipes or culverts that are deemed hydraulically or structurally deficient in the existing condition or as a result of this Project.

The Design-Builder shall replace damaged, destroyed, missing, or permanently attached castings on existing drainage structures. This shall include any structure located within the proposed roadway that is not already being modified or addressed within the proposed drainage Work or a structure which is within the Project limits, which is not being affected by any proposed drainage Work.

The Design-Builder shall embed culverts for aquatic organism passage for all streams in accordance with the requirements of FHWA Hydraulic Engineering Circular 26, "Culvert Design for Aquatic Organism Passage".

All new culverts and pipes for closed drainage system shall have a slope of not less than 0.5%.

The Design-Builder shall adhere to all permits, FEMA, and hydraulic design criteria when designing channel relocations, bridges, culverts, and culvert extensions. The Design-Builder shall use the TDOT *Drainage Manual* and TDOT *Design Procedures for Hydraulic Structures 2012*.

The Design-Builder shall re-grade existing ditches to remain in-place that are disturbed by construction by creating a straight-line profile along the centerline of the channel, as measured along the flow line.

The Design-Builder shall re-establish drainage in situations where sedimentation has changed the flow line from the existing profile. No work should be done to Waters of the State or US, which might appear to be a ditch, without proper permits.

3.4 PAVEMENT MARKINGS

The Design-Builder shall prepare pavement marking plans for the Department's concurrence. Pavement markings will be constructed for type and limits shown in the Functional Plans. The design and installation of permanent pavement markings shall be in strict accordance with the current edition of the Manual on Uniform Traffic Control Devices (MUTCD), TDOT Roadway Design Guidelines, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, and the current edition of the TDOT Standard Specifications. All pavement marking removal on final surfaces shall be accomplished by water blasting or another non-marring method. Any damage to the pavement surface caused by the selected method shall be removed and replaced at the contractor's expense.

Permanent pavement line markings shall be thermoplastic. Short unmarked sections shall not be allowed. Temporary pavement markings to be utilized for less than seven (7) working days may be painted. Temporary pavement markings to be utilized for seven (7) working days or more shall be spray thermoplastic or tape. On the final surface, the Design-Builder shall have the option of using temporary pavement markings installed to permanent standards at the end of each day's work and then installing the permanent markings after the paving operation is completed. All pavement markings beyond the immediate work area that are affected by the Work shall be reapplied to permanent standards.

3.5 SIGNING

The Design-Builder shall prepare signage plans for the Department's concurrence/review prior to ordering. Signs will be constructed as shown in the Functional Plans.

The design and installation of permanent roadway signs shall be in strict accordance with the current edition of the MUTCD, TDOT Roadway Design Guidelines and TDOT Standard Drawings, the current edition of the Standard Highway Signs, the TDOT Supplemental to the Standard Highway Signs, the current edition of the TDOT Standard Specifications, and TDOT Traffic Design Manual.

TN 511 signs (MUTCD Sign D12-5) shall be installed in accordance with TM 2509 – Project Information and 511 signs.

After the permanent sign locations have been staked, but prior to ordering any material for supports, there shall be a Field Review and Acceptance by the Department.

The Design-Builder shall verify all support lengths at the site prior to erection.

All sign sheeting shall be Type 3 Prismatic or better. All existing signs that do not meet the retro-reflectivity requirements shall be replaced. All yellow reflective warning signs shall be fluorescent yellow.

The Design-Builder shall furnish layout drawings of all extruded panel signs with spacing of all letters, numerals, shields, and arrows. The layout drawings shall be reviewed and concurred with by the Department prior to construction/installation.

All permanent signing plans; Signing Layouts, Sign Schedules, and Miscellaneous Detail Sheets shall be reviewed and concurred with by the Department prior to ordering and construction/installation.

All existing post-mounted signing shall be removed and replaced with new sign faces and new breakaway supports.

3.6 TRAFFIC SIGNALS

The Design-Builder shall construct the proposed traffic signals (including but not limited to cabinet, controller, traffic signal heads, wiring, detection equipment, conduit and pull boxes, traffic signal poles, and associated traffic signal timing and all other materials and methods required to provide a fully functional and operational traffic signal) at the following locations:

- Intersection of Eastbound I-24 off-ramp (Ramp 2) and on-ramp (Ramp 3) at Epps Mill Road
- Intersection of Westbound I-24 off-ramp (Ramp 4) and on-ramp (Ramp 1) at Epps Mill Road
- Intersection of Epps Mill Road at Forbus Drive

The Design-Builder shall design and construct traffic signals in accordance with Supplemental Specification 700SS (See **Contract Book 2 (Design-Build Contract)**), Special Provision 700SIG, the TDOT Traffic Design Manual, and Proprietary Item Requests and Justifications – City of Murfreesboro.

The Design-Builder shall coordinate the signals at the interchange using a fiber optic connection.

The Design-Builder shall coordinate with Jarrod Bonar, P.E., Assistant County Engineer, Rutherford County Planning & Engineering.

3.7 LIGHTING

The Design-Builder shall design and install full interchange lighting in the interchange. The installation shall provide relatively uniform lighting for the interchange. The design package shall include electronic design files using AGi32 software, layout sheets which illustrate the photometrics, and high-mast foundation information. The area of the interchange is defined as follows:

- Interstate 24 eastbound and westbound lanes from the eastern ends of the accel/decel lanes including tapers to western ends of the accel/decel lanes including tapers
- All four ramps of the interchange
- Epps Mill Road from the Interstate 24 eastbound terminal intersection to the Interstate 24 westbound terminal intersection

All lighting shall be 4000k LED lighting. The Design-Builder shall prepare lighting designs/plans in accordance with TDOT Standard Specifications for Road and Bridge Construction, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, Module 2, the latest edition to the National Electric Code, National Fire Protection Association (NFDA) 70, AASHTO Roadway Lighting Design Guide and the FHWA Lighting Handbook.

The mounting height for high-mast lighting shall be governed by the photometric analysis. However, the minimum requirement is 100' for high-mast poles.

The Design-Builder shall obtain all permits required for installation of interchange lighting.

No high-mast lighting poles shall be placed outside the interchange quadrants.

The distance between light poles and bridges must be a minimum of 50 feet.

All wiring shall be concealed underground in 2-inch schedule 40 PVC rigid conduit. The conduit shall be installed a minimum depth of 26 inches as measured from finished subgrade.

The ground wire shall be run inside conduit within structures, shall be colored green and have THW insulation.

The Design-Builder shall submit lighting photometrics for proposed roadway lighting sections to the Department for concurrence prior to ordering materials or beginning construction/installation.

The recommended values of the manufacturer shall be used for the total LLF. However, the total LLF cannot be less than 0.85 for LED.

3.8GROUND SURVEY

The ground survey including survey control will be provided by the Department.

The Design-Builder shall verify the ground survey and survey control before utilizing in the design of the project (See Section 1.3). In addition, the Design-Builder will be responsible for field surveys and support activities, such as, but not limited to geotechnical investigations, ROW stakeout, construction stakeout, etc.

If the Design-Builder's design footprint extends beyond the limits of the survey provided by the Department, the Design-Builder shall be responsible for securing the necessary additional survey.

All field survey activities shall be performed in accordance with the latest version of the TDOT Survey manual and any other applicable design standards previously referenced.

3.9 PAVEMENT DESIGN

The Pavement Design Schedule for this Project has been developed and is located in Appendix A.

Proposed pavements shall be constructed utilizing the pavement designs provided unless otherwise approved by the Department via the ATC process.

Prime Coat and Tack Coat are required and shall be applied as part of the Project.

4. STRUCTURES

The Design-Builder will be responsible for the design and construction of all structures within the Project limits including the bridge over Interstate 24 and retaining walls, as further described below.

4.1 BRIDGES

The Design-Builder shall be responsible for the design and construction of one (1) new bridge on Epps Mill Road over I-24. The Design-Builder shall be responsible for the demolition and removal of the existing bridge on Epps Mill Road over I-24 that this new bridge replaces.

Design Requirements

New bridges shall be designed and detailed using the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Tenth Edition (2024), and the AASHTO Guide Specifications for LRFD Seismic Bridge Design, Second Edition (2011) with all interims, and the TDOT Structures Division Structural Design and Memorandums.

Proposed Accelerated Bridge Construction (ABC) methods shall be submitted to the Department through an ATC for approval by the Department.

Precast, prestressed Girders shall be continuous for live loads. The final concrete beam strength shall be between 5,000 psi and 10,000 psi. If structural steel girders are used, they shall be designed continuous for all loads. Structural steel shall be A709 Grade 50W. Concrete for the bridge deck shall be Class "D" (f'c=4,000 psi) and meet the requirements of the Standard Specifications. The minimum slab thickness shall be 8.25" and all slab steel shall be epoxy coated. Concrete for substructures shall be Class "A" (f'c = 3,000 psi) and meet the requirements of the Standard Specifications. Other types of concrete required by the design from the Design-Builder shall meet the minimum design strength requirements and also the requirements of the Standard Specifications or any applicable Supplemental Specification or Special Provision.

All bridges shall be designed for HL-93 live loading increased by 10% (multiplied by 1.1) as specified in TDOT SDG-5-103.00. The bridge design shall include 35 pounds per square foot (psf) for a future wearing surface.

Bridge deck surface finish shall be in accordance with Method 3 of Article 604 of the Standard Specifications.

Pavement at bridge ends (See Standard Drawing STD-1-5) is required at all bridges.

End of bridge drains will not be allowed in the Pavement at Bridge Ends (approach slabs).

Abutments shall be of integral construction to eliminate joints at bridge ends.

The Design-Builder shall perform a hydraulic analysis for bridge deck drainage and shall meet the criteria in the TDOT *Design Procedures for Hydraulic Structures*.

Deck drains (if needed) shall be as shown on STD-1-2SS and follow the requirements of the TDOT *Design Procedures for Hydraulic Structures 2012*. Deck drains shall not discharge onto current or future

lanes or shoulders of Interstate 24. If used, a closed drainage system shall not be placed outside of the exterior bridge girders.

The Design-Builder shall submit shop drawings in accordance with the requirements set forth in the *Standard Specifications for Road and Bridge Construction* for bridge components, erection plans and calculations for concurrence by the Department. The shop drawings, erection plans, and demolition plans shall be submitted in a timely manner allowing ten (10) business days for the Department's review.

Should the Design-Builder elect to use drilled shafts, they shall be constructed in accordance with Special Provision SP625 Drilled Shaft Specifications.

The new structure over Interstate 24 shall be wide enough to incorporate the full roadway width as presented in Section 3.2 (three 12-foot lanes, two 8-foot shoulders, two 5'-6" sidewalks, and two STD-11-1 parapets). The new structure shall provide a minimum of 16'6" of vertical clearance as described in Section 3.2.

All guardrail (including guardrail terminal, anchor, and hardware) shall be MASH TL-3 compliant.

The Design-Builder shall conduct and submit a load rating analysis for each of the new bridges that are constructed. The load ratings are to be completed using AASHTOWare Bridge Rating (BrR) or CSi Bridge software and submitted with the Bridge Construction Plans for review. The load rating analysis report and load rating modeling file shall be updated for the as-built conditions with the final as-built plans. For a listing of the specific vehicles to be load rated as well as description of the report format, see the reference material on the project website.

All exposed concrete surfaces shall receive an applied texture coated finish of Mountain Gray (AMS STD-595A color No. 36440), except that the top and side of the rail facing traffic shall receive a White finish (AMS STD-595A color No. 37886).

Each abutment wingwall shall have a 2'-0" Tri-Star emblem as shown on TDOT Standard Drawing STD-8-6. If a bent is required for the Design-Builder's design for the bridge over Interstate 24, the end faces of the bent cap shall include a 3'-0" Tri-Star emblem as shown on the TDOT Standard Drawing STD-8-6.

4.2 RETAINING WALLS

Retaining walls shall be built in accordance with Special Provision SP624, Retaining Walls. The exposed face of all retaining walls shall receive an ashlar stone finish approved by the Department.

For cast-in-place concrete retaining walls, all exposed concrete surfaces shall receive an applied texture coated finish of Mountain Gray (AMS STD-595A color No. 36440).

The retaining wall locations, lengths, heights, and the beginning and end stations of walls as shown on the Functional Plans are approximate. The final locations, lengths, heights, and the beginning and end stations of all walls shall be determined by the Design-Builder.

5. INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

The Design-Builder shall prepare ITS design/plans and install ITS related equipment/structures as described herein in accordance with the TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Standard Specifications, TDOT Traffic Design Manual, TDOT ITS Project Development Guidelines and TDOT Special Provision SP725 in RFP Book 2 (Design-Build Contract). The following ITS elements are required, including all conduit, pull boxes, power and communication cables:

- 1 CCTV
- 1 RDS
- 1 Demarcation
- Wireless Communication Point-to-Point (P2P) Radio

5.1 FIELD INVESTIGATIONS

The Design-Builder shall be responsible for verification of existing conditions, including research of all existing TDOT Intelligent Transportation System (ITS) records/plans and all other ITS related information.

The Design-Builder shall coordinate with the electrical power companies and provide electrical power for all ITS devices included in the project. The Design-Builder shall pay all costs for providing electrical power service. In addition, the Design-Builder shall pay all electric service recurring costs for the ITS until Substantial Completion.

5.2 DESIGN REQUIREMENTS

Fiber and Electrical Power for ITS devices

The Design-Builder shall maintain the existing fiber conduit, electrical conduit and communications. If fiber conduit relocation is required, the Design-Builder shall design and install the relocated fiber line and splice it into the existing fiber line prior to the start of any roadway construction.

All fiber and electrical conduit shall be designed to minimize conflicts with or damage to other roadway items such as drainage structures, foundations, signing, lighting, guardrail, retaining walls, and landscaping.

The proposed fiber and power relocation designs shall be reviewed and receive concurrence from the Traffic Operation Division prior to ordering materials or beginning relocation.

Pull boxes for fiber optic trunk line shall be placed every 1,200 feet. Pull boxes must meet all requirements set forth in the TDOT Fiber Optic Standard Drawings. The ITS system redundancy shall be tested with TDOT TMC IT prior to fiber and power relocation.

CCTV

The Design-Builder shall install one (1) CCTV camera. All proposed CCTV camera poles shall be located outside of clear zone unless guardrail or barrier is present. Proposed CCTV camera poles shall not be placed in the median.

Radar Detection System (RDS)

The Design-Builder shall install one (1) RDS detection device. The new RDS detection device and support structure shall meet the requirements of Special Provision SP725.

When appropriate and possible, co-locate RDS detection devices with CCTV cameras to reduce the number of support structures to be installed. The Design-Builder shall ensure desired detection accuracy irrespective of the installation type. If co-locating with CCTV support structure, the Design-Builder shall coordinate with TDOT Region 3 to ensure location is easily accessible for maintenance of RDS and does not interfere with lowering the device.

The proposed RDS shall detect traffic in both directions of travel. All new RDS support structures shall be located outside of clear zone unless guardrail or barrier is present.

Wireless Ethernet Radio and Antenna (Point-to-Point)

The Design-Builder shall establish wireless radio communication to the nearest radio communication point on TDOT's ITS network located on the CCTV pole just east of the Elam Road bridge over I-24. The Design-Builder shall coordinate with the TDOT TMC ITS support team to ensure successful communication with the receiving radio. While initial investigation provides for the feasibility of wireless communication connectivity, the Design-Builder shall verify all wireless links for proper frequency, height and line of sight, based on the plan design, specifications, and accepted propagation study.

5.3 ADDITIONAL REQUIREMENTS

The Design-Builder shall use specific or compatible ITS software and hardware components to ensure networking and device connectivity and compatibility.

5.4 SUBMITTAL REQUIREMENTS

All ITS submittals, made as part of the project submittal program, shall be concurred with by the TDOT Traffic Operation Division.

The Department shall concur with the placement and location of all ITS field devices, structures and support pole locations prior to purchasing, construction or installation.

The Design-Builder shall submit all ITS designs/plans (ITS devices, support equipment, and support structures) to the TDOT Traffic Design Division, TDOT Traffic Operations Division, and TDOT Structures Division for concurrence prior to ordering materials or beginning construction/installation. Permitting for utility work shall follow the same process as outlined in Section 9.

In addition to the requirements set forth in Section 17.2.6 of Special Provision 725, as-built project plans shall also be submitted in PDF and DGN formats. The Design-Builder shall provide the TDOT Traffic

Design Division with a survey using Tennessee State Plane Coordinates showing the as-built location of all ITS related items along with any design calculations.

6. GEOTECHNICAL

The geotechnical exploration investigations shall be performed in accordance with the current *TDOT Geotechnical Guidelines* located on the Geotechnical Engineering Sections webpage on the Department's website:

https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/geotech/2023-10-GeotechGuidelines.pdf

The Design-Builder shall determine the amount and level of the geotechnical investigations to cover geological risks associated with this Project.

The Design-Builder shall perform a slope analysis for all proposed slopes.

The Design-Builder shall be responsible for obtaining the borings for all structural support and foundation locations where subsurface information is not sufficient or is warranted by variability in the geology. All borings shall be deep enough to show a complete soil and rock profile to the depth of the foundation-supporting layer. Refer to Chapter 3: Structural Foundation Deliveries, of the current *TDOT Geotechnical Guidelines.*

The Design-Builder shall collect appropriate field data and samples for geotechnical evaluation of embankments, subgrade, soil and rock cuts, culverts, bridge and retaining wall structures, storm water management structures and ponds, minor structures, including drainage pipes, and any other earth supported structures or elements of highway design and construction relevant to the Project. Refer to Section 2: Roadway Design Support, of the current *TDOT Geotechnical Guidelines*.

The Design-Builder shall perform all subsurface investigation and laboratory testing in accordance with the current *TDOT Geotechnical Guidelines*.

6.1 NOTIFICATION REQUIREMENTS

Any required lane, shoulder and/or ramp closures to perform geotechnical investigations must be approved a minimum of seven (7) days in advance by the Department and shall be in accordance with SP108B.

The Design-Builder shall notify the Department and all adjoining properties and stakeholders one week prior to commencing any activity on private property. A letter shall be mailed to all property owners where entry is needed. Property owner's names and addresses shall be obtained using the latest records available from the county Tax Assessor's office. To promote good relationships, a diligent effort shall be made to contact each property owner or tenant prior to entering the property. However, personal contact is preferable in order to explain that entry is required, the purpose of the activity, the activities involved and to determine facts pertinent to the activity.

The Department may limit when drilling activities or other geotechnical work including lane closures may occur within the Department's Right-of-Way.

The Department may require the Design-Builder to immediately halt drilling activities or other geotechnical work underway if in their judgement the Design-Builder's work causes a potential threat to the public safety or welfare.

The Design-Builder shall be required to provide traffic control for all drilling activities occurring within the Department's Right-of-Way including but not limited to lane, shoulder, and/or ramp closures.

6.2 GEOTECHNICAL REPORTS

The Design-Builder shall provide geotechnical reports, design and construction summaries that contain pertinent subsurface investigations, test, and engineering evaluations.

Prior to any geotechnical design submittal, as outlined in the *TDOT Geotechnical Guidelines*, the foundation design recommendation reports shall be sealed and signed by a Professional Engineer registered in the State of Tennessee who has completed a minimum of three geotechnical design projects of scope and complexity similar to that anticipated for this Project using the LRFD method and in accordance with the latest edition of the AASHTO LRFD *Bridge Design Specifications*.

7. RIGHT-OF-WAY

The Department has secured an approved Tennessee Environmental Evaluation Report (TEER) and the Department will acquire all Right-of-Way necessary to construct the project in accordance with the Functional Plans.

- The purchase of ROW will occur concurrent with the DB procurement and after Award, and conclude on or before February 28, 2027.

If the Design-Builder deems additional ROW, Permanent Easements, or Temporary Easements are needed outside of the secured ROW, the Design-Builder shall be responsible for performing all acquisition activities, including appraisals, appraisal reviews and acquisitions, and any required utilities coordination/relocation and acquisition of related permits. Any additional ROW acquisition shall be approved through an ATC.

The Design-Builder shall also be responsible for securing all approved environmental documents, ie. TEER, resulting from additional ROW, Permanent Easements, or Temporary Easements needed. The following explains the Design-Builder's responsibilities related to any additional right-of-way required.

7.1 ACQUISITION SERVICES REQUIREMENTS

If the Design-Builder requires Right-of-Way in addition to that provided by the Department, the following shall apply:

The Design-Builder, acting as an agent on behalf of the Department, shall provide ROW acquisition services for the Project.

The Design-Builder shall acquire property in accordance with all Federal and State laws and regulations, including but not limited to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (the "Uniform Act") the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs and (Part 24 of title 49 CFR). The acquisition of property shall follow the guidelines as established by the Department's ROW Procedures Manual (https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/ROW_Procedures_Manual.pdf).

ROW acquisition services shall include certified title reports, appraisal, appraisal review, negotiations, relocation assistance services, property management services, parcel closings and all related activities.

All appraiser(s), appraisal reviewer(s) and acquisition/relocation firms shall be selected from the Department's ROW Office's pre-qualified list.

The Department will retain authority for approving just compensation, relocation benefits and claims, administrative settlements, court settlements (settlement reached via the Attorney General's Office), and court awards.

The Department must issue an NTP with ROW Acquisition to the Design-Builder prior to any offers being made to acquire the property. This represents a hold point in the Design- Builder's Baseline Schedule.

The Department must also issue an NTP with Construction to the Design-Builder once the property has been acquired prior to commencing construction on the property. This also represents a hold point in the Design-Builder's Baseline Schedule.

The Design-Builder shall be responsible for all costs associated with the services provided by the appraiser(s), review appraiser(s), acquisition/relocation firm(s), title company, engineering and legal services related to the acquisition of ROW, the costs of any public hearings that may be required, administrative settlements, court fees associated with condemnations, and any other cost associated with the services related to the purchase of ROW. The Design-Builder's CPM schedule shall account the for the time required for this additional ROW acquisition process.

The Department will be responsible for the actual purchase price paid to property owners for the additional ROW property interest(s), whether such property interest(s) is acquired by fair market value purchase, approved administrative settlement, court settlement, or court award. The Design-Builder shall allocate 45 working days to process checks by the Department to be issued in the CPM schedule in addition to time required for other typical review processes.

7.2 TITLE REPORTS AND CLOSINGS

If the Design-Builder requires Right-of-Way in addition to that provided by the Department, the following shall apply:

The Design-Builder shall provide a current title report (no older than one hundred eighty (180) days) for each parcel at the time of the initial offer to landowner. Each title examination report shall be prepared by a Department-approved title company (each of the Department's Regional ROW Offices has a list of approved title firms). The Design-Builder shall furnish one (1) original and three (3) legible copies of a title report, including summary of 5-years sale history, on a form to be provided by the Department, designated as ROW Form-49, with copies of all recorded deeds, liens, selloffs, easements, subdivision plats, divorce decrees, wills, judgments, and other pertinent documents attached, for each numbered tract on the ROW plan. The Design-Builder shall furnish one (1) updating of the title report; the process of updating the title report will be performed as part of the closing.

In accordance with TCA 54-5-110, the Design-Builder shall cause the final Right-of-Way Plans to be filed and recorded in the office of the Register of Deeds in Rutherford County. The Design-Builder shall be responsible for reimbursement to the Design-Builder for the cost of recording the final Right-of-Way Plans.

The following terms and conditions shall also apply:

- Preliminary reports of title are required on all tracts for which a taking or an acquisition is shown on the acquisition table.
- Title insurance is not required.
- One (1) original and three (3) legible copies of the "Preliminary Report of Title" (Form 49) are to be submitted. All attachments must accompany the original and all three (3) copies.
- Reports must include information on all contiguous parcels of land which form a single tract under the same ownership.

- In addition to the information to be provided on the ROW Form-49, each preliminary report of title shall contain the tax map, and parcel number for the particular tract as well as the civil district in which the tract is located.In addition, include documentation of all Environmental Liens if they apply.
- The Design-Builder will furnish the correct mailing address of the property owner for each tract number. If the ROW plan is revised to add additional tracts from which there will be an acquisition as shown by the acquisition table, all services covered by this agreement are to be provided for those additional tracts.
- Facsimile of title report will not be accepted.
- Completion and filing of Form 1099 published by the Internal Revenue Service, is required in connection with closing of ROW acquisition.
- Copies of Tax Maps showing all tracts shall be included. These maps shall be complete, full-size sheets whenever possible.
- Copies of subdivision plots shall be included when the only deed description of an individual parcel consists of a lot number in the mentioned subdivision.
- Number the pages of each "Preliminary Report of Title".
- If any instrument is not legible on the provided copy, (attachments) then a typed legible instrument must accompany illegible copies.

The Design-Builder shall close all negotiated tracts on the Project. This service shall include:

- updating the title report to the time of closing;
- preparation of the warranty deed and any releases;
- preparation of a closing statement (ROW Form-24 provided by the Department);
- preparation of the deed transmittal statement (ROW Form-29 provided by the Department);
- preparation of the Tax Proration Form;
- preparation of the closing tract map;
- preparation of the W-9 form; and
- the preparation of the closing log form (ROW Form-17A provided by the Department)

The Design Builder is responsible for the arrangement of and making of such disbursements as may be necessary to cause the removal of property taxes, judgments and instruments constituting liens for money owed, and the recording of the warranty deed.

The Design-Builder shall be responsible for obtaining release of any liens or encumbrances including, but not limited to, any additional fees imposed by the lien-holder(s).

The Design-Builder agrees to discuss time and location for each proposed closing with the prospective grantor(s) and within reason to accomplish same in accordance with the grantor(s') advice. Normal closings are expected to take place within 45 calendar days of receipt of closing funds. Extenuating

circumstances requiring more than 45 calendar days will be reported by letter no later than the 45th calendar day from the receipt of funds. Requests for extensions beyond the normal accepted time will be considered on a case-by-case basis. Within 24 hours after closing, the Design-Builder shall notify Mr. Houston Greer, TDOT Region 3 ROW Transportation Manager 2, of this fact. All closings are to be done by personal contact, at a time and place that is convenient to the landowner. Where a closing by mail is requested, the written consent of the Department is required, except when the closing involves Out-of-State property owners.

7.3 APPRAISAL AND APPRAISAL REVIEWS

If the Design-Builder requires Right-of-Way in addition to that provided by The Department, the following shall apply:

The Design-Builder shall complete all appraisal services and work product to the standards set forth herein, with all costs to be borne by the Design-Builder. Failure on the part of the Design-Builder to complete each assignment according to said standards by the agreed upon due date shall be considered a material breach of this Contract.

The Design-Builder shall complete all appraisal services in accordance with TDOT's *Guidelines for Appraisers (https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/TDOT_Guidelines_for_Appraisers__06-30-15.pdf)*, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (the "Uniform Act"), the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs (Part 24 of title 49 CFR), the Uniform Standards of Professional Appraisal Practice [USPAP (Appraisal Foundation)], and Federal, State and local laws, rules, and regulations. Appraisal and Related Service shall include all or parts of the following: real estate appraisal, real estate appraisal review, real estate consultation, pre-trial conference, deposition, and court testimony, as further defined.

The Design-Builder shall furnish one (1) original and two (2) copies of each Market Data Brochure and each Appraisal Report. The Design-Builder shall also furnish one (1) additional copy of each appraisal report together with all exhibits and comparable data write-ups. This copy shall be clearly identified as the landowner's copy. Unless specifically directed otherwise in writing, all appraisal services products are to be delivered to Region 3 ROW office.

In addition to the standard photos of the subject property and exterior photos of the acquired improvements, the Design-Builder shall provide a typical interior photo of acquired/ affected structures having substantial contributory value (i.e. residences, commercial structures, large barns, etc.) Legible digital images are acceptable.

The Design-Builder shall update the appraisal report(s) on any tract(s) involved in condemnation to "date of possession" when requested to do so by the Department. Appraisal updates shall be completed within sixty (60) days after the request is made in writing by the Department. All such updates shall be in compliance with standards set forth above except that the standards in force as of the date of contract execution to conduct the updated appraisal service shall apply. The "update" appraisal request may require the Design-Builder to consider and include minor plan revisions and changes in market conditions.

Upon request by the Department, the Design-Builder's appraiser shall testify in any judicial or arbitration proceeding involving the determination of the value of the property, in support of the opinion of value of any and all of the property included in its appraisal report. Further, the Design-Builder agrees

to have its appraiser attend, as requested by the Department, any pre-trial conferences, meetings, depositions, etc. related to such proceedings. The Design-Builder shall be compensated for these litigation-related services in accordance with the Expert Valuation Witness Rates in effect at the time the service is rendered. The Expert Valuation Witness Rate Schedule may be adjusted periodically.

The Design-Builder and its appraiser shall execute disclaimers of any past, present or contemplated future personal interest in any of the properties included in the proposed agreement, as required by the Department, or if applicable, FHWA.

The Design-Builder shall maintain Errors and Omissions insurance in the amount of not less than one million dollars ($1,000,000.00) throughout the term of this Contract, and proof of which shall be made available to the State upon demand.

The Design-Builder shall provide appraisal reviews complying with technical review guidelines found in the Department's *Guidelines for Appraisers*, the Uniform Act, and (USPAP), and the Department's ROW Procedures Manual and make a recommendation of just compensation. The Design-Builder shall include a Fee Appraiser from the Department's prequalified appraiser list. The review appraiser shall also be on the Department's prequalified fee appraiser list. The Department shall have final approval of all the Design-Builder's ROW staff.

7.4 ACQUISITION, RELOCATION ASSISTANCE, AND PROPERTY MANAGEMENT

If the Design-Builder requires Right-of-Way in addition to that provided by The Department, the following shall apply:

The Department has an Appeals Advisory Board to hear any Relocation Assistance appeals. The Department agrees to assist with any out-of-state relocation by persons displaced within the rights-of-way by arranging with such other state(s) for verification of the relocation assistance claim.

The Design-Builder shall establish an acquisition/relocation office at a location that is accessible to the property owners and displacees on or near the project. The purpose of maintaining this office is to ensure effective and responsive service to meet the property owners' and displacees' needs. The office must be operational by the time acquisitions begin. The Design-Builder shall supply relocation and negotiation personnel with substantial experience in highway ROW acquisition, or similar work, in numbers sufficient to accomplish the required work in a timely manner. Design-Builder's ROW staff that performs acquisition and relocation/property management services shall be from the Department's pre-qualified consultant list for acquisition and relocation assistance and related services. All relocation and negotiation personnel are to be approved by the Department. After the Department has approved the personnel for a project, changes may only be made with the written approval of the Department. This office shall be staffed by persons knowledgeable of the Uniform Act and the Department's ROW Procedures Manual. This office shall be open during normal business hours and after hours by appointment.

The Design-Builder shall submit procedures for handling ROW acquisitions and relocations to the Department for concurrence prior to commencing ROW activities. This represents a hold point in the Design-Builder's Baseline Schedule. These procedures are to show the Design-Builder's methods, including the appropriate steps and workflow required for certified title reports, appraisals, appraisal review, negotiations, acquisition, relocations and parcel closings, and all related activities. These

procedures shall include the Department's review and concurrence of just compensation, administrative settlements, relocation benefits and claims.

A Department's Representative will be available to make timely decisions concerning establishing review and concurrence of just compensation, concurrence of administrative settlements, concurrence of relocation benefits and claims, on behalf of the Department. The Department's Representative is committed to issuing decisions on approval requests within sixty (60) calendar days. The commitment is based on the plan providing a reasonable and orderly workflow and the work being provided to the Department's Representative as completed.

The Design-Builder shall maintain accurate parcel files and, at the termination of the work on the project, turn over to the Department all relocation and negotiation files, appraisal and appraisal review files, and any other pertinent acquisition files, records or reports. All files shall be documented in accordance with the applicable State and Federal requirements. During the work on the project, the Design-Builder shall make all such files available, upon demand, for inspection by the Department and/or by the FHWA, when applicable.

The Design-Builder shall submit a project-specific Conceptual Stage Relocation Plan and an Acquisition Stage Relocation Plan for the Department's Review and Acceptance. The plan shall identify a prioritized schedule of ROW activities including but not limited to appraisal, appraisal review, the specific parcels to be acquired and all relocations. The plan shall allow for the orderly relocation of displaced persons based on time frames not less than those provided by the Uniform Act and/or the Department's *ROW Procedures Manual*. This plan shall be updated as necessary during the life of the Project.

The Design-Builder shall make the necessary relocation survey and promptly prepare and submit all required relocation documents in accordance with State and Federal regulations. The Design-Builder shall perform all relocations in accordance with the Uniform Act and the Department's *ROW Procedures Manual* as applicable.

The Design-Builder shall submit monthly status reports to the Department's ROW Division to manage and track the acquisition process. The status report must include but is not limited to the appraisal, appraisal review, and acquisition and relocation assistance status of all parcels. The Department's standard appraisal, appraisal review, acquisition and relocation assistance and property management forms and documents will be used as applicable.

The Design-Builder shall provide necessary property management services during the period of the Design-Builder's work, with all costs to be borne by the Design-Builder. Those property management services include, but are not limited to, private property owner utility adjustment cost estimates, salvage appraisals on improvements being acquired, moving cost determination, including the moving of on-premise signs and outdoor advertising devices, and determination and collection of rent after the "90-day" notice to vacate has expired.

The Design-Builder shall coordinate all work through the State's Regional ROW Transportation Manager 2 or his designated representative.

The Design-Builder shall recommend tracts for condemnation. When the Design-Builder recommends a tract for condemnation, the request for condemnation must have the necessary supporting documentation attached to properly completed forms as indicated by the Regional ROW Office. The

Regional ROW Office will check these forms and process this information to obtain a voucher. In general all voucher requests for any payment will be handled in this manner.

The Design-Builder shall conduct any public meetings as requested by the Department and as required by the Department's ROW procedures and practices.

The Design-Builder shall meet and coordinate with public officials of governmental agencies and civic groups as required or as requested by the Department.

The Design-Builder will be responsible for the costs associated with the payment to property owners for relocation benefits. The Design-Builder is also responsible for court costs associated with condemnation cases. The Department will make the initial deposit with the court in condemnation cases through the courts and will be responsible for the ultimate purchase price for the property by agreed settlement or court order. The Design-Builder will be responsible for all other payments during the condemnation process for court costs and any mediation. The Design-Builder will be responsible for disbursement of these payments and providing indefeasible title to the Department. All payments shall be made in accordance with the policies and procedures established in the Department's ROW Procedures Manual:

https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/ROW_Procedures_Manual.pdf

The Design-Builder shall prepare, obtain execution of, and record documents conveying title to such properties to the Department and deliver all executed and recorded general warranty deeds to the Department. For all property purchased in conjunction with the Project, title will be acquired in fee simple (except for the acquisition of slope, construction or permanent drainage easements, in lieu of fee simple title, with respect to any portion of the ROW, which must be concurred with by the Department's Design Division) and shall be conveyed to the Department, Grantee, by a Departments-approved general warranty deed, free and clear of all liens and encumbrances except encumbrances expressly permitted by the Department in writing in advance. All easements shall be acquired in the name of the Department.

Because these acquisitions are being made on behalf of the Department, the Department shall make the ultimate determination in each case as to whether settlement is appropriate or whether the filing of a condemnation action is necessary, taking into consideration the recommendations of the Design-Builder. When the Department authorizes the filing of condemnation, the Design-Builder shall prepare all required documents necessary to file and forward to the Department's Region 3 ROW Office.

The Design-Builder shall provide the necessary staff and resources as directed by the Department to work with the Department and the Attorney General's Office throughout the entire condemnation process until the property is acquired by settlement, by deed, or by Final Consent Judgment executed by the Department and the appropriate court. The Design-Builder shall provide updated appraisals (i.e., appraisal reports effective as of the date of possession) and expert testimony supporting condemnation proceedings upon request by the Department and/or the Attorney General's Office.

The Design-Builder will be responsible for all contacts with landowners for ROW and construction items and shall be responsible for properly setting all ROW monuments associated with the Project.

The Design-Builder shall maintain adequate access to all occupied properties to ensure emergency and personal vehicle access. Utility service must be available to all occupied properties at all times prior to and until relocation is complete.

During the acquisition process and for a period of three (3) years after final payment is made to the Design-Builder for any phase of the work, and until the Department has indefeasible title to the property, all Project documents and records not previously delivered to the Department, including but not limited to design and engineering costs, construction costs, costs of acquisition of ROW, and all documents and records necessary to determine compliance with the laws relating to the acquisition of ROW and the costs of relocation of utilities, shall be maintained and made available to the Department for inspection or audit. Throughout the design, acquisition and construction phases of the Project, copies of all documents/correspondence shall be submitted to both the Department Headquarters Office and the Department's Region 3 ROW Office.

The Design-Builder shall ensure no open burning will occur within 1,000 feet of an occupied dwelling.

The Design-Builder shall maintain a sufficient buffer or hold-off zone around parcels which have not been acquired and/or occupied properties to ensure compliance with ROW procedures prior to starting construction activities in these affected areas. There shall be no construction-related activities within the hold-off zone until the property is acquired and/or vacated. The Department will provide written notification before the contractor can enter the hold-off zone.

Fidelity Bond

If the Design-Builder requires Right-of-Way in addition to that provided by The Department, the following shall apply:

The Design Builder shall furnish a fidelity bond in the amount of $250,000.00 with the State being made the insured for the period of time from the first offer to the owners until all tracts have a recorded deed or vouchers submitted for condemnation, in such form as approved by the State. The bond shall indicate the State's ROW project number (both Federal and State numbers, if applicable).

Condemnation

If the Design-Builder requires Right-of-Way in addition to that provided by The Department, the following shall apply:

Property acquisition requiring condemnation shall be handled by the State Attorney General's Office. TDOT has no control over the timeframe for the condemnation proceedings. The Design-Builder shall anticipate time for condemnation proceedings. The Design-Builder is solely at risk for any delays for right-of-entry associated with condemnation proceedings.

8. UTILITIES

As defined in CI/ASCE 38-02, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, the Department has performed a utility quality level D subsurface utility explorations (SUE) for this Project. With the exception of the locations listed in section titled "Coordination Responsibilities", this information is provided to the Design-Builder for use as preliminary estimate of the horizontal and vertical locations of the existing utilities within the Project limits.

- A Project Utility Information Report is provided for reference only on the Project website and reflects the most current information available to the Department. Utilities that may potentially be in conflict with the Project are depicted in the appropriate rainbow color.

8.1 UTILITY INVESTIGATIONS

The Design-Builder shall be responsible for identifying any utility conflicts, coordinating with the utilities in the design of the relocated facilities, and preparing construction plans for the relocation of the utility facilities as required to accommodate the proposed Project design. Exact locations shall be determined in the field by contacting the utility companies involved and additional SUE investigations as necessary. Notification by calling the Tennessee One Call System, Inc., at 1-800-351-1111 as required by TCA 65-31-106 is the responsibility of the Design-Builder.

The Design-Builder shall make all reasonable efforts to design the Project to avoid conflicts with utilities, and minimize impacts where conflicts cannot be avoided.

The Design-Builder shall at all times be responsible for verifying all information related to the survey information as to the location (both vertical and horizontal of the Utilities). The providing of information by the Department shall not relieve the Design-Builder of this obligation, nor transfer any of that responsibility to the Department.

8.2 GENERAL REQUIREMENTS

The Design-Builder shall be familiar with 1680-6-1 Rules and Regulations for Accommodating Utilities within Highway Rights-of-Way, Tennessee Code Annotated (TCA) Part 8 Relocation of Utilities 54-5-801 through 54-5-856, and 23 CFR Part 645 "Utilities". Adherence to the above referenced regulations and procedures is mandatory.

Utility facility relocations will require the proposed plans to be submitted to the Department as an Application and Utility Use and Occupancy Agreement for review and issuance of permits for the accommodation of utilities within highway right-of-way. The Design Builder, with the consent of the utility, can make that submittal on behalf of the utility after the review and approval by the utility of the utility relocation plans.

The Design-Builder must utilize a firm which is prequalified with the Department to perform utility coordination services.

Immediately after submittal of the accepted final Definitive Design Plans, the Design-Builder will use the "Local Government Guidelines for the Management of Federal and State-Funded Transportation Projects," issued by the Program Development and Administration Division Chapter 6.2 as a guide to utility coordination. In compliance with the statute (TCA 54-5-854), a minimum of 120 -165 calendar days will be included in the Critical Path Method Schedule for Utility Investigation.

The Design-Builder shall utilize a single dedicated person responsible for managing all utility coordination and required concurrence with the TDOT Utility Office. The Utility Coordination Manager shall have the following knowledge, skills, and abilities:

A minimum of 4 years of experience performing utility coordination in accordance with TDOT standards, policies, and procedures.

Knowledge of the Department plans production process and utility coordination practices.

Knowledge of aforementioned rules, regulations, and codes.

8.3 COORDINATION RESPONSIBILITIES

Prior to submitting the bid, the Design-Builder will be solely responsible for contacting owners of all affected utilities in order to determine the extent to which utility relocations and/or adjustments will have upon the schedule of work for the Project. While some work may be required in the vicinity of utility facilities that will remain in place, other utility facilities may need to be adjusted concurrently with the Design-Builder's operations.

The Design-Builder shall be responsible for confirming the utility locations, confirming the type of facilities, identifying the utility owners and determining the cost responsibilities in order to coordinate the relocation of any utilities in conflict with the Project with respect to the "General Requirements" section.

The Design-Builder shall notify each individual utility owner of their plan of operation in the area of the utilities. Prior to commencing work, the Design-Builder shall contact the utility owners and request them to properly locate their respective utility on the ground. This notification shall be given at least three (3) business days prior to commencement of operations around the utility in accordance with TCA 65-31-106.

The Design-Builder shall coordinate the relocation or adjustment of the utilities in accordance with the RFP. The Department will process and certify all compensable utilities. The Design-Builder shall process and certify all non-compensable utilities for potential conflict and/or relocations. The Department will be the approving authority for all utility permits, compensable agreements and acceptance of utility relocation plans.

The following Utilities have been identified by the Department as having facilities within the Project corridor for which the Department contemplates an adjustment, protection, or relocation is possible.

Utility	Owner	Contact	Phone Number
Electrical	Middle Tennessee Electric	Christopher Weaver	615-566-8035

Water	Murfreesboro Consolidated Utility District	Will Steele	615-225-3313
Sewer	Murfreesboro Water Resources Department	David Pendley	615-796-9635
Petroleum Pipeline	Colonial Pipeline Company	Robert Jack	678-223-5020
Fiber Optic	Lumen (Century Link)	Michael Schryer	931-580-4648
CATV	AT&T	Kenneth Kornegey	615-631-7221

8.4COMPENSABLE UTILITIES

The Department shall make the necessary arrangements with the utility owners on compensable utilities identified and submitted by the Design-Builder and the Design-Builder shall make the necessary arrangements with the utility owners for all non-compensable utilities including new installations required for the Project, adjustments, relocations or removals where the Design-Builder and utility company determine that such work is essential for highway safety and performance of the required construction.

The Design-Builder shall be responsible for determining the cost responsibility (compensable or non-compensable utilities) for the utility relocations. The Department will be responsible for non-betterment (compensable utilities) utility relocation cost when the utility company has prior rights-of-way or compensable interest. The utility company shall be responsible for the relocation costs if they cannot furnish evidence of prior rights- of-way or compensable interest (non-compensable utilities) in their facilities. The Design-Builder shall be responsible for all costs associated with utility relocations due to haul roads and/or any other temporary conditions resulting from the Design-Builder's methods of operation or sequence of work.

If the Design-Builder elects to make arrangements with a utility company to incorporate a new utility installation as part of the highway construction, or a relocation not addressed above, then this utility work done by the Design-Builder and the associated costs for the work shall be negotiated and agreed upon between the Design-Builder and the utility company.

If the Design-Builder is requested, in writing, by an entity to relocate, upgrade or incorporate new facilities as part of the highway construction, designs shall be coordinated with the utility owner, and the Department. The associated design and construction costs shall be negotiated and agreed upon between the Design-Builder and the utility company. Environmental permitting for utility work construction shall follow the same process as outlined in Section 9. Any and all design permits for utility facilities, such as water and sewer permits from TDEC, will remain the responsibility of the utility to obtain and provide to the Design-Builder.

No additional compensation or time shall be granted for any delays, inconveniences, or damage sustained by the Design-Builder or its Subcontractors due to interference from utilities or the operation of relocating utilities.

8.5 ADDITIONAL REQUIREMENTS

The Design-Builder shall accommodate utility adjustments, reconstruction, new installation and routine maintenance work to be performed by others that may be underway or take place during the progress of the contract.

In the event of a utility conflict, the Design-Builder shall request that the utility company submit relocation plans (plans to be provided by the Design-Builder to Utility Owners) that show existing utilities and proposed utility relocations.

The Department will be the approving authority for all utility permits, agreements and acceptance of plans.

The Department Utility Office must execute approved agreements on Design-Build highway projects. The Utility Relocation Agreements (Cost Agreement) and encroachment permit agreements are available from the Department.

Sampling, testing, monitoring and reporting shall be performed by the Design-Builder in accordance with standard industry practices for water, wastewater, oil, and gas and in accordance with the Utility Owner's standard specifications and requirements.

8.6 CONSTRUCTION REQUIREMENTS

The Design-Builder shall provide all necessary protective measures to safeguard existing utilities from damage during construction of this Project. In the event that special equipment is required to work over and around the utilities, the Design-Builder will be required to furnish such equipment.

Any damage to the existing facilities associated with the construction activities shall be the sole responsibility of the Design-Builder to repair the damaged utility at no additional cost to the Department or the respective Utility Owner.

9. ENVIRONMENTAL

The Department has secured an approved Tennessee Environmental Evaluation Report (TEER). The Design-Builder shall review and adhere to the approved TEER document and technical reports; specifically, any environmental commitments listed on the "Green Sheet" of the approved TEER document. These commitments are to be adhered to throughout the design and construction process. The TEER document, including the "Green Sheet" environmental commitments, are provided on the Project website. All commitments listed with respect to their technical area are to be fulfilled prior to construction work (as applicable).

If the Design-Builder's design footprint extends beyond the study area and/or changes to impacts to identified resources, the Design-Builder will be responsible for the additional environmental technical studies and re-evaluation of the TEER document.

No additional time will be allotted to the Project schedule for the Design-Builder's preparation of the TEER document re-evaluation, TDOT Environmental Division staff's review and concurrence of the TEER document re-evaluation, or agency coordination.

9.1 ENVIRONMENTAL BOUNDARIES

The Design-Builder shall make certain all features from the Environmental Boundaries Report (EBR) are field verified by a Tennessee Qualified Hydrologic Professional (TN-QHP) and an updated EBR is prepared as necessary. The Design-Builder may refer to the following web page for information and minimum qualifications concerning TN-QHP: https://tnhdt.org/page.asp?Title=Info

For impacts to any streams, springs, wetlands, sinkholes or other water resource features identified during construction, and not previously documented in the original EBR, it shall be the responsibility of the Design-Builder to provide the data sheets and forms listed below to the Department's Region 3 ETO for review prior to submittal to the regulatory agencies:

Streams

- Hydrologic Determination Field Data Sheet (Version 1.4)
- Ecology Water Resources Field Data Sheet
- Tennessee Division of Water Resources Moderate Habitat Assessment Field Data Sheet
- A location map, marked up plan sheets, and a U.S. Geological Survey (USGS) Quad map showing the proposed stream(s) using Department-provided map templates
- Photo summary of each feature including photo views of the location of the proposed alteration, upstream, downstream, and along the centerline of the Project.

Wetlands

- Wetland Determination Data Form (U.S. Army Corps of Engineers, (USACE)) – Eastern Mountain and Piedmont Region: Version 2.0

- Tennessee Division of Water Resources: Tennessee Rapid Assessment Methodology (TRAM) documentation for wetlands including: TRAM Decision Key, TRAM Outstanding Natural Resource Water or Exceptional Tennessee Water Decision Table, appropriate HGM field data forms (if applicable) or Non-HGM field data forms (if applicable) for the wetland type being assessed, and TRAM Quantitative Summary Table.

- A location map, marked up plan sheets, and a USGS Quad map showing the proposed wetland(s) using Department-provided map templates.

- Photo summary of each feature including photo views of the location of the proposed alteration and wetland boundaries.

If an updated EBR is required, it shall be completed in accordance with Department practices. The Design-Builder shall be responsible for obtaining any necessary Documentation Standards from the TDOT Environmental Division.

Water resource determinations shall be completed by a Tennessee Qualified Hydrologic Professional (TN-QHP). The certification for the TN-QHP must be submitted along with the Hydrologic Determination Field Data Sheet for the individual preparing the data sheets and forms. All additional environmental field studies are to be performed by the Design-Builder's personnel with the required qualifications.

9.2 STATE OR FEDERAL ENDANGERED/THREATENED SPECIES

As noted in the approved TEER document, TDOT has determined the Project is Not Likely to Adversely Affect the leafy prairie clover (Dalea foliosa), and has No Effect on other listed species.

If the Design-Builder makes changes to the plans, construction methodology, and/or ROW, this will immediately require additional review(s) of the proposed changes by the U.S. Fish and Wildlife Service (USFWS), Tennessee Wildlife Resources Agency (TWRA), and the Tennessee Department of Environment and Conservation (TDEC) Division of Natural Areas. The Design-Builder shall contact the Department's Region 3 Environmental Tech Office prior to any coordination. If TWRA or USFWS requires any species surveys, sweeps, or transplants, the Department will require the Design-Builder to perform the work. The Design-Builder must provide the following to the Department's Region 3 Environmental Tech Office before starting coordination with the USFWS and TWRA.

- Surveys will be conducted as appropriate, depending on the species. The Design-Builder's biologist shall prepare a sampling plan as recommended by the USFWS,TWRA, and/or TDEC Division of Natural Areas. The plan shall include (at a minimum) the techniques, equipment, analytical techniques or metrics (e.g., IBI, TMI), time frame, staff qualifications, and the appropriate collection permits identification numbers (if applicable).

- A sweep is generally associated with fish, mussels, or crayfish; and is typically conducted immediately prior to commencement of construction work in the water. The sweep is performed the same day as installation of the coffer dams or when the work is being done in the water. A plan describing the methods for conducting the sweep will be required. All sweep methods and procedures must be coordinated with USFWS and TWRA prior to the sweep.

- A translocation plan, if applicable, shall be submitted to the USFWS (for Federal- listed plants) and the TDEC Division of Natural Areas (for State-listed plants) for approval. This will include,

at a minimum, a description of the translocation site including the ownership of the parcel, the technique for moving the plants, the proposed relocation site, the time frame for the move, long term protection strategies at the translocation site, and the qualifications of the staff involved.

The Design-Builder shall be responsible for any additional project commitments required by the resource agencies as a result of the additional agency review and coordination. These commitments may include but are not limited to: preparation of species reports or biological assessments, any species surveys, species sweeps and relocations, additional prohibitions on work during designated time periods, and any required species monitoring.

The Design-Builder shall (in consultation with the Department) allow time in the CPM for the Department's Region 3 Environmental Tech Office to coordinate with TWRA, USFWS, and the TDEC Division of Natural Areas, if required.

Migratory Birds

The Design-Builder shall perform all construction work in observance of the Migratory Bird Treaty Act (MBTA) of 1918 (last amended in 1998) wherein all migratory birds, with the exception of pigeons and starlings, are protected.

If migratory birds' nest or roosts are observed the Design-Builder's biologist should use best professional judgment regarding the nesting behaviors and social tendencies of the species in question (i.e., solitary vs. colonial, etc.) to determine what constitutes a significant concentration of nesting birds. Some examples of nesting populations include heron rookeries, turkey vulture roosts, and cliff swallow nests on bridges. The definition of significant concentration will vary depending on the species. For example, a single robin or bluebird nest would not be significant, but a single bald eagle nest or twenty cliff swallow nests may be.

Rare Plant Species

If impacts to the rare plant species listed on the Species Form of the EBR or their habitats are unavoidable, the plans must include measures to translocate the species to a suitable, high-quality mitigation site as noted above. Due to the uncommonly high concentration of rare plant species in the wetlands around the project, the Design-Builder must submit the plans to the Department's Region 3 Environmental Tech Office for coordination with TDEC's Division of Natural Areas for their Review and Approval prior to commencing work or translocation in these areas.

9.3 OTHER NATURAL RESOURCES

The Design-Builder shall ensure identification, survey and monitoring of other natural resources such as sinkholes, caves or specialized habitats. The Design-Builder shall coordinate with the Department's Region 3 Environmental Tech Office for coordination with regulatory agencies (i.e. TDEC) when necessary and obtain any necessary permits for modifications to the natural resources (i.e. TDEC Underground Injection Control Permit, etc.).

9.4 GPS/GIS DATA COLLECTION

The Design-Builder's data collection for streams, wetlands, springs, sinkholes or other jurisdictional features shall be with mapping grade accuracy (defined as sub meter).

9.5MITIGATION OF STREAMS AND WETLANDS

The Design-Builder shall be responsible for any and all compensatory mitigation of impacts to environmental features (streams and/or wetlands) for the Project as documented in the initial EBR, or additional features identified prior to and during construction. The Design-Builder shall be responsible for all costs associated with obtaining mitigation. This may include (but is not limited to):

- Planning;
- TEER Technical Studies and required TEER Re-evaluations;
- Right-of-Way or Real Property Protection (see Appendix F of the 2019 TDEC Stream Mitigation Guidelines dwr-nr-g-01-stream-mitigation-guidelines-052019.pdf)
- Design;
- Permitting;
- Construction of on-site/off-site mitigation for stream and/or wetlands impacts;
- Post-construction monitoring and maintenance of the mitigation sites;
- Purchasing stream and/or wetland mitigation credits from an approved bank/organization.

Construction of linear transportation and utility projects requiring State and federal permits have the potential to impact and degrade streams. These impacts often result in loss of aquatic resource values, including stream length, hydrology, available habitat, and other beneficial ecological and physical characteristics. If the proposed design impacts a stream that results in a loss of aquatic resource value, the Design-Builder shall use the most current mitigation guidelines in the State of Tennessee to assess mitigation needs. Currently, state and federal agencies approve the use of the Tennessee Stream Quantification Tool (SQT) and Tennessee Debit Tool (TDT) to determine the existing condition for each impacted reach and the amount of mitigation needed. It is essential that the Design-Builder retain a consultant with experience collecting this type of data to prevent revisions resulting in delays in obtaining permits. The Design-Builder shall provide all documentation as outlined in the SQT and TDT to the Department's Region 3 Environmental Tech Office for review before submittal to the Tennessee Department of Environment & Conservation or U.S. Army Corps of Engineers. For guidance on data collection, worksheets needed, etc., see the Tennessee Department of Environment & Conservation web page for Compensatory Mitigation for Streams and Wetlands. https://www.tn.gov/environment/permit-permits/water-permits1/aquatic-resource-alteration-permit--arap-/permit-water-arap-compensatory-mitigation.html

If required, constructed mitigation sites and stream relocations shall be constructed within the first six months once construction activities have started. Mitigation sites and stream relocations shall be completed in time to allow for the Design-Builder to complete at minimum one year of monitoring. This monitoring shall be conducted in full prior to completion of construction activities. Monitoring does not start until all components of the mitigation plan(s) have been installed /constructed. As stated above, the Design-Builder is responsible for all maintenance and monitoring of the mitigation site / stream relocation. The Department will monitor these sites after the project completion date for the remainder of the monitoring period outlined in the permits. During the remainder of the monitoring period, outlined in the permit, if TDOT, USACE or TDEC identifies any deficient or failing mitigation measures, it shall be the responsibility of the Design-Builder to perform corrective actions.

The Design-Builder shall provide mitigation for any impacts to environmental features (streams, wetlands, etc.) in accordance with state and federal regulations, such as the 2008 Federal Mitigation Rule (40 CFR Part 230, Compensatory Mitigation for Losses of Aquatic Resources).

All stream and wetland mitigation shall follow the current requirements outlined in the most current Stream Mitigation Guidelines for the State of Tennessee (available at dwr-nr-g-01-stream-mitigation-guidelines-052019.pdf), prepared by the TDEC, Division of Water Resources Permits Section and federal mitigation requirements of the Department of the Army, Corps of Engineers 33 CFR Parts 325 and 332. All proposed stream and wetland mitigation shall be submitted to and coordinated with the Department's Region 3 ETO and the Headquarters Environmental Mitigation Office for coordination with regulatory agencies prior to the submittal of the permit application. It shall be the responsibility of the Design-Builder to make any and all adjustments deemed necessary by the regulatory agencies to the proposed mitigation plan.

The Design-Builder shall be responsible for all on-site/off-site mitigation requirements listed in the permits and all costs associated with mitigation requirements.

9.6PERMITTING

The Department has not procured, nor will the Department procure, permits for the Design-Builder. The Design-Builder shall determine all of the permits required in order to perform the work.

The Design-Builder shall be solely responsible for and obtain any necessary state and federal environmental permits or approvals resulting from their design and construction. If environmental permits are necessary; prior to completion of the Definitive Design Plans, the Design-Builder shall contact the Department Alternative Contracting Office immediately for guidance. The Department's Region 3 Environmental Tech Office (ETO) and TDOT HQ Permitting Office shall be included in all correspondence and/or negotiations with agencies. The Region 3 ETO will be the lead Department contact concerning Water Quality Permitting.

The Design-Builder shall be solely responsible for complying with and obtaining any necessary building, demolition, grading, and environmental permits or approvals, including but not limited to archaeology, ecology, historical, hazardous materials, air and noise, TVA 26a, TDEC ARAP/401, USACE Section 404, and TDEC National Pollution Discharge Elimination System (NPDES) permits, from federal, state and/or local agencies regarding any material and staging areas and the operation of any project-dedicated asphalt and/or concrete plants, and any waste or borrow areas that will be used. Any such permits shall be supplied to the Department's Region 3 ETO prior to the commencement of activities in the permitted area(s).

The Design-Builder is responsible, under the laws and regulations listed above, to avoid and minimize, to the maximum extent practicable, impacts to Waters of the State and/or Waters of the U.S. when designing and constructing the project. Avoidance and minimization of impacts are beneficial to the Design-Builder because such actions avoid or reduce the amount of compensatory mitigation that may be required to obtain water quality permits prior to construction.

If environmental permits are necessary prior to completion of the Definitive Design Plans, the Design Builder shall contact the Department's Alternative Contracting Office immediately for guidance.

The Design-Builder shall obtain and pay for all regulatory permits as required by applicable laws, the plans, or contract specifications. This includes stormwater discharges associated with construction

support activities including, but not limited to: equipment staging yards, material storage areas, excess excavated materials disposal, demolition disposal (waste) areas, and borrow areas. These areas are to be addressed in accordance with the TDOT Procedures for Providing Offsite Waste and Borrow on Construction Projects (current version). The Design-Builder shall be cognizant of and adhere to the requirements of the various permits that will be necessary for construction and operation of the Project.

Applying for and Obtaining Permits

The Design-Builder shall be responsible for preparing all documents (permit application package) and attending all public meetings necessary to obtain the environmental permits required for the construction of this Project. TDOT application templates will be provided to the Design-Builder and shall be used in the permit application package.

The Design-Builder shall acquire information and prepare permit drawings/sketches that reflect the impacts and minimization efforts resulting from the Design-Builder's design of this Project. If water quality permits are required, there shall be scheduled reviews of permittable plans, application, and permit conditions by the Department's Region 3 ETO and upon request, Headquarters Environmental Division Permitting Section to ensure regulatory practices are consistent. TDOT will review the Design-Builder's permits, permit applications, and permit documents within ten (10) business days.

The Design-Builder shall schedule a pre-application meeting with the permitting agencies to discuss the project and impacts to water quality features before submittal of the water quality application. The Department's Region 3 ETO and HQ Permits Office shall be included on any correspondence or meetings with the permitting agencies.

The Design-Builder shall be responsible for developing the permit application for all jurisdictional water resource impacts. The Design-Builder shall be responsible for all public notice requirements such as documentation to be placed in the local paper and in the field and answering of public notice comments. The Design-Builder shall employ all personnel that it deems necessary in order to provide permit compliance.

The Design-Builder shall submit the permit application in its own name and ensure the permit is issued in its name. If under the applicable laws and regulations, the permit application cannot be submitted in the Design-Builder's name, the Design-Builder shall submit the permit application as an Authorized Agent of the Department and ensure the permits are issued with the Department as the Permittee. The Design-Builder shall attend a final review meeting with the Department to review all permit applications prior to submitting the application to the permitting agencies.

Environmental permits may also be required when activities such as core sampling, seismic exploratory operations, geotechnical investigations, ROW fence replacement, utility relocations, and historic resources surveys are within Waters of the State or Waters of the U.S. These permits may also be required for placement and operations of scientific measurement devices.

The Department's Region 3 ETO and Headquarters Environmental Division Permitting Section shall be invited to any meeting between the Design-Builder and the respective regulatory agency to discuss issues related to the application for (or refusal of) a permit. The Design-Builder shall inform the Department a minimum of ten (10) business days in advance of the time and location such a meeting is to take place and provide a meeting agenda five (5) business days in advance of the meeting.

The Design-Builder shall represent the Department in any proceedings relating to reservations, objections, appeals and/or applications for preliminary injunctions initiated by others against the permit

application or by itself against the permit decision. In such proceedings, the Design-Builder shall do everything in its power to defend the submitted application.

If any regulatory agency rejects or denies the permit application, it is the Design-Builder's responsibility to make the necessary revisions to ensure the permit is approved. If revisions are required to obtain permits, there should be scheduled reviews of the revisions by the Department's Regional ETO and upon request, the Headquarters Environmental Division Permitting Section to ensure regulatory practices are consistent. The Design-Builder shall be responsible for preparing designs and proposing construction methods that are permittable. All permits required for a particular construction activity shall be acquired prior to commencing the particular construction activity. All costs and delays associated with incomplete permit packages, agency rejection, agency denials, agency processing time, or any permit violations shall be the responsibility of the Design-Builder and will not be considered sufficient reason for time extension.

The Design-Builder shall plan, implement, monitor and maintain all applicable Erosion Prevention and Sediment Control (EPSC) measures and Best Management Practices (BMPs) in accordance with all TDOT standards during construction. The Design-Builder shall bear all cost and risks associated with applying for, obtaining and complying with permits.

Permit Application Package Contents

The permit application package (applicable for USACE §404, TVA Section 26a, and TDEC ARAPs) shall include, but not be limited to, the following information:

- TDOT Application Templates or an Approved Equal which meets all required Sections of the Agencies Applications forms (i.e. TDEC CN-1091, USACE ENG 4345, NPDES NOC, etc.);
- A signed application cover letter to the TDEC Division of Water Resources, Water Permits Section and the USACE. The application cover letter shall include alternatives for each impact to environmental features, proposed methods utilized by the Design-Builder to minimize impacts to each environmental feature, and proposed mitigation for impacts to environmental features (if required);
- Copy of signed TDEC ARAP CN-1091 form (the originally-signed CN1091 form shall be submitted to TDEC);
- Copy of Signed USACE ENG Form 4345 (if applicable). The originally signed form shall be submitted to the USACE. Feature impact tables (including summary table if the application includes any site with mitigation);
- Signed DA/TVA form or DA form (if applicable);
- Signed TVA Applicant Disclosure Form (if applicable);
- TN Debit Tool (utilizing the data collected by SQT Method) datasheets showing project related impacts. Separate tables may be required if TDEC and USACE impacts differ. Refer to TDEC's website listed above on TN SQT (if needed for mitigation);
- Labeled USGS color quadrangle map;

- Permit sketches for each impact. If the project has an USACE Individual Section 404 Permit, the names and addresses of all property owners adjacent to all impacts must be provided on a separate permit sketch. Permit sketches shall be prepared in accordance with the TDOT Design Guidelines;
- Compensatory Mitigation and Monitoring Plan for all streams and wetlands (if applicable). This includes in-lieu-fee and bank credit reservations letters, Permittee Responsible Mitigation design and narrative (known as a 12-step) and wetland debit sheet;
- A copy of the Environmental Boundaries Report as well as any revisions or additions. The EBR needs to be completed and all agency coordination and comments have been finalized. The final EBR shall include all the documentation indicated in Section 9.2 as well as TN-SQT data. An approved PJD or AJD along with TDEC verification is also required;
- A copy of approved TEER Document including all Section 106 clearances;
- Provide a Federal Emergency Management Agency (FEMA) flood insurance rate map (FIRM) for the subject project with construction limits labeled if not included in the TEER Environmental Document. Include with the application any FEMA No-Rise Certification letter, Conditional Letter of Map Revision (CLOMR), and/or Letter of Map Revision (LOMR), if applicable; and
- Include a half-size set of roadway plans and bridge layouts showing all environmental features. The plans shall be highlighted to distinguish between existing and new work. Environmental Division Permits Section uses the following guidelines:
    - New culvert construction (extensions included) including endwalls and rip-rap shall be highlighted in orange on the proposed layout.
    - Existing culverts shall be highlighted in blue on the present layout (blue on the proposed layout if sections are remaining).
    - Stream inlet and outlet protection measures and channel transitions shall also be dimensioned, labeled on the plans, and recorded in the impact table.
    - Streams/springs shall be highlighted in blue on the present and proposed layout.
    - Wetlands shall be highlighted on present layout (green for permanent impacts and yellow for temporary impacts). Be sure to label plans accordingly.
    - Bank stabilization, outfall structures, and sinkholes shall be highlighted in pink on proposed layout.
    - General Notes, Special Notes, Project Commitments sheet, and EPSC plans with the roadway plans shall also be included.

Any temporary construction measures, including de-watering, construction access, haul roads, EPSC measures, temporary crossings, stream diversions, etc. shall be addressed in the permit application. The Design-Builder shall clearly indicate the location of and impacts from haul roads on jurisdictional areas. The Design-Builder shall identify all proposed borrow and waste sites and provide all clearance documentation per the TDOT Procedures for Providing Offsite Waste and Borrow on Construction Projects (current version):

https://www.tn.gov/content/dam/tn/tdot/construction/old_web_page/WasteBorrowManual.pdf

These details shall be included in the permit application data. Further, the Design-Builder shall describe the methods of construction of all structures.

NPDES Permit Specific Requirements

A TDEC National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction stormwater runoff is required for this Project. It shall be the responsibility of the Design-Builder to develop final EPSC sheets, a Storm Water Pollution Prevention Plan (SWPPP) and obtain the NPDES CGP for the Project.

The Design-Builder shall schedule a pre-application meeting with TDEC to discuss construction phasing of the project and estimated time frames for submittals. The Department's Region 3 ETO and TDOT HQ Permitting Office shall be included in all correspondence and/or negotiations with agencies. The Region 3 ETO is the lead and will be the Department's contact for stormwater permitting.

https://www.tn.gov/environment/permit-permits/water-permits1/npdes-permits.html

The SWPPP template and Manual shall be used as a guide in preparation of the SWPPP and the Design-Builder is responsible for complying with all requirements of the CGP.

The SWPPP shall include the EPSC plans for application of coverage under the CGP. The SWPPP and Notice of Intent (NOI) shall be submitted at least forty-five (45) business days prior to beginning construction activities. Once a Notice of Coverage (NOC) is received by the Design-Builder, the EPSC plans and SWPPP shall be kept current for all stages of construction. Any changes in scope subsequent to submitting the SWPPP for coverage under the CGP shall be submitted to both TDEC and the Department for their records.

If at any time, the Design-Builder is not in compliance with any applicable permit regulations, all noncompliance items must be addressed by the Design-Builder within 24 hours of such identification. The Department has the authority to suspend work until such time as the deficiencies have been corrected. The Design-Builder shall not be granted any cost or time compensation for any work suspensions associated with non-compliance. Any monetary fees and/or fines associated with any violations shall be the sole responsibly of the Design-Builder. In the event that a Notice of Violation (NOV) is issued by a regulatory agency, the response to the NOV shall be written by the Design-Builder and approved by the Department's Region 3 ETO prior to submittal to the agency.

The Design-Builder shall prepare EPSC plans detailing BMPs to prevent erosion, control sedimentation, and prevent the discharge of any pollutants from leaving the Department's ROW/easements or entering jurisdictional features, or stormwater conveyances and be transported to receiving waters during the construction of the Project. The Design-Builder shall identify all outfall locations on the EPSC plans with an appropriate numbering or lettering system. The Design-Builder shall revise the SWPPP and the EPSC plans as necessary based on actual construction activities throughout the duration of the Project. All SWPPP and EPSC revisions shall be documented. The Design-Builder shall certify that the individual who prepared and reviewed the EPSC plans and SWPPP is currently certified according to the CGP. The Design-Builder shall also certify that the BMPs are designed so that if properly implemented, installed, and maintained, they will manage erosion and prevent sedimentation to waters

of the state and on adjacent property owners, as well as comply with the terms of the TDEC NPDES Construction General Permit.

The Design-Builder shall follow all of the Department's Design Standards/Guidelines when developing the EPSC plans and SWPPP for the subject project.

Inspections

The Design-Builder shall complete project site inspections of the erosion control measures, disturbed areas, areas used for storage of material, construction entrance/exit, and all outfalls. The Design-Builder shall be accompanied by a TDOT representative during these site inspections. Following the inspection, a report shall be prepared and maintained with the SWPPP. The CGP requires the inspections to be performed at least twice a week, 72 hours or more apart. The inspector must document the findings of the inspection fully in the report, and provide a copy to the site operator and the contractor, document that the rain gage has been read and rainfall recorded on a daily basis or that a reference site has been used to document rainfall. The inspector shall also document that all records are being completed and maintained per the TN CGP.

The inspector shall use photo documentation to clearly convey recommendations to the site operator and contractor. All photos shall be saved to document site conditions over time to support the inspection report findings when the site is audited by TDEC or other regulators.

The Design-Builder shall maintain a rain gauge on-site that measures up to sux (6) – inches of rainfall. The rain gauge shall be located along the project site in an open area such that measurements will not be influenced by outside factors. Rainfall monitoring shall be initiated prior to clearing, grubbing, excavation, grading, cutting or filling. The rain gauge shall be read and emptied after every rainfall event occurring on the project site at approximately the same time of day. The rainfall records shall be recorded and maintained with the SWPPP. Record data should include date of rain event, amount of rainfall and the approximate duration.

Inspectors performing the required twice weekly inspections must have one of the following: a valid certification from the "Fundamentals of Erosion Prevention and Sediment Control Level I" course, licensure as a professional engineer or landscape architect, Certified Professional in Erosion and Sediment Control (CPESC) certification, or successful completion of the "Level II Principles for Erosion Prevention and Sediment Control for Construction Sites" course. A copy of each inspector's certificate, license, or training record should be kept on site.

As outlined in the NPDES CGP, the Department will perform the monthly Environmental Quality Assurance Project Compliance Assessments (QA Inspections) on this Project, which will include any waste and borrow areas. Should the project have repeat non-conformances on QA Inspections, Water Quality violations or a NOV, the Department may increase the frequency of QA inspections to two per month. The extra QA inspection will occur until the project has been brought back into compliance for two consecutive QA inspections. The Design-Builder will be required to compensate the Department for these additional QA inspections.

Water Quality Permits Specific Requirements

The Design-Builder assumes all responsibility as the Authorized Agent of the Department (Permittee) as indicated in the permit that relates to protection of the "Waters of the United States" and/or "Waters of the State of Tennessee" pursuant to the following:

- Sections 401 and 404 of the Federal Clean Water Act (33 U.S.C. §1344), and all implementing regulations, including without limitation, regulations of the U.S. Army Corps of Engineers governing permits for discharges of dredged or fill material into waters of the United States in 33 CFR Part 323;
- The Tennessee Water Quality Control Act (T.C.A. §69-3-101, et. seq.) and all implementing regulations, including without limitation the Rules of TDEC governing National Pollutant Discharge Elimination System (NPDES) permits in Chapter 1200-4-10, and Aquatic Resource Alteration Permits in Chapter 1200-4-7; Class V Injection Well Permits for work in or near sinkholes;
- Section 26a of the Tennessee Valley Authority (TVA) Act of 1933 as amended (49 Stat 1079, 16 U. S. C. sec. 831y1.) and all implementing regulations, including without limitation the regulations of the Tennessee Valley Authority governing construction in the Tennessee River System in 18 C.F.R., Part 1304.

Permit Register

The Design-Builder shall administer a permit register and provide an updated permit register in every progress report. The permit register shall include an overview of all permits required of the Project. The permit register requires each permit to be indicated as follows:

- Name and address of the granting authority;
- Purpose of the permit;
- Reference to the document in which the permit conditions are defined
- Status of permit;
- Date by which the authorization of the specific permit is anticipated;
- Permit conditions relevant for the Work;
- Date by which the permit is required (milestone);
- How the Design-Builder ensures that he shall comply with the permit requirements and conditions; and
- Validity and the expiry date (if any) of the permit.

9.7 TENNESSEE ENVIRONMENTAL EVALUATION REPORT (TEER) DOCUMENT

The Design-Builder shall review, and adhere to the approved TEER document and technical reports, and specifically any environmental commitments listed on the "Green Sheet" of the approved TEER document. These commitments are to be taken into account throughout the design and construction process. All commitments listed with respect to their technical area are to be fulfilled during construction activities and/or prior to completion of the Project.

The TEER document, including the "Green Sheet" environmental commitments are provided on the Project website. These include but are not limited to the following:

- The Design-Builder shall avoid both the Pearson and Cobb Cemeteries with at least a 10-foot buffer for the duration of the Project.

Should any environmental features within the Environmental Technical Study Area (ETSA) not addressed in the TEER document be uncovered during construction activities, all construction activities will stop immediately in that area and the Design-Builder will contact the TDOT Environmental Analysis Office for consultation. All technical study activities must be completed in accordance with Department practices; the Design-Builder shall be responsible for obtaining any necessary Documentation Standards from the TDOT Environmental Analysis Office.

In accordance with the TEER, a re-evaluation(s) of the approved document may be required to address any additional ROW and/or easements not studied under the original footprint of the proposed project or changes to the Project design that were not covered under the approved TEER document. The re-evaluation(s) may take place at any time during the development of the Project. The re-evaluation must be reviewed and concurred with by the Department's Environmental Division.

Should any changes to the design of the project occur, the Design-Builder shall provide the Environmental Division with a notification and copy of the revised plans. The Design-Builder will be responsible for any technical studies and the TEER document re-evaluation required.

9.8DISPOSAL OF MATERIALS

All disposal activities shall be in accordance with the TDOT Procedures for Providing Offsite Waste and Borrow on Construction Projects (current version) located at:

https://www.tn.gov/content/dam/tn/tdot/construction/old_web_page/WasteBorrowManual.pdf

Borrow and waste disposal areas shall be located in non-wetland areas and above the 100-year, Federal Emergency Management Agency floodplain. Borrow and waste disposal areas shall not affect any Waters of the State/U.S. unless these areas are specifically covered by an ARAP, §404, and/or NPDES permit, obtained solely by the Design-Builder.

9.9EROSION PREVENTION AND SEDIMENT CONTROL (EPSC)

All EPSC designs and implementation shall be the responsibility of the Design-Builder.

Grass strips and side slopes shall be permanently stabilized by seeding with mulch or sodding in accordance with Part 8 of the Standard Specifications to prevent damage to adjacent facilities and property due to erosion on all newly graded cut and fill slopes that have permanently ceased.

Pre-construction vegetative ground cover shall not be destroyed, removed or disturbed (i.e. clearing and grubbing initiated) more than fourteen (14) calendar days prior to grading or earth moving activities unless the area is mulched, seeded with mulch or other temporary cover is applied.

Clearing, grubbing, and other disturbances to riparian vegetation shall be limited to the minimum necessary for slope construction and equipment operations. Existing vegetation, including stream and wetland buffers (unless permitted), should be preserved to the maximum extent possible. Unnecessary vegetation removal is prohibited.

Temporary stabilization shall be initiated within fourteen (14) calendar days when construction activities on a portion of the site are temporarily ceased and earth disturbing activities shall not resume until after fourteen (14) calendar days. Permanent stabilization measures in disturbed areas shall be initiated within fourteen (14) calendar days after final grading of any phase of construction.

Steep slopes shall be temporarily stabilized not later than seven (7) calendar days after construction activity on the slope has temporarily or permanently ceased. For this project, steep slopes shall be defined as natural or created slopes of greater than 3H:1V, regardless of height.

Permanent stabilization shall replace temporary measures as soon as practicable. Priority shall be given to finishing operations and permanent EPSC measures over temporary EPSC measures.

Inspection, repair, and maintenance of EPSC structures shall be performed on a regular basis and sediment shall be removed from sediment control structures when the design capacity has been reduced by fifty percent (50%). During sediment removal, the Design-Builder shall take care to ensure that structural components of EPSC structures are not damaged and thus made ineffective. If damage does occur, the Design-Builder shall repair the structures at their own expense.

EPSC controls shall be inspected according to permit requirements to verify measures have been installed and maintained in accordance with TDOT standard drawings, specifications, and good engineering practices. EPSC inspections shall be documented on the TDOT EPSC inspection report and a copy of each inspection report shall be provided to the Department.

Sediment removed from sediment control structures shall be placed and be treated in a manner so that the sediment is contained within the Project limits and does not migrate onto adjacent properties and into Waters of the State/United States.

The Design-Builder shall establish and maintain a comprehensive and proactive method to inspect and prevent the off-site migration or deposit of sediment off the Project limits (e.g. ROW, easements, etc.), into Waters of the State/United States, or onto roadways used by the general public. If sediment escapes the construction site, off-site accumulations of sediment that have not reached a stream must be removed at a frequency sufficient to minimize off-site impacts (e.g., fugitive sediment that has escaped the construction site and has collected in a street must be removed so that it is not subsequently washed into storm sewers and streams by the next rain and/or so that it does not pose a safety hazard to users of public streets). Arrangements concerning removal of sediment on adjoining property must be settled with the adjoining property owner before removal of sediment.

Upon conclusion of the inspections, EPSC measures found to be ineffective shall be repaired, replaced, or modified before the next rain event, if possible, but in no case more than twenty-four (24) hours after the inspection or when the condition is identified. If the repair, replacement or modification is not practical within the 24-hour timeframe, written documentation must be provided in the field diary and EPSC inspection report. An estimated repair, replacement or modification schedule shall be documented within twenty-four (24) hours of identification. All costs associated with modifications made to these measures shall be the responsibility of the Design-Builder and all modifications shall be concurred with by the Department.

Temporary EPSC measures may be removed at the beginning of the workday but must be replaced at the end of the workday or before/during a precipitation event.

Delaying planting of cover vegetation until winter months or dry months shall be avoided.

Offsite vehicle tracking of sediments and the generation of dust shall be minimized. A stabilized construction access (a point of entrance/exit to the construction project) shall be provided to reduce the tracking of mud and dirt onto public roads by construction vehicles.

The Design-Builder shall have a plan in place for dust control. The dust control plan shall be developed prior to the start of any construction activities and shall be submitted to the Department for approval.

The EPSC plan shall be updated by the Design-Builder whenever EPSC inspections indicate, or where State or Federal officials determine EPSC measures are proving ineffective in eliminating or significantly minimizing pollutant sources or are otherwise not achieving the general objectives of controlling pollutants in storm water discharges associated with the construction activity.

The accepted EPSC plan shall require that EPSC measures be in place before clearing, grubbing, excavation, grading, culvert or bridge construction, cutting, filling or any other earthwork occurs, except as such work may be necessary to install EPSC measures.

EPSC measures shall be installed and functional prior to any earth moving operations and shall be maintained throughout the construction period except as such work may be necessary to install EPSC measures.

The Design-Builder shall establish and maintain a proactive method to prevent litter and construction wastes from entering Waters of the State/United States. These materials shall be removed from stormwater exposure prior to anticipated storm events or before being carried offsite by wind, or otherwise prevented from becoming a pollutant source for stormwater discharges. After use, materials used for EPSC shall be removed from the site by the Design-Builder.

9.10 DEPARTMENT INSPECTIONS

The Department will review and monitor the Project (Quality Assurance Inspections), including all waste and borrow areas, to ensure compliance with all applicable environmental regulations and stormwater management activities throughout the duration of the Project.

If at any time, the Design-Builder is not in compliance with any applicable permit regulations, all non-compliance items must be addressed by the Design-Builder within twenty-four (24) hours of such identification. The Department has the authority to suspend work until such time as the deficiencies have been corrected.

The Design-Builder shall not be granted any cost or time compensation for any work suspensions associated with non- compliance. Any monetary fees and/or fines associated with any violations, assessed by regulatory agencies shall be the responsibility of the Design-Builder.

The Design-Builder shall monitor any constructed mitigation sites for the required monitoring period post construction as defined in the permits and shall be responsible for the correction of any deficient or failing mitigation measures during this time. The cost for any repairs during the required monitoring period shall be included in the Design Builder's bid.

Should the project have repeat non-conformances on QA Inspections, Water Quality violations, or a NOV, the Department may increase the frequency of QA inspections to two per month. The extra QA inspection will occur until the project has been brought back into compliance for two consecutive QA inspections. The Design-Builder will be required to compensate the Department for these additional QA inspections.

10. CONSTRUCTION REQUIREMENTS

The Design-Builder shall meet the requirements of the Department's Standard Specifications for Road and Bridge Construction (January 1, 2021 edition), Supplemental Specifications, contractual Special Provisions, the Manual on Uniform Traffic Control Devices (MUTCD), and the Tennessee Occupational Safety and Health Administration (TOSHA).

The Design-Builder shall ensure that all applicable "General and Special Notes" found in Section VI of the current edition of the TDOT Roadway Design Guidelines and TDOT Instructional Bulletins (IBs) applicable on the date the RFP is issued are adhered to during construction.

Reference Special Provision 108 B Project Completion Time and Liquidated Damages as included in **Contract Book 2 (Design-Build Contract)**.

10.1 CONSTRUCTION SERVICES

The Design-Builder shall supervise and administer all construction activities in accordance with Contract requirements.

The Design-Builder shall perform all other construction work required to complete the Project in conformance with all Contract requirements, including Legal Requirements.

The Design-Builder shall keep the work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.

The Design-Builder shall be required to furnish any special equipment needed to accomplish all aspects of the work.

Any area that is disturbed outside limits of construction during the life of this Project shall be repaired by the Design-Builder at their expense. All repaired areas shall be inspected and be deemed satisfactory by the Department.

The Design-Builder shall coordinate its work with that of other contractors working on or near the Project. The Design-Builder shall consider the schedule of other contractors when developing its schedule to maintain continuity of work and compliance with the Project schedule.

10.2 ACCEPTANCE OF MATERIALS

All materials utilized in this project shall meet the requirements set forth in the contract, plans, and specifications. Materials incorporated into the project must have certifications, test reports, and/or acceptance testing as specified in the Department's Quality Assurance Program for the Sampling

and Testing of Materials and Products (SOP 1-1) (https://www.tn.gov/tdot/materials-and-tests/standard-operating-procedures.html). The Design-Builder shall communicate what materials will be utilized in the project, along with estimated quantities, in sufficient time that adequate samples and/or acceptance testing can be performed by TDOT representatives. The Design-Builder shall provide the Department an estimated quantities list using the Department's pay item list for each lump sum item so that the Department may determine the number(s) and type(s) of testing required.

The Design-Builder is responsible for determining all means and methods of construction for the Project. However, this does not relieve the Design-Builder of the responsibility to protect the public, environment, and private property.

10.3 MAINTENANCE DURING CONSTRUCTION

The Design-Builder shall prepare a project maintenance plan including mowing and litter cycles for Department Review and Acceptance that meets the requirements herein.

The Design-Builder is responsible for the maintenance of the Project in accordance with the approved maintenance plan until Project acceptance by the Department. The Design-Builder will be responsible for maintenance of all ROW areas within the Project Limits as defined in Section 1.1 Project Description.

The Design-Builder shall mitigate potholes greater than or equal to 1 square foot and 1.25 inches deep or an equivalent volume of size, shape and location that presents a hazard to the traveling public within 24 hours of discovery or notification within the maintenance limits.

10.3.1 General Requirements

The Design-Builder shall maintain the Project from the date of the Design-Builder's first NTP for Construction until Project acceptance by the Department, in a manner which provides a safe and reliable transportation system.

The Design-Builder shall be fully responsible for maintenance as required by the Department's Standard Specifications for Road and Bridge Construction, January 2021 edition, Section 104.05 – Maintenance During Construction. The Design-Builder shall be responsible for all components of the transportation system within construction limits within the ROW to include, but not limited to, asphalt roadway, signing, concrete to cover the loop ramps and other concrete pavement adjacent to the project, roadway illumination, drainage structures, bridges and cable wire barrier fence and guardrail until final acceptance of the Project by the Department.

10.3.2 ROW Mowing and Litter Removal

The Design-Builder shall perform ROW mowing and litter removal service to provide a consistent vegetation height and a clean non-littered appearance from the date of the Design-Builder's Notice to Proceed from the Department until Project completion and acceptance by the Department. See Special Provision SP806 regarding contract mowing and Special Provision SP719A regarding removal and disposal of litter.

It shall be the Design-Builder's responsibility to mow and pick up litter on the full ROW. Annually, there will be a minimum of four (4) mowing and five (5) litter cycles. During the final two (2) months prior to project acceptance, there shall be one (1) mowing cycle per month.

10.3.3 Acceptance of the Project

Upon Acceptance of the Project, the Department will assume responsibility for the operation and maintenance of the entire Project. Nothing contained herein shall otherwise limit any warranty obligations of the Design-Builder with respect to any defect or non-conforming Work.

11. TRAFFIC CONTROL / PAVEMENT MARKING SCOPE OF WORK

The interchange and roadway widening construction shall be in accordance with Special Provision SP108B. Access to all side roads shall be maintained during construction.

Definitions

- Road Closure: Complete removal of traffic from a section of roadway using a signed detour route.
- Lane Closure: Reduction in the current number of lanes provided to traffic
- Rolling Road Block: Temporarily delaying traffic for a limited amount of time without stopping traffic or providing a detour.

11.1 GENERAL REQUIREMENTS

The Design-Builder shall develop a Transportation Management Plan, including a Traffic Control System, that addresses major aspects of the work for individual construction areas, phases and stages, including temporary traffic control, transportation and information strategies. The Transportation Management Plan shall be in accordance with:

- TDOT Standard Specifications for Road and Bridge Construction, January 2021 edition
- TDOT Standard Drawings
- TDOT Standard Traffic Operations Drawings
- TDOT Traffic Design Manual
- TDOT Design Guidelines
- TDOT Work Zone Safety and Mobility Manual
- ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features (Current Edition)
- Latest edition of the Manual of Uniform Traffic Control Devices

- Use traffic control materials from the Department's Qualified Products List (QPL): Monthly_QPL.pdf
- The Design-Builder shall ensure drainage spread across all traffic lanes does not exceed allowable spread. Design-Builder shall provide drainage/spread calculations for all phases of traffic control phasing.
- The Transportation Management Plan shall describe in detail all accommodations for traffic access and flow during all stages of construction for the life of the Project. The plan shall include the following:
    - Detailed proposed sequencing plan that includes each step of the Project, including all major traffic shifts or changes, minor shifts or changes, closures, and alternate traffic patterns.
    - Overall goals of the sequencing plan and how the plan aligns with the Project Critical Path.
    - Plans for providing queue protection during operations requiring temporary lane closures, temporary road closures, rolling roadblocks, traffic pacing, and setting up or removing long-term lane shifts.
    - Conceptual construction staging diagrams (scale: 1 inch = 200 feet), including lane configuration and traffic management of the Interstate, State Routes, and local streets during the different stages of construction. Staging areas within the project limits shall be approved by the Department.
    - Narrative description of how Design-Builder shall schedule and sequence the construction to minimize impacts on the environment, communities and traveling public while still providing acceptable construction performance.
    - Brief description of the laydown, recycling, staging, disposal areas, waste and borrow pits, and maintenance locations to be used during construction.
    - Description of how the ROW and adjacent roads and properties will be maintained and protected, including the intended measures to be used to mitigate and minimize noise, vibration, light, dust, erosion/run-off, and local road damage.

11.2 TEMPORARY LANE / ROAD CLOSURES

The Design-Builder shall maintain the existing number of lanes on Interstate 24 throughout construction except for Department-approved night or weekend lane closures in accordance with SP108B. No full closures on I-24 will be allowed.

Minimum lane widths shall be eleven (11) feet. Minimum inside and outside shoulder widths shall be two (2) feet. The Design-Builder shall include a request for state troopers when submitting its requests for lane closures.

The Design-Builder is responsible for obtaining any State Transportation Permits required for beam transport.

11.3 TEMPORARY MARKINGS

Temporary markings shall adhere to guidance outlined in Section IV of current edition of the Department's Design Division Roadway Design Guidelines for pavement markings.

11.4 TEMPORARY SIGNAGE

All temporary signage shall be in accordance with the current edition of TDOT Standard Specifications for Road and Bridge Construction (January 2021 edition), Supplemental Specifications, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, TDOT Design Guidelines, TDOT Work Zone Safety and Mobility Manual, and the latest edition of the Manual of Uniform Traffic Control Devices.

11.5 CHANGEABLE MESSAGE SIGNS

Changeable message signs shall be used in advance of changed roadway conditions such as lane closures, road closures, or lane shifts. The locations of these changeable message signs shall be reviewed by the Department prior to implementation. Portable changeable message signs should be used as a supplement to, and not as a substitute for, conventional signs and pavement markings. Portable changeable message sign trailers should be delineated on a permanent basis by affixing retroreflective material, known as conspicuity material, in a continuous line on the face of the trailer as seen by oncoming road users.

11.6 QUEUE PROTECTION DEVICES

Queue Protection Devices shall be used in strict accordance with the special provisions outlined in the contract documents.

11.7 CHANGEABLE DETOUR AND CONSTRUCTION SIGNAGE

All construction signing shall be in strict accordance with the current edition of the MUTCD. No detours will be allowed during construction unless agreed upon by the Department.

11.8 CONSTRUCTION WORK ZONE

Traffic control devices shall not be displayed or erected unless related conditions are present necessitating warning.

11.9 PAVEMENT EDGE DROP-OFF TRAFFIC CONTROL

See Chapter 9, Section 5, of the TDOT Roadway Design Guidelines for applicable requirements.

12. NEARBY DEVELOPMENTS

12.1 PROJECT SPRING AT SR-2

The Design-Builder shall coordinate closely with Project Spring and the contractor for Project Spring. Barrett Firearms is relocating their facility from Miller Lane to SR-2. The new facility site is located directly across from Epps Mill Road at SR-2. A site plan for this development is included in the Reference Material on the project website.

The development construction is anticipated to occur in advance of the Project construction. Project Spring shall construct a temporary entrance located directly across from existing Epps Mill Road at SR-2. As part of their access permit, the developer will widen SR-2 to develop a southbound left turn lane on SR-2 into the Barrett facility. The developer will also install a traffic signal at the existing Epps Mill Road/SR-2 intersection.

It is anticipated that the developer's improvements to Epps Mill Road will be fully constructed before the Design-Builder's final design is approved and construction begins. The Design-Builder shall relocate Epps Mill Road and improve SR-2 per the Functional Plans, which will involve tying into the SR-2 improvements made by Project Spring.

Once Epps Mill Road is relocated and the new Epps Mill/SR-2 relocated intersection is fully constructed, Project Spring will be responsible for relocating the traffic signal and their main driveway entrance to the new Epps Mill Road/SR-2 intersection. The relocation of their entrance and relocation of any traffic signal at the new intersection of Epps Mill and SR-2 intersection are not part of the Design-Builder's scope of work.

12.2 DEVELOPMENT NEAR EPPS MILL ROAD AND CAPITAL WAY

The preliminary site plan for a proposed Arco Murray development near Epps Mill Road and Capital Way is included in Reference Material on the project website. This proposed development is adjacent to the construction limits of the Project. TDOT does not anticipate any impact in design or construction of the Project due to the adjacent development project.

13. APPENDIX A: PAVEMENT DESIGN

APPENDIX A

FLEXIBLE PAVEMENT DESIGN

County	Rutherford	TDOT PIN	124683.06
Route	I-24	Design YR	2048
Description	From S.R 2 to West of Capitol Way (Includes I-24 Interchange)		
Road	Full Depth design for Epps Mill Road		

Pavement Schedule

Mainline			
	Item #	Description	Depth (in)
Pavement	411-02.10	ACS Mix (PG 70-22) GRADING D	1.25
	307-02.08	Asphalt Conc Mix (PG 70-22) (BPMB-HM) GR B-M2	2.5
	307-02.01	Asphalt Conc Mix (PG 70-22) (BPMB-HM) GR A	4.5
Base	303-01	Mineral Aggregate Base, Type A	12
Subgrade			

Shoulder			
	Item #	Description	Depth (in)
Pavement	411-02.10	ACS Mix (PG 70-22) GRADING D	1.25
	307-02.08	Asphalt Conc Mix (PG 70-22) (BPMB-HM) GR B-M2	2.5
Base	303-01	Mineral Aggregate Base, Type A	16.5
Subgrade			

Notes:

1. Mill 1.25 inches of the existing pavement and resurface with 1.25 inches of D mix for Ties-ins
2. Add Tack Coat Per Standard Specification 403.05 between each pavement layer
3. Use Prime coat at 0.30 to 0.35 gallons per square yard between base and pavement
4. Use the mainline design for shoulders less than 4 feet wide
5. Use shoulder design for temporary traffic, if needed
6. Use design for all intersection at Epps Mill Road (north and south of I-24)

APPENDIX A

FLEXIBLE PAVEMENT DESIGN

County	Rutherford	TDOT PIN	124683.06
Route	I-24	Design YR	2048
Description	From S.R 2 to West of Capitol Way (Includes I-24 Interchange)		
Road	Full Depth design for Interstate I-24		

Pavement Schedule

Mainline			
	Item #	Description	Depth (in)
Pavement	411-03.23	ACS Mix (PG 76-22) OGFC	1.25
	307-03.12	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR CM	1.5
	307-03.08	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR B-M2	2.5
	307-03.01	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR A	6.25
	307-01.22	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR A-S	4
Base	303-01	Mineral Aggregate Base, Type A	12
Subgrade			

Shoulder			
	Item #	Description	Depth (in)
Pavement	411-03.23	ACS Mix (PG 76-22) OGFC	1.25
	307-03.12	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR CM	1.5
	307-03.08	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR B-M2	2.5
	307-03.01	Asphalt Conc Mix (PG 76-22) (BPMB-HM) GR A	3.5
Base	303-01	Mineral Aggregate Base, Type A	18.75
Subgrade			

Notes:

1. The existing surface on I-24 is currently OGFC. Mill 2.75 inches of the existing pavement and resurface with 1.25 inches of OGFC and 1.5 inches of GR CM for Ties-ins
2. Add Tack Coat Per Standard Specification 403.05 between each pavement layer
3. Use Prime coat at 0.30 to 0.35 gallons per square yard between base and pavement
4. Tack coat should not be applied on top of Grading A-S layer
5. This flexible pavement design shall be used for acceleration/deceleration lanes
6. Ramps, from the gore area to Epps Mill Road, will be rigid concrete pavements
7. Use shoulder for temporary traffic, if needed

APPENDIX A

RIGID PAVEMENT DESIGN

County	Rutherford	TDOT PIN	124683.06
Route	I-24	Design YR	2048
Description	From S.R to West of Capitol Way (Includes I-24 Interchange)		
Road	Full Depth design for Ramps on Exit 89 at I-24		

Pavement Schedule

Mainline			
	Item #	*Description*	*Depth (in)*
Pavement	501-01.03	*Portland Cement Concrete Pavement (Plain)*	*10*
	313-03	*Treated Permeable Base*	*4*
Base	303-01	*Mineral Aggregate Type A Base Grading D*	*4*
Subgrade			

Note:

1 Use mainline design for the concrete shoulders as well

2 Subsurface drainage – Aggregate underdrain with pipe