SEPTEMBER 09, 2013
PREPARED BY: Marshall H. Dougherty, Jr.
Upik Y. Suwarno

SPECIFICATIONS PACKAGE

FINANCIAL PROJECT ID(S): 429867-1-58-01

FEDERAL FUNDS

A DISTRICT ONE ON-SYSTEM LOCAL AGENCY PROGRAM PROJECT
MANATEE COUNTY

The applicable Articles and Subarticles of the General Requirements & Covenants division (Division I) of the 2013 edition of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction are added, and all of the Construction Details and Materials divisions (Division II & III) are revised, as follows:

I hereby certify that this specifications package has been properly prepared by me, or under my responsible charge, in accordance with procedures adopted by the Florida Department of Transportation.

Signature and Seal: _____

UPIK Y. SUWARNO LICENSE No. 62995 STATE OF FLORIDA PROFESSIONAL ENGINEER

Date: 9-10-13

Engineer of Record: Upik Y. Suwarno, P.E.
Fla. License No.: 62995
Firm: Cardno TBE
12481 Telecom Drive
Tampa, FL 33637
Certificate of Authorization: 3843
Page(s): 1 - 241

SPECIAL PROVISIONS

DEFINITIONS AND TERMS

The following SECTION 1 – DEFINITIONS AND TERMS language is added:

1-3 Definitions.

The following terms, when used in the Contract Documents, have the meaning described:

Contractor's Engineer of Record.

A Professional Engineer registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, who undertakes the design and drawing of components of the permanent structure as part of a redesign or Cost Savings Initiative Proposal, or for repair designs and details of the permanent work. The Contractor's Engineer of Record may also serve as the Specialty Engineer.

The Contractor's Engineer of Record must be an employee of a pre-qualified firm. The firm shall be pre-qualified in accordance with the Rules of the Department of Transportation, Chapter 14-75. Any Corporation or Partnership offering engineering services must hold a Certificate of Authorization from the Florida Department of Business and Professional Regulation.

As an alternate to being an employee of a pre-qualified firm, the Contractor's Engineer of Record may be a pre-qualified Specialty Engineer. For items of the permanent work declared by the State Construction Office to be "major" or "structural", the work performed by a pre-qualified Specialty Engineer must be checked by another pre-qualified Specialty Engineer. An individual Engineer may become pre-qualified in the work groups listed in the Rules of the Department of Transportation, Chapter 14-75, if the requirements for the Professional Engineer are met for the individual work groups. Pre-qualified Specialty Engineers are listed on the State Construction Website. Pre-qualified Specialty Engineers will not be authorized to perform redesigns or Cost Savings Initiative Proposal designs of items fully detailed in the plans.

Department.

Manatee County.

Engineer.

The Professional Engineer, registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, acting as the project's Construction Engineering Inspection Manager. The Engineer may be County in-house staff or a consultant retained by the County.

Note: In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be done, if, as, or, when, or where "acceptable, accepted, approval, approved, authorized, condemned, considered necessary, contemplated, deemed necessary, designated, determined, directed, disapproved, established, given, indicated, insufficient, ordered, permitted, rejected, required, reserved, satisfactory, specified, sufficient, suitable, suspended, unacceptable, or unsatisfactory," it shall be understood as if the expression were followed by the words "by the Engineer," "to the Engineer," or "of the Engineer."

Specialty Engineer.

A Professional Engineer registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, who undertakes the design and drawing preparation of components, systems, or installation methods and equipment for specific temporary portions of the project work or for special items of the permanent works not fully detailed in the plans and required to be furnished by the Contractor such as but not limited to pot bearing designs, non-standard expansion joints, MSE wall designs and other specialty items. The Specialty Engineer may also provide designs and details for items of the permanent work declared by the State Construction Office to be "minor" or "non-structural". The Specialty Engineer may be an employee or officer of the Contractor or a fabricator, an employee or officer of an entity providing components to a fabricator, or an independent consultant.

For items of work not specifically covered by the Rules of the Department of Transportation, a Specialty Engineer is qualified if he has the following qualifications:

(1) Registration as a Professional Engineer in the State of Florida.

(2) The education and experience necessary to perform the submitted design as required by the Florida Department of Business and Professional Regulation.

SCOPE OF THE WORK

The following SECTION 4 – SCOPE OF THE WORK language is added:

4-3 Alteration of Plans or of Character of Work.

When the Department requires work that is not covered by a price in the Contract and such work does not constitute a "Significant Change" as defined in 4-3.1, and the Department finds that such work is essential to the satisfactory completion of the Contract within its intended scope, the Department will make an adjustment to the Contract. The Engineer will determine the basis of payment for such an adjustment in a fair and equitable amount.

The term "significant change" applies only when the Engineer determines that the character of the work, as altered, differs materially in kind or nature from that involved or included in the original proposed construction. The allowance due to the Contractor will be determined by the Department.

In the instance of an alleged "significant change", the determination by the Engineer shall be conclusive and shall not be subject to challenge by the Contractor in any forum, except upon the Contractor establishing by clear and convincing proof that the determination by the Engineer was without any reasonable and good-faith basis.

CONTROL OF THE WORK

The following SECTION 5 – CONTROL OF THE WORK language is added:

5-11 Final Acceptance.

When, upon completion of the final construction inspection of the entire project, the Engineer determines that the Contractor has satisfactorily completed the work, the Engineer will give the Contractor written notice of final acceptance.

CONTROL OF MATERIALS

The following SECTION 6 – CONTROL OF MATERIALS language is added:

6-1 Acceptance Criteria.

6-1.1 General: Acceptance of materials is based on the following criteria. All requirements may not apply to all materials. Use only materials in the work that meet the requirements of these Specifications. The Engineer may inspect and test any material, at points of production, distribution and use.

6-1.2 Sampling and Testing: Use the Department's current sample identification and tracking system to provide related information and attach the information to each sample. Restore immediately any site from which material has been removed for sampling purposes to the pre-sampled condition with materials and construction methods used in the initial construction, at no additional cost to the Department.

Ensure when a material is delivered to the location as described in the Contract Documents, there is enough material delivered to take samples, at no expense to the Department.

6-1.2.1 Pretest by Manufacturers: Submit certified manufacturer's test results to the Engineer for qualification and use on Department projects. Testing will be as specified in the Contract Documents. The Department may require that manufacturers submit samples of materials for independent verification purposes.

6-1.2.2 Point of Production Test: Test the material during production as specified in the Contract Documents.

6-1.2.3 Point of Distribution Test: Test the material at Distribution facilities as specified in the Contract Documents.

6-1.2.4 Point of Use Test: Test the material immediately following placement as specified in the Specifications. After delivery to the project, the Department may require the retesting of materials that have been tested and accepted at the source of supply, or may require the testing of materials that are to be accepted by Producer Certification. The Department may reject all materials that, when retested, do not meet the requirements of these Specifications.

6-1.3 Certification:

6-1.3.1 Producer Certification: Provide complete certifications for materials as required. Furnish to the Engineer for approval, Producer Certifications for all products listed on the Qualified Products List and when required by the applicable material Specification(s). Do not incorporate any manufactured products or materials into the project without approval from the Engineer. Materials will not be considered for payment when not accompanied by Producer Certification. Producers may obtain sample certification forms through the Department's website. Ensure that the certification is provided on the producer's letterhead and is signed by a legally responsible person from the producer and notarized.

6-1.3.1.1 Qualified Products List: The Product Evaluation Section in the State Specifications and Estimates Office publishes and maintains a Qualified Products List. This list provides assurance to Contractors, consultants, designers, and Department personnel that specific products and materials are approved for use on Department facilities. The Department will limit the Contractor's use of products and materials that require pre-approval to items listed on the Qualified Products List effective at the time of placement.

Manufacturers seeking evaluation in accordance with Departmental procedures of an item must submit a Product Evaluation Application, available on

the Department's website www2.dot.state.fl.us/specificationsestimates/productevaluation/qpl/submittalprocess.aspx , with supporting documentation as defined and detailed by the applicable Specifications and Standards. This may include certified test reports from an independent test laboratory, certification that the material meets all applicable specifications, signed and sealed drawings and calculations, quality control plans, samples, infrared scans, or other technical data.

Manufacturers successfully completing the Department's evaluation are eligible for inclusion on the Qualified Products List. The Department will consider any marked variations from original test values for a material or any evidence of inadequate field performance of a material as sufficient evidence that the properties of the material have changed, and the Department will remove the material from the Qualified Products List.

6-1.3.1.2 Approved Products List: The State Traffic Operations Office maintains the Approved Products List of Traffic Control Signal Devices. Traffic Monitoring Site Equipment and Materials are also included on the Approved Products List. This list provides assurance to Maintaining Agencies, Contractors, consultants, designers, and Department personnel that the specific items listed are approved for use on Department facilities. The Department will limit the Contractor's procurement and use of Traffic Control Signal Devices, and Traffic Monitoring Site equipment and materials to only those items listed on the Approved Products List that is effective at the time of procurement, except as provided in Section 603.

The approval process is described in detail on the State Traffic Operation website, www.dot.state.fl.us/trafficoperations/terl/apl2.htm . Manufacturers seeking evaluation of a specific device must submit an application which can be obtained from the State Traffic Operations Office.

6-1.3.2 Contractor Installation Certification: Provide installation certifications as required by the Contract Documents.

6-2 Applicable Documented Authorities other than Specifications.

6-2.1 General: Details on individual materials are identified in various material specific Sections of the Specifications that may refer to other documented authorities for requirements. When specified, meet the requirements as defined in such references.

6-2.2 Test Methods: Methods of sampling and testing materials are in accordance with the Florida Methods (FM). If a Florida Method does not exist for a particular test, perform the testing in accordance with the method specified in the Specification. When test methods or other standards are referenced in the Specifications without identification of the specific time of issuance, use the most current issuance, including interims or addendums thereto, at the time of bid opening.

6-2.3 Construction Aggregates: Aggregates used on Department projects must be in accordance with Rule 14-103, FAC.

6-3 Storage of Materials and Samples.

6-3.1 Method of Storage: Store materials in such a manner as to preserve their quality and fitness for the work, to facilitate prompt inspection, and to minimize noise impacts on sensitive receivers. More detailed specifications concerning the storage of specific materials are prescribed under the applicable Specifications. The Department may reject improperly stored materials.

6-3.2 Use of Right-of-Way for Storage: If the Engineer allows, the Contractor may use a portion of the right-of-way for storage purposes and for placing the Contractor's plant and

equipment. Use only the portion of the right-of-way that is outside the clear zone, which is the portion not required for public vehicular or pedestrian travel. When used, restore the right-of-way to pre-construction condition at no additional cost to the Department or as specified in the Contract Documents. Provide any additional space required at no expense to the Department.

6-3.3 Responsibility for Stored Materials: Accept responsibility for the protection of stored materials. The Department is not liable for any loss of materials, by theft or otherwise, or for any damage to the stored materials.

6-3.4 Storage Facilities For Samples: Provide facilities for storage of samples as described in the Contract Documents and warranted by the test methods and Specifications.

6-4 Defective Materials.

Materials not meeting the requirements of these Specifications will be considered defective. The Engineer will reject all such materials, whether in place or not. Remove all rejected material immediately from the site of the work and from storage areas, at no expense to the Department.

Do not use material that has been rejected and the defects corrected, until the Engineer has approved the material's use. Upon failure to comply promptly with any order of the Engineer made under the provisions of this Article, the Engineer has the authority to have the defective material removed and replaced by other forces and deduct the cost of removal and replacement from any moneys due or to become due the Contractor.

As an exception to the above, within 30 calendar days of the termination of the LOT or rejection of the material, the Contractor may submit a proposed scope of work to the Engineer for an engineering or independent laboratory (as approved by the Engineer) analysis to determine the disposition of the material. A Specialty Engineer, who is an independent consultant, or the Contractor's Engineer of Record as stated within each individual Section shall perform any such analysis. Upon the Engineer's approval of the scope of work submitted by the Contractor, the engineering analysis must be completed and the report must be submitted to the Engineer within 45 calendar days, or other time frame as approved by the Engineer. The report must be signed and sealed by the Specialty Engineer. The Engineer will determine the final disposition of the material after review of the information submitted by the Contractor. No additional monetary compensation or time extension will be granted for the impact of any such analysis or review.

6-5 Products and Source of Supply.

6-5.3 Contaminated, Unfit, Hazardous, and Dangerous Materials: Do not use any material that, after approval and/or placement, has in any way become unfit for use. Do not use materials containing any substance that has been determined to be hazardous by the State of Florida Department of Environmental Protection or the U.S. Department of Environmental Protection. Provide workplaces free from serious recognized hazards and to comply with occupational safety and health standards, as determined by the U.S. Department of Labor Occupational Safety and Heath Administration.

LEGAL REQUIREMENTS AND RESPONSIBILITIES TO THE PUBLIC

The following SECTION 7 – LEGAL REQUIREMENTS AND RESPONSIBILITIES TO THE PUBLIC language is added:

7-1.3 Introduction or Release of Prohibited Aquatic Plants, Plant Pests, or Noxious Weeds: Do not introduce or release prohibited aquatic plants, plant pests, or noxious weeds into the project limits as a result of clearing and grubbing, earthwork, grassing and mulching, sodding, landscaping, or other such activities. Immediately notify the Engineer upon discovery of all prohibited aquatic plants, plant pests, or noxious weeds within the project limits. Do not move prohibited aquatic plants, plant pests, or noxious weeds within the project limits or to locations outside of the project limits without the Engineer's permission. Maintain all borrow material brought onto the project site free of prohibited aquatic plants, plant pests, noxious weeds, and their reproductive parts. Refer to Rule 16C-52 and Rule 5B-57, of the Florida Administrative Code for the definition of prohibited aquatic plants, plant pests, and noxious weeds.

Furnish the Engineer, prior to incorporation into the project, with a certification from the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, stating that the sod, hay, straw, and mulch materials are free of noxious weeds, including Tropical Soda Apple.

7-1.7 Insecticides and Herbicides. Use products found on the following website, www.flpesticide.us/ , approved by the Florida Department of Agriculture for the State of Florida. The use of restricted products is prohibited. Do not use any products in the sulfonylurea family of chemicals. Herbicide application by broadcast spraying is not allowed.

Procure any necessary licenses, pay all charges and fees, and give all notices necessary for lawful performance of the work.

Ensure that all employees applying insecticides and herbicides possess a current Florida Department of Agriculture Commercial Applicator license with the categories of licensure in Right-of-Way Pest Control and Aquatic Pest Control. Provide a copy of current certificates upon request, to the Engineer.

Ensure that employees who work with herbicides comply with all applicable Federal, State, and local regulations.

Comply with all regulations and permits issued by any regulatory agency within whose jurisdiction work is being performed. Post all permit placards in a protected, conspicuous location at the work site.

Acquire any permits required for work performed on the rights-of-way within the jurisdiction of National Forests in Florida. Contact the Local National Forest Ranger District, or the United States Department of Agriculture (USDA) office for the proper permits and subsequent approval.

Acquire all permits required for aquatic plant control as outlined in Chapter 62C-20, Florida Administrative Code, Rules of the Florida Department of Environmental Protection. Contact the Regional Field Office of Bureau of Invasive Plant Management of the Florida Department of Environmental Protection for proper permits and subsequent approval. If application of synthetic organo-auxin herbicides is necessary, meet the requirements of Chapter 5E-2, Florida Administrative Code.

7-7.2 Overloaded Equipment. Do not operate on any road or street any hauling unit or equipment loaded in excess of (1) the maximum weights specified in the Florida Uniform Traffic Control Law, or (2) lower weights legally established for any section of road or bridge by the Department or local authorities. The governmental unit having jurisdiction over a particular road or bridge may provide exceptions by special permit under the provisions of 7.0. This restriction applies to all roads and bridges inside and outside the Contract limits as long as these roads and bridges are open for public use. The Contractor may overload roads and bridges which are to be demolished after they are permanently closed to the public. The Contractor is responsible for all loss or damages resulting from equipment operated on a structure permanently closed to the public.

7-7.5 Contractor's Equipment on Bridge Structures. The Specialty Engineer shall analyze the effect of imposed loads on bridge structures, within the limits of a construction contract, resulting from the following operations:

(1) Overloaded Equipment as defined 6.0:
    (a) Operating on or crossing over completed bridge structures.
    (b) Operating on or crossing over partially completed bridge structures.
(2) Equipment within legal load limits:
    (a) Operating on or crossing over partially completed bridge structures.
(3) Construction cranes:
    (a) Operating on completed bridge structures.
    (b) Operating on partially completed bridge structures.

Any pipe culvert(s) or box culvert(s) qualifying as a bridge under 1-3 is excluded from the requirements above.

A completed bridge structure is a bridge structure in which all elemental components comprising the load carrying assembly have been completed, assembled, and connected in their final position. The components to be considered shall also include any related members transferring load to any bridge structure.

The Specialty Engineer shall determine the effect that equipment loads have on the bridge structure and develop the procedures for using the loaded equipment without exceeding the structure's design load capacity.

Submit to the Department for approval eight copies of design calculations, layout drawings, and erection drawings showing how the equipment is to be used so that the bridge structure will not be overstressed. The Specialty Engineer shall sign and seal one set of the eight copies of the drawings and the cover sheet of one of the eight copies of the calculations for the Department's Record Set.

MEASUREMENT AND PAYMENT

The following SECTION 9 – MEASUREMENT AND PAYMENT language is added:

9-1.3 Determination of Pay Areas:

9-1.3.1 Final Calculation: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be determined by calculation, the Engineer will use lengths and widths in the calculations based on the station to station dimensions shown on the plans; the station to station dimensions actually constructed within the

limits designated by the Engineer; or the final dimensions measured along the surface of the completed work within the neat lines shown on the plans or designated by the Engineer. The Engineer will use the method or combination of methods of measurement that reflect, with reasonable accuracy, the actual surface area of the finished work as the Engineer determines.

9-1.3.2 Plan Quantity: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be the plan quantity, the Engineer will determine the final pay quantity based on the plan quantity subject to the provisions of 9-3.2. Generally, the Engineer will calculate the plan quantity using lengths based on station to station dimensions and widths based on neat lines shown in the plans.

9-3 Compensation for Altered Quantities.

9-3.1 General: When alteration in plans or quantities of work not requiring a supplemental agreement as hereinbefore provided for are offered and performed, the Contractor shall accept payment in full at Contract unit bid prices for the actual quantities of work done, and no allowance will be made for increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor, resulting either directly from such alterations, or indirectly from unbalanced allocation among the Contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefore, or from any other cause.

Compensation for alterations in plans or quantities of work requiring supplemental agreements shall be stipulated in such agreement, except when the Contractor proceeds with the work without change of price being agreed upon, the Contractor shall be paid for such increased or decreased quantities at the Contract unit prices bid in the Proposal for the items of work. If no Contract unit price is provided in the Contract, and the parties cannot agree as to a price for the work, the Contractor agrees to do the work in accordance with 4-3.2.

9-3.2 Payment Based on Plan Quantity:

9-3.2.1 Error in Plan Quantity: As used in this Article, the term "substantial error" is defined as the smaller of (a) or (b) below:

(a) a difference between the original plan quantity and final quantity of more than 5%,

(b) a change in quantity which causes a change in the amount payable of more than $5,000.

On multiple job Contracts, changes made to an individual pay item due to substantial errors will be based on the entire Contract quantity for that pay item.

Where the pay quantity for any item is designated to be the original plan quantity, the Department will revise such quantity only in the event that the Department determines it is in substantial error. In general, the Department will determine such revisions by final measurement, plan calculations, or both, as additions to or deductions from plan quantities.

In the event that either the Department or the Contractor contends that the plan quantity for any item is in error and additional or less compensation is thereby due, the claimant shall submit, at their own expense, evidence of such in the form of acceptable and verifiable measurements or calculations. The Department will not revise the plan quantity solely on the basis of a particular method of construction that the Contractor selects. For earthwork items, the claimant must note any differences in the original ground surfaces from that shown in the original plan cross-sections that would result in a substantial error to the plan quantity, and must be properly documented by appropriate verifiable level notes, acceptable to both the Contractor and the Department, prior to disturbance of the original ground surface by

construction operations. The claimant shall support any claim based upon a substantial error for differences in the original ground surface by documentation as provided above.

9-3.2.2 Authorized Changes in Limits of Work: Where the Department designates the pay quantity for any item to be the original plan quantity and authorizes a plan change which results in an increase or decrease in the quantity of that item, the Department will revise the plan quantity accordingly. In general, the Department will determine such revisions by final measurement, plan calculations or both.

9-3.2.3 Specified Adjustments to Pay Quantities: Do not apply the limitations specified in 9-3.2.1 and 9-3.2.2 to the following:

(1) Where these Specifications or Special Provisions provide that the Department determines the pay quantity for an item on the basis of area of finished work adjusted in accordance with the ratio of measured thickness to nominal thickness.

(2) Where these Specifications provide for a deduction due to test results falling outside of the allowable specified tolerances.

(3) To payment for extra length fence posts, as specified in 550-6.3.

9-3.3 Lump Sum Quantities:

9-3.3.1 Error in Lump Sum Quantity: Where the Department designates the pay quantity for an item to be a lump sum and the plans show an estimated quantity, the Department will adjust the lump sum compensation only in the event that either the Contractor submits satisfactory evidence or the Department determines and furnishes satisfactory evidence that the lump sum quantity shown is in substantial error as defined in 9-3.2.1.

EROSION CONTROL PLAN FORMAT.
(REV 2-14-11) (1-13)

ARTICLE 104-5, Paragraph (3) (a) (Page 126) is deleted and the following substituted:

(a) Projects permitted by the Southwest Florida Water Management District (SWFWMD), require the following:

Submission of the erosion control plan for all Noticed General Permit projects to the Engineer for review and approval. No SWFWMD review or approval is required.

Submission of a copy of the erosion control plan, for all projects other than Noticed General Permit projects, to the Engineer for review and to the appropriate SWFWMD office for review and approval. Include the SWFWMD permit number on all submitted data or correspondence.

The Contractor may schedule a meeting with the appropriate SWFWMD Office to discuss his erosion control plan in detail, to expedite the review and approval process. Advise the Engineer of the time and place of any meetings scheduled with SWFWMD.

The Department will provide the requirements for the erosion control plan prior to the pre-construction meeting.

Prepare and submit an accurate and acceptable erosion control plan to the water management district. The SWFWMD may take up to 30 days to review and approve

the erosion control plan. Lack of sufficient information or detail may result in rejection of the plan. Re-submittal of a revised plan initiates another 30 day review and approval period.

SWFWMD personnel have requested the following information, at a minimum, be included in the plan.

(1) Modify the key map from the construction plans showing the location of the project, a list of the erosion control items to be used on the project and a legend depicting what erosion control items are to be used on the project. Legend items may be in any format that allows the reviewer to understand which items are located where. They may be various shapes. Colored pencil, felt tip pens, cross hatching, or other means may also be used.

(2) Modify the plan/profile sheets from the construction plans to show the actual location of the erosion control devices. Each sheet should have a legend box showing what erosion control items are being used on that sheet. The legend box shall also describe what pattern or colors are being used to denote each type of erosion control device.

(3) Include a narrative in the submittal that details the length of time the items will be in place, maintenance schedules and methods of containment and removal of pollutants or hazardous wastes. Provide the name and telephone number of the contact person responsible for monitoring and maintaining the erosion control devices.

(4) The information described above is the minimum information that should be provided in the submittal. Include additional information that will assist SWFWMD in reviewing the erosion control plan. Errors or omissions may result in lengthening the time required to get the erosion control plan approved.

(5) Submit the erosion control plan to the Southwest Florida Water Management District Service Office which issued the specific permit, addresses and telephone numbers are shown below.

For those projects located in Polk County, Hardee County and Highlands County contact the following office.

(a) Bartow Service Office
Southwest Florida Water Management District
170 Century Boulevard
Bartow, Florida 33830-7700
1-800-492-7862 or 1-863-534-1448

For those projects located in Manatee County, Sarasota County, DeSoto County, and Charlotte County contact the following office.

(b) Sarasota Service Office
Southwest Florida Water Management District
6750 Fruitville Road
Sarasota, Florida 34240-9711
1-800-320-3503 or 1-941-377-3722

(6) Submit four (4) sets of the erosion control plan to the appropriate SWFWMD Service Office. Request in the transmittal letter that two sets of the approved erosion control plan be returned. Retain one set for the files and provide one set to the Engineer.

Do not begin construction activities until the erosion control plan receives written approval from both SWFWMD and the Engineer.

EXCAVATION AND EMBANKMENT – ACCEPTANCE PROGRAM.
(REV 9-16-09) (FA 11-9-09) (1-13)

SUBRTICLE 120-10.3.1 (Page 168) is deleted and the following substituted:

120-10.3.1 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Test Name	Quality Control	Verification	Verification of Shoulder Only Areas, Bike/Shared Use Paths, and Sidewalks
Standard Proctor Maximum Density	One per soil type	One per soil type	One per soil type
Density	One per LOT	One per eight LOTs and for wet conditions, the first lift not affected by water	One per two LOTs
Soil Classification	One per Standard Proctor Maximum Density	One per Standard Proctor Maximum Density	One per Standard Proctor Maximum Density

EXCAVATION FOR STRUCTURES AND PIPE – ACCEPTANCE PROGRAM.
(REV 9-16-09) (FA 11-9-09) (1-13)

SUBARTICLE 125-9.3.1 (Page 183) is deleted and the following substituted:

125-9.3.1 Frequency: Conduct QC Standard Proctor maximum density sampling and testing at a minimum frequency of one test per soil type. The verification test will be at a minimum of one test per soil type:

Test Name	Quality Control	Verification
Standard Proctor Maximum Density	One per soil type	One per soil type
Density	One per LOT	One per eight LOTs and for wet conditions, the first lift not affected by water
Soil Classification	One per Standard Proctor Maximum density	One per Standard Proctor Maximum density

STABILIZING – ACCEPTANCE PROGRAM.
(REV 9-16-09) (FA 11-9-09) (1-13)

SUBARTICLE 160-4.2.4 (Page 194) is deleted and the following substituted:

160-4.2.4 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Test Name	Quality Control	Verification	Verification for Shoulder Only, Bike/Shared Use Path and Sidewalk Construction
Modified Proctor Maximum Density	One per two consecutive LOTs	One per sixteen consecutive LOTs	One per four LOTs
Density	One per LOT	One per eight LOTs	One per two LOTs
Stabilizing Mixing Depth	Three per 500 feet	Witness one per LOT	Witness one per LOT
LBR	One per two consecutive LOTs	One per sixteen consecutive LOTs	One per four LOTs
Gradation, LL/PI & Soil Classification (Local materials)	Not Required	One per sixteen consecutive LOTs	One per four LOTs

ROCK BASE – ACCEPTANCE PROGRAM.
(REV 9-16-09) (FA 11-9-09) (1-13)

SUBARTICLE 200-7.2.2 (Page 204) is deleted and the following substituted:

200-7.2.2 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Mainline Pavement Lanes, Turn Lanes, Ramps, Parking Lots, Concrete Box Culverts and Retaining Wall Systems		
Test Name	Quality Control	Verification
Modified Proctor Maximum Density	One per eight consecutive LOTs	One per 16 consecutive LOTs
Density	One per LOT	One per eight LOTs
Roadway Surface	Ten per LOT	Witness
Roadway Thickness	Three per LOT	Witness

Shoulder-Only, Bike/Shared Use Path and Sidewalk Construction		
Test Name	Quality Control	Verification
Modified Proctor Maximum Density	One per two LOTs	One per four LOTs
Density	One per LOT	One per two LOTs
Surface	Five per 500 feet	Witness
Thickness	Three per 1000 consecutive feet	Witness

PORTLAND CEMENT CONCRETE – ACCEPTANCE SAMPLING FREQUENCY. (REV 6-25-10) (FA 7-8-10) (1-13)

SUBARTICLE 346-9.2 (Pages 320 - 321) is deleted and the following substituted:

346-9.2 Sampling Frequency for Quality Control Tests:

As a minimum, sample and test concrete of each design mix for water to cementitious materials ratio, air content, temperature, slump and compressive strength once per LOT as defined by Table 8. When more than one concrete production facility is used for the same mix design, describe the method of sampling, testing and LOT numbering in the QC Plan. The Engineer will randomly verify one of every eight consecutive LOTs of each design mix based on a random number generator, and may perform additional Independent Verification tests. All QC activities, calculations, and inspections will be randomly confirmed by the Department.

TABLE 8	
Class Concrete	Maximum LOT Size
I	one day's production
I (Pavement)	250 lane ft, or one day's production, whichever is less
II, II (Bridge Deck), III, IV, V (Special), V, VI	50 yd^3, or one day's production, whichever is less
IV (Drilled Shaft)	50 yd^3, or two hours between placements, whichever is less
III (Seal)	Each Seal placement

346-9.2.1 Reduced Frequency for Acceptance Tests: When ten consecutive strength test results from the same mix design for a Class IV or higher class of concrete are produced at the same concrete production facility, on a given Contract have all been verified and have attained an average strength greater than two standard deviations above the specified minimum, then the LOT may represent a maximum production quantity of 100 yd^3. When five consecutive strength test results from the same mix design for a Class III or lower class of concrete is produced at the same concrete production facility on a given Contract have all been

verified and have attained an average strength greater than two standard deviations above the specified minimum, the LOT may represent a maximum production quantity of 100 yd^3.

The average of the consecutive compressive strength test results, based on the class of concrete, can be established using historical data from a previous Department project. The data must also represent the same prime/subcontractor. The tests from the previous Department project must be within the last 60 calendar days or may also be established by a succession of samples on the current project. Only one sample can be taken from each LOT. Test data must be from a laboratory meeting the requirements of Section 105.

If at any time a strength test is not verified and/or the average strength of the previous ten or five consecutive samples based on the class of concrete described above, from the same mix design and the same production facility is less than the specified minimum plus two standard deviations, the maximum production quantity represented by the LOT will return to 50 yd^3. In order to reinitiate reduced frequency, a new set of strength test results will be required.

SUPPLEMENTAL SPECIFICATIONS

102 MAINTENANCE OF TRAFFIC.
(REV 10-9-12) (1-13)

SECTION 102 (Pages 106 – 122) is deleted and the following substituted:

SECTION 102
MAINTENANCE OF TRAFFIC

102-1 Description.

Maintain traffic within the limits of the project for the duration of the construction period, including any temporary suspensions of the work. Construct and maintain detours. Provide facilities for access to residences, businesses, etc., along the project. Furnish, install and maintain traffic control and safety devices during construction. Furnish and install work zone pavement markings for maintenance of traffic (MOT) in construction areas. Provide any other special requirements for safe and expeditious movement of traffic specified in the Plans. MOT includes all facilities, devices and operations as required for safety and convenience of the public within the work zone.

Do not maintain traffic over those portions of the project where no work is to be accomplished or where construction operations will not affect existing roads. Do not obstruct or create a hazard to any traffic during the performance of the work, and repair any damage to existing pavement open to traffic.

Include the cost of any work that is necessary to meet the requirements of the Contract Documents under the MOT pay item, when there is not a pay item provided.

102-2 Materials.

Meet the following requirements:

Bituminous Adhesive	Section 970
Temporary Retroreflective Pavement Markers	Section 990
Paint	Section 971
Removable Tape	Section 990
Glass Spheres	Section 971
Temporary Traffic Control Device Materials	Section 990
Retroreflective and Nonreflective Sheeting for Temporary Traffic Control Devices	Section 994

102-2.1 Temporary Traffic Control Devices: Use only the materials meeting the requirements of Section 990, Section 994, Design Standards and the Manual on Uniform Traffic Control Devices (MUTCD).

102-2.2 Detour: Provide all materials for the construction and maintenance of all detours.

102-2.3 Commercial Materials for Driveway Maintenance: Provide materials of the type typically used for base, including recycled asphalt pavement material, and having stability and drainage properties that will provide a firm surface under wet conditions.

102-3 Specific Requirements.

102-3.1 Beginning Date of Contractor's Responsibility: Maintain traffic starting the day work begins on the project or on the first day Contract time is charged, whichever is earlier.

102-3.2 Worksite Traffic Supervisor: Provide a worksite traffic supervisor in accordance with Section 105. Provide the worksite traffic supervisor with all equipment and materials needed to set up, take down, maintain traffic control, and handle traffic-related situations.

Ensure that the worksite traffic supervisor performs the following duties:

1. Performs on site direction of all traffic control on the project.
2. Is on site during all set up and take down, and performs a drive through inspection immediately after set up.
3. Is on site during all nighttime operations to ensure proper MOT.
4. Immediately corrects all safety deficiencies and does not permit minor deficiencies that are not immediate safety hazards to remain uncorrected for more than 24 hours.
5. Is available on a 24 hour per day basis and present within 45 minutes after notification of an emergency situation and is prepared to positively respond to repair the work zone traffic control or to provide alternate traffic arrangements.
6. Conducts daily daytime and weekly nighttime inspections of projects with predominately daytime work activities, and daily nighttime and weekly daytime inspections of projects with predominantly nighttime work activities of all traffic control devices, traffic flow, pedestrian, bicyclist, and business accommodations.

Advise the project personnel of the schedule of these inspections and give them the opportunity to join in the inspection as is deemed necessary. Submit a comprehensive weekly report, using the Department's currently approved form, to the Engineer detailing the condition of all traffic control devices (including pavement markings) being used. Include assurances in the inspection report that pedestrians are accommodated with a safe, accessible travel path around work sites separated from mainline traffic in compliance with the Americans with Disabilities Act (ADA) Standards for Transportation Facilities, that existing or detoured bicyclist paths are being maintained satisfactorily throughout the project limits, and that existing businesses in work areas are being provided with adequate entrances for vehicular and pedestrian traffic during business hours. Have the worksite traffic supervisor sign the report and certify that all of the above issues are being handled in accordance with the Contract Documents. When deficiencies are found, the worksite traffic supervisor is to note such deficiencies and include the proposed corrective actions, including the date corrected.

The Department may disqualify and remove from the project a worksite traffic supervisor who fails to comply with the provisions of this Section. The Department may temporarily suspend all activities, except traffic, erosion control and such other activities that are necessary for project maintenance and safety, for failure to comply with these provisions.

102-4 Alternative Traffic Control Plan.

The Contractor may propose an alternative traffic control plan (TCP) to the plan presented in the Contract Documents. Have the Contractor's Engineer of Record sign and seal the alternative plan. Prepare the TCP in conformance with and in the form outlined in the current version of the Department's Plans Preparation Manual. Indicate in the plan a TCP for each phase of activities. Take responsibility for identifying and assessing any potential impacts to a utility that may be caused by the alternate TCP proposed by the Contractor, and notify the Department in writing of any such potential impacts to utilities.

Engineer's approval of the alternate TCP does not relieve the Contractor of sole responsibility for all utility impacts, costs, delays or damages, whether direct or indirect, resulting from Contractor initiated changes in the design or construction activities from those in

the original Contract Specifications, Design Plans (including TCPs) or other Contract Documents and which effect a change in utility work different from that shown in the Utility Plans, joint project agreements or utility relocation schedules.

The Department reserves the right to reject any alternative TCP. Obtain the Engineer's written approval before beginning work using an alternate TCP. The Engineer's written approval is required for all modifications to the TCP. The Engineer will only allow changes to the TCP in an emergency without the proper documentation.

102-5 Traffic Control.

102-5.1 Standards: FDOT Design Standards are the minimum standards for the use in the development of all TCPs. The MUTCD, Part VI is the minimum national standard for traffic control for highway construction, maintenance, and utility operations. Follow the basic principles and minimum standards contained in these documents for the design, application, installation, maintenance, and removal of all traffic control devices, warning devices and barriers which are necessary to protect the public and workers from hazards within the project limits.

102-5.2 Maintenance of Roadway Surfaces: Maintain all lanes that are being used for the MOT, including those on detours and temporary facilities, under all weather conditions. Keep the lanes reasonably free of dust, potholes and rutting. Provide the lanes with the drainage facilities necessary to maintain a smooth riding surface under all weather conditions.

102-5.3 Number of Traffic Lanes: Maintain one lane of traffic in each direction. Maintain two lanes of traffic in each direction at existing four (or more) lane cross roads, where necessary to avoid undue traffic congestion. Construct each lane used for MOT at least as wide as the traffic lanes existing in the area before commencement of construction. Do not allow traffic control and warning devices to encroach on lanes used for MOT.

The Engineer may allow the Contractor to restrict traffic to one-way operation for short periods of time provided that the Contractor employs adequate means of traffic control and does not unreasonably delay traffic. When a construction activity requires restricting traffic to one-way operations, locate the flaggers within view of each other when possible. When visual contact between flaggers is not possible, equip them with 2-way radios, official, or pilot vehicles, or use traffic signals.

102-5.4 Crossings and Intersections: Provide and maintain adequate accommodations for intersecting and crossing traffic. Do not block or unduly restrict any road or street crossing the project unless approved by the Engineer. Before beginning any construction, provide the Engineer the names and phone numbers of persons that can be contacted when signal operation malfunctions.

102-5.5 Access for Residences and Businesses: Provide continuous access to all residences and all places of business.

102-5.6 Protection of the Work from Injury by Traffic: Where traffic would be injurious to a base, surface course, or structure constructed as a part of the work, maintain all traffic outside the limits of such areas until the potential for injury no longer exists.

102-5.7 Flagger: Provide trained flaggers in accordance with Section 105.

102-5.8 Conflicting Pavement Markings: Where the lane use or where normal vehicle or pedestrian paths are altered during construction, remove all pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) that will conflict with the adjusted vehicle or pedestrian paths. Use of paint to cover conflicting pavement markings is prohibited. Remove conflicting pavement markings using a method that will not damage the surface texture of the

pavement and which will eliminate the previous marking pattern regardless of weather and light conditions.

Remove all pavement markings that will be in conflict with "next phase of operation" vehicle pedestrian paths as described above, before opening to vehicle traffic or use by pedestrians.

Cost for removing conflicting pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) to be included in Maintenance of Traffic, Lump Sum.

102-5.9 Vehicle and Equipment Visibility: Equip all pickups and automobiles used on the project with a minimum of one Class 2 amber or white warning light that meets the Society of Automotive Engineers Recommended Practice SAE J595, dated November 1, 2008, or SAE J845, dated December 1, 2007, and incorporated herein by reference. Existing lights that meet SAE J845, dated March, 1992, or SAE J1318, dated April, 1986, may be used to its end of service life. Lights should be unobstructed by ancillary vehicle equipment such as ladders, racks or booms. If the light is obstructed, additional lights will be required. The lights shall be operating when a vehicle is in a work area where a potential hazard exists, when operating the vehicle at less than the average speed for the facility while performing work activities, making frequent stops or called for in the Plans or Design Standards.

Equip all other vehicles and equipment with a minimum of 4 square feet of retroreflective sheeting or flashing lights.

To avoid distraction to motorists, do not operate the lights on the vehicles or equipment when the vehicles are outside the clear zone or behind a barrier.

102-5.10 No Waiver of Liability: Conduct operations in such a manner that no undue hazard results due to the requirements of this Article. The procedures and policies described herein in no way acts as a waiver of any terms of the liability of the Contractor or his surety.

102-6 Detours.

102-6.1 General: Construct and maintain detour facilities wherever it becomes necessary to divert traffic from any existing roadway or bridge, or wherever construction operations block the flow of traffic.

102-6.2 Construction: Plan, construct, and maintain detours for the safe passage of traffic in all conditions of weather. Provide the detour with all facilities necessary to meet this requirement. Where pedestrian facilities are detoured, blocked or closed during the work, provide safe alternate accessible routes through or around the work zone meeting the requirements of the ADA Standards for Transportation Facilities.

When the Plans call for the Department to furnish detour bridge components, construct the pile bents in accordance with the Plans, unless otherwise authorized by the Engineer.

Submit a letter with the following: company name, phone number, office address, project contact person, project number, detour bridge type, bridge length, span length, location and usage time frames, to the Engineer at least 30 calendar days before the intended pick-up date, to obtain the storage facility location and list of components for the project. Upon receipt of letter, the Engineer will, within ten calendar days provide an approved material list to the Contractor and the appropriate Department storage yard.

Provide a letter with an original company seal, identifying the representative with authority to pick up components, to the Engineer at least 10 calendar days before the proposed pick-up date. The Department is not obligated to load the bridge components without this notice. Take responsibility and sign for each item loaded at the time of issuance.

Provide timber dunnage, and transport the bridge components from the designated storage facility to the job site. Unload, erect, and maintain the bridge, then dismantle the bridge and load and return the components to the designated storage facility.

Notify the Engineer in writing at least 10 calendar days before returning the components. Include in this notice the name of the Contractor's representative authorized to sign for return of the bridge components. The yard supervisor is not obligated to unload the bridge components without this notice.

The Department will provide equipment and an operator at the Department's storage facility to assist in loading and unloading the bridge components. Furnish all other labor and equipment required for loading and unloading the components.

The Departments representative will record all bridge components issued or returned on the Detour Bridge Issue and Credit Ticket. The tickets must be signed by a Department and a Contractor representative, after loading or unloading each truck to document the quantity and type of bridging issued or returned.

Bind together all bridge components to be returned in accordance with the instructions given by the storage facility. The yard supervisor will repack components that are not packed in compliance with these instructions. Upon request, written packing instructions will be made available to the Contractor, before dismantling of the bridge for return to the Department's storage facility.

Assume responsibility for any shortage or damage to the bridge components. Monies due the Contractor will be reduced at the rate of $35.00 per hour plus materials for repacking, repairs or replacement of bridge components.

The skid resistance of open steel grid decking on the detour bridge may decrease gradually after opening the bridge to traffic. The Department will furnish a pneumatic floor scabbler machine for roughening the roadway surface of the detour bridge decking. Provide an air compressor at the job site with 200 cubic foot per minute capacity, 90 psi air pressure for the power supply of the machine, and an operator. Transport the scabbler machine to and from the Department's structures shop. Repair any damage to the scabbler machine caused by operations at no expense to the Department. Perform scabbling when determined necessary by the Engineer. The Department will pay for the cost of scabbling as Unforeseeable Work in accordance with 4-4.

Return the bridge components to the designated storage facility beginning no later than 10 calendar days after the date the detour bridge is no longer needed, the date the new bridge is placed in service, or the date Contract Time expires, whichever is earliest. Return the detour bridging at an average of not less than 200 feet per week. Upon failure to return the bridge components to the Department within the time specified, compensate the Department for the bridge components not returned at the rate of $5.00 per 10 feet, per day, per bridge, for single lane; and $10.00 per 10 feet, per day, per bridge, for dual lane until the bridge components are returned to the Department.

102-6.3 Construction Methods: Select and use construction methods and materials that provide a stable and safe detour facility. Construct the detour facility to have sufficient durability to remain in good condition, supplemented by maintenance, for the entire period that the detour is required.

102-6.4 Removal of Detours: Remove detours when they are no longer needed and before the Contract is completed. Take ownership of all materials from the detour and dispose of

them, except for the materials on loan from the Department with the stipulation that they are returned.

102-6.5 Detours Over Existing Roads and Streets: When the Department specifies that traffic be detoured over roads or streets outside the project area, do not maintain such roads or streets. However, maintain all signs and other devices placed for the purpose of the detour.

102-6.6 Operation of Existing Movable Bridges: The Department will maintain and operate existing moveable bridges that are to be removed by the Contractor until such time as they are closed to traffic. During this period, make immediate repairs of any damage to such structures caused by use or operations related to the work at no expense to the Department, but do not provide routine repairs or maintenance. In the event that use or operations result in damage to a bridge requiring repairs, give such repairs top priority to any equipment, material, or labor available.

102-7 Traffic Control Officer.

Provide uniformed law enforcement officers, including marked law enforcement vehicles, to assist in controlling and directing traffic in the work zone when the following types of work is necessary on projects:

1. Directing traffic/overriding the signal in a signalized intersection.
2. When Design Standards, Index No. 619 is used on freeway facilities (interstates, toll roads, and expressways) at nighttime for work within the travel lane.
3. When Design Standards, Index No. 655 Traffic Pacing for overhead work is called for in the Plans or approved by the Engineer.
4. When pulling conductor/cable above an open traffic lane on limited access facilities, when called for in the Plans or approved by the Engineer.
5. When Design Standards, Index No. 625 Temporary Road Closure 5 Minutes or Less is used.

102-8 Driveway Maintenance.

102-8.1 General: Ensure that each residence and business has safe, stable, and reasonable access.

102-8.2 Construction Methods: Place, level, manipulate, compact, and maintain the material, to the extent appropriate for the intended use.

As permanent driveway construction is accomplished at a particular location, the Contractor may salvage and reuse previously placed materials that are suitable for reuse on other driveways.

102-9 Temporary Traffic Control Devices.

102-9.1 Installation and Maintenance: Install and maintain temporary traffic control devices as detailed in the Plans, Index 600 of the Design Standards and when applicable, in accordance with the approved vendor drawings, as provided on the Department's Qualified Products List (QPL) or the Department's Approved Products List (APL). Erect the required temporary traffic control devices to prevent any hazardous conditions and in conjunction with any necessary traffic re-routing to protect the traveling public, workers, and to safeguard the work area. Use only those devices that are on the QPL or the APL. Immediately remove or cover any devices that do not apply to existing conditions.

All temporary traffic control devices must meet the requirements of National Cooperative Highway Research Program Report 350 (NCHRP 350) or the Manual for Assessing

Safety Hardware 2009 (MASH) and current FHWA directives. Manufacturers seeking evaluation must furnish certified test reports showing that their product meets all test requirements set forth by NCHRP 350 or the MASH. Manufacturers seeking evaluation of Category I devices for inclusion on the QPL shall include the manufacturer's self-certification letter. Manufacturer's seeking evaluation of Category II and Category III devices for inclusion on the QPL shall include the FHWA WZ numbered acceptance letter with attachments and vendor drawings of the device in sufficient detail to enable the Engineer to distinguish between this and similar devices. For devices requiring field assembly or special site preparation, vendor drawings shall include all field assembly details and technical information necessary for proper application and installation and must be signed and sealed by a Professional Engineer registered in the State of Florida. Manufacturers seeking evaluation of Category IV devices for inclusion on the QPL or APL must comply with the requirements of Section 990 and include detailed vendor drawings of the device along with technical information necessary for proper application, field assembly and installation.

Ensure that the QPL or APL number is permanently marked on the device at a readily visible location. Sheeting used on devices is exempt from this marking requirement.

Notify the Engineer of any scheduled operation which will affect traffic patterns or safety sufficiently in advance of commencing such operation to permit his review of the plan for the proposed installation of temporary traffic control devices.

Ensure an employee is assigned the responsibility of maintaining the position and condition of all temporary traffic control devices throughout the duration of the Contract. Keep the Engineer advised at all times of the identification and means of contacting this employee on a 24 hour basis.

Keep temporary traffic control devices in the correct position, properly directed, clearly visible and clean, at all times. Ensure that all traffic control devices meet acceptable standards as outlined in American Traffic Safety Services Association (ATSSA) "Quality Guidelines for Temporary Traffic Control Devices and Features". Immediately repair, replace or clean damaged, defaced or dirty devices.

102-9.2 Work Zone Signs: Provide signs in accordance with the Plans and Design Standards. Meet the requirements of 700-2.5 and 990-8 Use only approved systems, which includes sign support posts or stands and attachment hardware (nuts, bolts, clamps, brackets, braces, etc.), meeting the vendor requirements specified on the QPL drawings.

Attach the sign to the sign support using hardware meeting the manufacturer's recommendations and as specified in the Design Standards.

Provide Federal Highway Administration's (FHWA) accepted sign substrate for use with accepted sign stands on the National Highway System (NHS) under the provisions of the NCHRP Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

102-9.3 Business Signs: Provide and place signs in accordance with the Plans and Design Standards, Index No. 600 series. Furnish signs having retroreflective sheeting meeting the requirements of Section 990.

102-9.4 High Intensity Flashing Lights: Furnish Type B lights in accordance with the Plans and Design Standards.

102-9.5 Warning/Channelizing Devices: Furnish warning/channelizing devices in accordance with the Plans and Design Standards.

102-9.5.1 Retroreflective Collars for Traffic Cones: Use collars for traffic cones listed on the QPL that meet the requirements of Section 990. Use cone collars at night designed to properly fit the taper of the cone when installed. Place the upper 6 inch collar a uniform 3-1/2 inches distance from the top of the cone and the lower 4 inch collar a uniform 2 inches distance below the bottom of the upper 6 inch collar. Ensure that the collars are capable of being removed for temporary use or attached permanently to the cone in accordance with the manufacturer's recommendations. Provide a white sheeting having a smooth outer surface and that has the property of a retroreflector over its entire surface.

102-9.5.2 Barrier Wall (Temporary): Furnish, install, maintain, remove and relocate a temporary barrier wall in accordance with the Plans. Ensure that temporary concrete barrier wall for use on roadway sections, complies with Design Standards, Index Nos. 412, 415 or 414 as specified in the Plans. Ensure that temporary concrete barrier wall for use on bridge and wall sections, complies with Design Standards, Index No 414 as specified in the Plans. Ensure that temporary water filled barrier wall used on roadway sections meets the NCHRP Report 350 criteria or the MASH and is listed on the QPL. Barriers meeting the requirements of Design Standards, Index Nos. 412, 415 or temporary water filled barriers on the QPL will not be accepted as an alternate to barriers meeting the requirements of Design Standards, Index No. 414.

102-9.5.3 Glare Screen (Temporary): Use temporary glare screens listed on the QPL that meet the requirements of Section 990. Furnish, install, maintain, remove and relocate glare screen systems in conjunction with temporary barrier wall at locations identified in the Plans.

Ensure the anchorage of the glare screen to the barrier is capable of safely resisting an equivalent tensile load of 600 pounds per foot of glare screen, with a requirement to use a minimum of three fasteners per barrier section.

When glare screen is utilized on temporary barrier wall, warning lights will not be required.

102-9.6 Temporary Crash Cushion (Redirective/Gating): Furnish, install, maintain and subsequently remove temporary crash cushions in accordance with the details and notes shown in the Plans, the Design Standards, and requirements of the pre-approved alternatives listed on the QPL. Maintain the crash cushions until their authorized removal. Repair all attachment scars to permanent structures and pavements after crash cushion removal. Make necessary repairs due to defective material, work, or Contractor operations at no cost to the Department. Restore crash cushions damaged by the traveling public within 24 hours after notification as authorized by the Engineer.

102-9.7 Guardrail (Temporary): Furnish guardrail (temporary) in accordance with the Plans and Design Standards. Meet the requirements of Section 536.

102-9.8 Arrow Board: Furnish arrow boards that meet the requirements of Section 990 as required by the Plans and Design Standards to advise approaching traffic of lane closures or shoulder work. Type B arrow boards may be used on low to intermediate speed (0 mph to 50 mph) facilities or for maintenance or moving operations on any speed facility. Type C arrow boards shall be used for all other operations on high-speed (50 mph and greater) facilities and may be substituted for Type B arrow boards on any speed facility.

102-9.9 Portable Changeable Message Sign (PCMS): Furnish PCMSs that meet the requirements of Section 990 as required by the Plans and Design Standards to supplement other temporary traffic control devices used in work zones.

A truck mounted PCMS may be used as a stand alone MOT device only when used for accident or incident management situations as defined in the MUTCD and is listed on the APL.

102-9.10 Portable Regulatory Signs (PRS): Furnish PRSs that meet the requirements of 990 as required by the Plans and Design Standards.

Activate portable regulatory signs only during active work activities and deactivate when no work is being performed.

102-9.11 Radar Speed Display Unit (RSDU): Furnish RSDUs that meet the requirements of Section 990 as required by the Plans and Design Standards to inform motorists of the posted speed and their actual speed.

Activate the radar speed display unit only during active work activities and deactivate when no work is being performed.

102-9.12 Temporary Signalization and Maintenance: Provide temporary signalization and maintenance at existing, temporary, and new intersections including but not limited to the following:

(1) Installation of temporary poles and span wire assemblies as shown in the Plans,

(2) Temporary portable traffic signals as shown in the Plans,

(3) Adding or shifting signal heads,

(4) Trouble calls,

(5) Maintaining intersection and coordination timing and preemption devices.

Restore any loss of operation within 12 hours after notification.

Provide traffic signal equipment that meets the requirements of the Design Standards and 603-2. The Engineer may approve used signal equipment if it is in acceptable condition. Replacement components for traffic signal cabinet assemblies will be provided by the maintaining agency.

102-9.13 Temporary Traffic Detection and Maintenance: Provide temporary traffic detection and maintenance at existing, temporary, and new signalized intersections. Provide temporary traffic detection equipment listed on the APL. Restore any loss of detection within 12 hours. Ensure 90% accuracy per signal phase, measured at the initial installation and after any lane shifts, by comparing sample data collected from the detection system with ground truth data collected by human observation. Collect the sample and ground truth data for a minimum of five minutes during a peak and five minutes during an off-peak period with a minimum three detections for each signal phase. Perform the test in the presence of the Engineer.

102-9.14 Truck Mounted Attenuators and Trailer Mounted Attenuators: Furnish, install and maintain only those attenuators that meet the requirements of NCHRP 350 or the MASH.

Use truck mounted attenuators or trailer mounted attenuators, when called for in the Design Standards. Use attenuators listed on the QPL.

When attenuators are called for, use either a truck mounted attenuator or a trailer mounted attenuator system designed and installed in accordance with the manufacturers recommendations.

Equip the attenuator cartridge with lights and reflectors in compliance with applicable Florida motor vehicle laws, including turn signals, dual tail lights, and brake lights.

Ensure that lights are visible in both the raised and lowered positions if the unit is capable of being raised.

Ensure that the complete unit is painted DOT yellow (Fed. Std. 595 b, No. 13538). Stripe the rear facing of the cartridge in the operating position with the alternating 6 inch white and 6 inch safety orange 45 degree striping to form an inverted "V" at the center of the unit and slope down and toward the outside of the unit, in both directions from the center. In the raised position, place at least the same square footage of striping on the bottom of the cartridge as placed on the rear facing cartridge in the open position. Use Type III retroreflectorized sheeting for striping.

Attenuators will not be paid for separately. Include the cost of the truck with either a truck mounted attenuator or a trailer mounted attenuator in MOT Lump Sum. Payment includes all costs, including furnishing, maintaining and removal when no longer required, and all materials, labor, tools, equipment and incidentals required for attenuator maintenance.

102-9.15 Temporary Raised Rumble Strip Sets: When called for in the Plans, furnish, install, maintain, remove, and reinstall temporary raised rumble strip sets.

Install the temporary raised rumble strip sets per the manufacturer's recommendations and in accordance with Design Standards, Index No. 600.

The temporary raised rumble strip may be either a removable polymer striping tape or a molded engineered polymer material.

102-9.16 Automated Flagger Assistance Devices (AFAD): Furnish, install, maintain, remove and relocate AFADs in accordance with the Plans and Design Standards. Position AFADs where they are clearly visible to oncoming traffic and out of the lane of traffic. The devices may be operated either by a single flagger at one end of the traffic control zone, from a central location, or by a separate flagger near each device's location.

AFADs may be either a remotely controlled Stop/Slow AFAD mounted on either a trailer or a movable cart system, or a remotely controlled Red/Yellow Lens AFAD.

AFADs will not be paid for separately. AFADs may be used as a supplement or an alternate to flaggers in accordance with Index 603. Include the cost for AFADs in Maintenance of Traffic Lump Sum.

102-9.17 Temporary Lane Separator: Furnish, install, maintain, remove and relocate temporary lane separator in accordance with the Plans and Design Standards, Index No 600. Anchor the portable temporary lane separator with a removable anchor bolt. Use epoxy on bridge decks where anchoring is not allowed. Remove the epoxy from the bridge deck by hydroblasting or other method approved by the Engineer.

102-10 Work Zone Pavement Marking.

102-10.1 Description: Furnish and install work zone pavement markings for MOT in construction areas and in close conformity with the lines and details shown in the Plans and Design Standards.

Centerlines, lane lines, edge lines, stop bars and turn arrows will be required in work zones prior to opening the road to traffic.

The most common types of work zone pavement markings are painted pavement markings and removable tape. Other types of work zone pavement markings may be identified in the Plans.

102.10.2 Painted Pavement Markings:

102-10.2.1 General: Use painted pavement markings meeting the requirements of Section 710. Use standard waterborne paint unless otherwise identified in the Plans or approved by the Engineer.

102-10.3 Removable Tape:

102-10.3.1 General: Use removable tape listed on the QPL and meeting the requirements of 990-4.

102-10.3.2 Application: Apply removable tape with a mechanical applicator to provide pavement lines that are neat, accurate and uniform. Equip the mechanical applicator with a film cut-off device and with measuring devices that automatically and accumulatively measure the length of each line placed within an accuracy tolerance of plus or minus 2%. Ensure removable tape adheres to the road surface. Removable tape may be placed by hand on short sections, 500 feet or less, if it is done in a neat accurate manner.

102-10.3.3 Retroreflectivity: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 300 mcd/lx·m2 for white and contrast markings and not less than 250 mcd/lx·m2 for yellow markings. Black portions of contrast tapes and black masking tapes must be non-reflective and have a reflectance of less than 5 mcd/lx m2. At the end of the six month service life, the retroreflectance of white and yellow removable tape shall not be less than 150 mcd/lx·m^2.

102-10.3.4 Removability: Provide removable tape capable of being removed from bituminous concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 40ºF, without the use of heat, solvents, grinding or blasting.

102-10.4 Temporary Retroreflective Pavement Markers (RPM's): Use markers listed on the QPL and meeting the requirements of 990-5. Apply all markers in accordance with the Design Standards, Index No. 600, prior to opening the road to traffic. Replace markers any time after installation when more than three consecutive markers fail or are missing, at no expense to the Department, in a timely manner, as directed by the Engineer.

102-11 Method of Measurement.

102-11.1 General: Devices installed/used on the project on any calendar day or portion thereof, within the allowable Contract Time, including time extensions which may be granted, will be paid for at the Contract unit price for the applicable pay item, except those paid for as Lump Sum.

102-11.2 Traffic Control Officers: The quantity to be paid for will be at the Contract unit price per hour (4 hour minimum) for the actual number of officers certified to be on the project site, including any law enforcement vehicles and all other direct and indirect costs. Payment will be made only for those traffic control officers specified in the Plans and authorized by the Engineer.

102-11.3 Special Detours: When a detour facility is specifically detailed in the Plans, or is otherwise described or detailed as a special item, and an item for separate payment is included in the proposal, the work of constructing, maintaining, and subsequently removing such detour facilities will be paid for separately. Traffic control devices, warning devices, barriers, signing, and pavement markings for special detours will also be paid for separately.

When the Plans show more than one detour, each detour will be paid for separately, at the Contract lump sum price for each.

Where a separate item for a specific detour facility is included in the proposal, payment will be made under special detour.

102-11.4 Commercial Material for Driveway Maintenance: The quantity to be paid for will be the certified volume, in cubic yards, of all materials authorized by the Engineer, acceptably placed and maintained for driveway maintenance. The volume, which is authorized to be reused, and which is acceptably salvaged, placed, and maintained in other designated driveways will be included again for payment.

102-11.5 Work Zone Signs: The number of temporary post-mounted signs (temporary regulatory, warning and guide) certified as installed/used on the project will be paid for at the Contract unit price for work zone signs. When multiple signs are located on single or multiple posts, each sign panel will be paid individually. Signs greater than 20 square feet and detailed in the Plans will be paid for under Lump Sum MOT.

Temporary portable signs (excluding mesh signs) and vehicular mounted signs will be included for payment under work zone signs, only if used in accordance with the Design Standards.

102-11.6. Business Signs: The number of business signs certified as installed/used on the project will be paid for at the Contract unit price for business signs.

102-11.7 High Intensity Flashing Lights: The number of high intensity flashing lights (Type B) certified as installed/used on the project will be paid for at the Contract unit price for high intensity flashing lights (temporary - Type B).

102-11.8 Channelizing Devices: The number of Type I, Type II, direction indicator barricade, Type III, vertical panel, drum and longitudinal channelizing devices certified as installed/used on the project meeting the requirements of Design Standards, Index No. 600 and have been properly maintained will be paid for at the Contract unit prices for barricade (temporary). Payment will be made for each channelizing device that is used to delineate trailer mounted devices. Payment will be made for channelizing devices delineating portable changeable message signs during the period beginning 14 working days before Contract Time begins as authorized by the Engineer.

102-11.9 Barrier Wall (Temporary): The Contract unit price for barrier wall (temporary) will be full compensation for furnishing, installing, maintaining, and removing the barrier wall. When called for, the Contract unit price for barrier wall (temporary/relocate) will be full compensation for relocating the barrier. The certified quantity to be paid for will be determined by the number of sections times the nominal length of each section.

102-11.10 Lights, Temporary, Barrier Wall Mount: The number of Type C steady burn lights, mounted on barrier wall, certified as installed/used on the project, meeting the requirements of the Design Standards and have been properly maintained will be paid for at the Contract unit price for lights temporary, barrier wall mount.

102-11.11 Glare Screen (Temporary): The certified quantity to be paid for will be determined by the number of sections times the nominal length of each section.

102-11.12 Temporary Crash Cushions:

102-11.12.1 Redirective: The quantity to be paid for will be the number of temporary crash cushions (redirective) certified as installed/used and maintained on the project, including object marker.

102-11.12.2 Gating: The quantity to be paid for will be the number of temporary crash cushions (gating) certified as installed/used and maintained on the project, including object marker.

102-11.13 Temporary Guardrail: The quantity to be paid for will be the length, in feet, of temporary guardrail constructed and certified as installed/used on the project. The length of a run of guardrail will be determined as a multiple of the nominal panel lengths.

102-11.14 Arrow Board: The quantity to be paid at the contract unit price will be for the number of arrow boards certified as installed/used on the project on any calendar day or portion thereof within the contract time.

102-11.15 Portable Changeable Message Sign: The quantity to be paid at the Contract unit price will be for the number of portable changeable message signs certified as installed/used on the project on any calendar day or portion thereof within the contract time. Payment will be made for each portable changeable message sign that is used during the period beginning fourteen working days before Contract Time begins as authorized by the Engineer.

102-11.16 Portable Regulatory Signs: The quantity to be paid for will be the number of portable regulatory signs certified as installed/used on the project on any calendar day or portion thereof within the Contract time, will be paid for the Contract unit price for portable regulatory sign.

102-11.17 Radar Speed Display Unit: The quantity to be paid for will be the number of radar speed display units certified as installed/used on the project on any calendar day or portion thereof within the Contract Time, will be paid for the Contract unit price for radar speed display unit.

102-11.18 Temporary Signalization and Maintenance: For existing intersections, the quantity to be paid for will be the number of signalized intersections per day for the full duration of the Contract. For temporary intersections, the quantity to be paid for will be the number of signalized intersections per day for the duration of the temporary intersection. No separate payment will be made for temporary signalization and maintenance at new intersections.

102-11.19 Temporary Traffic Detection and Maintenance: For existing intersections, the quantity to be paid for will be the number of signalized intersections per day beginning the day Contract Time begins and ending the day the permanent detection is operational and the final lane configuration is in place. For temporary and new intersections, the quantity to be paid for will be the number of signalized intersections per day beginning the day the temporary detection is functional and ending the day: the permanent detection is operational and the final lane configuration is in place for a new intersection; or, when the detection is removed for a temporary intersection.

102-11.20 Work Zone Pavement Markings: The quantities, furnished and installed, to be paid for will be the length of skip and solid pavement markings, and the area of pavement markings placed as follows:

(a) The total transverse distance, in feet, of skip pavement marking authorized and acceptably applied. The length of actual applied line will depend on the skip ratio of the material used. Measurement will be the distance from the beginning of the first stripe to the end of the last stripe with proper deductions made for unpainted intervals as determined by plan dimensions or stations, subject to 9-1.3.

(b) The net length, in feet, of solid pavement marking authorized and acceptably applied.

(c) The number of directional arrows or pavement messages authorized and acceptably applied.

(d) The number of temporary RPM's authorized and acceptably applied.

102-11.21 Temporary Raised Rumble Strips: The quantity to be paid for will be the number of temporary raised rumble strip sets certified as installed/used on the project on any calendar day or portion thereof within the Contract Time.

102-11.22 Temporary Lane Separator: The quantity of temporary lane separator to be paid for will be plan quantity, in feet, including drainage gaps, completed and accepted.

102-12 Submittals.

102-12.1 Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for certified MOT payment items for each project in the Contract. Submit the certification of quantities to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

102-12.2 Contractor's Certification of Quantities: Request payment by submitting a certification of quantities no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less an amount previously retained or withheld. The basis will include a detail breakdown provided on the certification of items of payment in accordance with 102-13. After the initial setup of the MOT items and counts, the interval for recording the counts will be made weekly on the certification sheet unless there is a change. This change will be documented on the day of occurrence. Some items may necessitate a daily interval of recording the counts.

102-13 Basis of Payment.

102-13.1 Maintenance of Traffic (General Work): When an item of work is included in the proposal, price and payment will be full compensation for all work and costs specified under this Section except as may be specifically covered for payment under other items.

102-13.2 Traffic Control Officers: Price and payment will be full compensation for the services of the traffic control officers.

102-13.3 Special Detours: Price and payment will be full compensation for providing all detour facilities shown in the Plans and all costs incurred in carrying out all requirements of this Section for general MOT within the limits of the detour, as shown in the Plans.

102-13.4 Commercial Materials for Driveway Maintenance: Price and payment will be full compensation for all work and materials specified for this item, including specifically all required shaping and maintaining of driveways.

102-13.5 Work Zone Signs: Price and payment will be full compensation for all work and materials for furnishing signs, supports and necessary hardware, installation, relocating, maintaining and removing signs.

102-13.6. Business Signs: Price and payment will be full compensation for all materials and labor required for furnishing, installing, relocating, maintaining, and removing the signs as well as the cost of installing any logos provided by business owners.

102-13.7 High Intensity Warning Lights: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing high intensity flashing lights (Type B).

102-13.8 Channelizing Devices: Prices and payment will be full compensation for furnishing, installing, relocating, maintaining and removing the channelizing devices, including the costs associated with attached warning lights as required.

102-13.9 Barrier Wall (Temporary): Price and payment will be full compensation for furnishing, installing, maintaining, and removing the barrier. When called for, barrier wall (temporary) (relocate) will be full compensation for relocating the barrier.

102-13.10 Lights, Temporary, Barrier Wall Mount: Price and payment will be full compensation for all work and materials for furnishing, installing and maintaining the warning lights mounted on barrier wall. Payment will not be made for lights that are improperly placed or are not working.

102-13.11 Glare Screen (Temporary): Price and payment will be full compensation for furnishing, installing, maintaining, and removing the glare screen certified as installed/used on the project. When called for, glare screen (relocate) will be full compensation for relocating the glare screen.

102-13.12 Temporary Crash Cushion (Redirective/Gating): Price and payment will be full compensation for furnishing, installing, maintaining and subsequently removing such crash cushions. Payment for restoring damaged crash cushions will be the manufacturer's/distributor's invoice price for the new materials/parts plus 20% markup. The 20% markup is compensation for all necessary work including; but not limited to, labor, equipment, supplies and profit, as authorized by the Engineer. Additional MOT required for the repair of the crash cushion will be paid for under the appropriate MOT pay item.

102-13.13 Temporary Guardrail: Price and payment will be full compensation for furnishing all materials required for a complete installation, including end anchorage assemblies and any end connections to other structures and for installing, maintaining and removing guardrail.

102-13.14 Arrow Board: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing arrow boards.

102-13.15 Portable Changeable Message Sign: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing portable changeable message signs.

102-13.16 Portable Regulatory Signs: Price and payment will be full compensation for furnishing, installing, relocating, maintaining and removing a completely functioning system as described in these Specifications portable regulatory signs. Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing portable regulatory signs.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and/or MOT operations.

102-13.17 Radar Speed Display Unit: Price and payment will be made only for a completely functioning system as described in these specifications. Payment will include all labor, hardware, accessories, signs, and incidental items necessary for a complete system. Payment will include any measurements needed to insure that the unit conforms to all specification requirements.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and/or MOT operations. Price and payment will be full

compensation for furnishing, installing, operating, relocating, maintaining and removing radar speed display unit.

102-13.18 Temporary Signalization and Maintenance: Price and payment will constitute full compensation for furnishing, installing, operating, maintaining and removing temporary traffic control signals including all equipment and components necessary to provide an operable traffic signal. Payment will be withheld for each day at each intersection where the temporary signalization is not operational within 12 hours after notification.

102-13.19 Temporary Traffic Detection and Maintenance: Price and payment will constitute full compensation for furnishing, installing, operating, maintaining and removing temporary traffic detection including all equipment and components necessary to provide an acceptable signalized intersection. Take ownership of all equipment and components. Payment will be withheld for each day at each intersection where the temporary detection is not operational within 12 hours after notification.

102-13.20 Temporary Raised Rumble Strips: Price and payment will be full compensation for all work and materials described in this Section, including all cleaning and preparing of surfaces, disposal of all debris, furnishing of all materials, application, curing, removal, reinstalling and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work.

102-13.21 Work Zone Pavement Markings: Price and payment 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 will be withheld until all deficiencies are corrected.

Removable tape may be substituted for work zone paint at no additional cost to the Department.

Payment for temporary RPMs used to supplement line markings will be paid for under temporary retroreflective pavement markers. Install these markers as detailed in the Design Standards.

102-13.22 Temporary Lane Separator: Price and payment will be full compensation for all work specified in this Section.

102-13.23 Payment Items: Payment will be made under:

Item No. 102- 1-	Maintenance of Traffic - lump sum.
Item No. 102- 2-	Special Detour - lump sum.
Item No. 102- 3-	Commercial Material for Driveway Maintenance - per cubic yard.
Item No. 102- 14-	Traffic Control Officer - per hour.
Item No. 102- 60-	Work Zone Sign - per each per day.
Item No. 102- 61-	Business Sign - each.
Item No. 102- 71-	Barrier Wall - per foot.
Item No. 102- 75-	Temporary Lane Separator - per foot
Item No. 102- 94-	Glare Screen - per foot.
Item No. 102- 73-	Guardrail (Temporary) - per foot.
Item No. 102- 74-	Barricade (Temporary) - per each per day.
Item No. 102- 76-	Arrow Board - per each per day.
Item No. 102- 77-	High Intensity Flashing Lights (Temporary - Type B) - per each per day.

Item No. 102- 78-	Temporary Retroreflective Pavement Markers - each.
Item No. 102- 79-	Lights, Temporary, Barrier Wall Mount - per each per day.
Item No. 102- 81-	Crash Cushion (Gating) (Temporary) - per location.
Item No. 102- 89-	Crash Cushion (Redirective) (Temporary) - per location.
Item No. 102- 99-	Portable Changeable Message Sign (Temporary) - per each per day.
Item No. 102-104-	Temporary Signalization and Maintenance - per intersection per day.
Item No. 102-107-	Temporary Traffic Detection and Maintenance - per intersection per day.
Item No. 102-150-	Portable Regulatory Sign - per each per day.
Item No. 102-150-	Radar Speed Display Unit - per each per day.
Item No. 102-910-	Temporary Raised Rumble Strip Set - per set per day
Item No. 102-911-	Removable Tape (White/Black) - per foot.
Item No. 102-912-	Removable Tape (Yellow) - per foot.
Item No. 710-	Painted Pavement Markings.
Item No. 711-	Thermoplastic Traffic Stripes and Markings.

105 CONTRACTOR QUALITY CONTROL GENERAL REQUIREMENTS – COMPLIANCE WITH THE MATERIALS MANUAL.

(REV 3-7-13) (FA 3-15-13) (7-13)

SUBARTICLE 105-3.2 (Page 134) is deleted and the following substituted:

105-3.2 Compliance with the Materials Manual.

Producers of Flexible Pipe shall meet the requirements of Section 6.1, Volume II of the Department's Materials Manual, which may be viewed at the following URL: http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section61.pdf .

Producers of Precast Concrete Pipe shall meet the requirements of Section 6.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL: http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section62.pdf .

Producers of Precast Concrete Drainage Structures shall meet the requirements of Section 6.3, Volume II of the Department's Materials Manual, which may be viewed at the following URL: http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section63.pdf .

Producers of Precast/Prestressed Concrete Products shall meet the requirements of Sections 8.1 and 8.3 of the Department's Materials Manual, which may be viewed at the following URLs: http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section81.pdf . http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section83.pdf .

Producers of Precast Prestressed Concrete Products using Self Consolidating Concrete shall meet the requirements of Section 8.4, Volume II of the Department's Materials Manual, which may be viewed at the following URL: http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section84.pdf

Producers of Incidental Precast/Prestressed Concrete Products shall meet the

requirements of Section 8.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section82.pdf .

Producers of Portland Cement Concrete shall meet the requirements of Section 9.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section92.pdf .

Producers of Structural Steel and Miscellaneous Metal Components shall meet the requirements of Sections 11.1, 11.2, 11.4 and 11.5 of the Department's Materials Manual, which may be viewed at the following URLs:
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section111.pdf .
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/section112.pdf .
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/files/Section114.pdf
http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/files/Section115.pdf

SUBARTICLE 105-8.8 (Page 140). The title of the Subarticle is deleted and the following substituted:

105-8.8 Supervisory Personnel – Post-Tensioned and Movable Bridge Structures:

SUBARTICLE 105-8.8.7.1 (Page 143) is deleted and the following substituted:

105-8.8.7.1 Post-Tensioning: Perform all PT field operations under the direct supervision of a Level II CTQP Qualified PT Technician who must be present at the site of the post-tensioning work during the entire duration of the operation. For the superstructures of bridges having concrete post-tensioned box or I girder construction, provide at least two CTQP qualified PT technicians, Level I or II, on the work crew. The supervisor of the work crew, who must be a Level II CTQP Qualified PT Technician, may also be a work crew member, in which case, the supervisor shall count as one of the two CTQP qualified work crew members. For PT operations other than the superstructures of post-tensioned box or I girder construction, perform all PT operations under the direct supervision of a Level II CTQP Qualified PT Technician who must be present at the site of the PT work during the entire duration of the operation. Work crew members are not required to be CTQP qualified.

SUBARTICLE 105-8.8.7.2 (Pages 143 - 144) is deleted and the following substituted:

105-8.8.7.2 Grouting: Perform all grouting field operations under the direct supervision of a Level II CTQP Qualified Grouting Technician who must be present at the site of the grouting work during the entire duration of the operation. For the superstructures of bridges having concrete post-tensioned box or I girder construction, provide at least two CTQP qualified grouting technicians, Level I or II, on the work crew. The supervisor of the work crew, who must be a Level II CTQP Qualified Grouting Technician, may also be a work crew member, in which case, the supervisor shall count as one of two CTQP qualified work crew members. For grouting operations other than the superstructures of post-tensioned box or I girder construction, perform

all grouting operations under the direct supervision of a Level II CTQP Qualified Grouting Technician who must be present at the site of the grouting work during the entire duration of the operation. Work crew members are not required to be CTQP qualified.

Perform all vacuum grouting operations under the direct supervision of a crew foreman who has been trained and has experience in the use of vacuum grouting equipment and procedures. Submit the crew foreman's training and experience records to the Engineer prior to performing any vacuum grouting operation.

107 LITTER REMOVAL AND MOWING.
(REV 12-3-12) (FA 12-12-12) (7-13)

Section 107 (Pages 147 - 148) is deleted and the following substituted:

SECTION 107
LITTER REMOVAL AND MOWING

107-1 Description.

Provide pickup, removal and disposal of litter within the project limits from the outside edge of travel way to the right of way line. Include the median on divided highways, from the inside edge of travel way to the inside edge of travel way. Litter includes; but is not limited to, bottles, cans, paper, tires, tire pieces, lumber, vehicle parts, metal junk, and brush debris. Exclude any inaccessible areas and area identified in the Plans as new landscaping in accordance with Section 580.

Mow turf or vegetation within the project limits. Turf consists of grasses planted in accordance with Section 570. Vegetation consists of planted and natural grasses, weeds, and other natural vegetation that have been preciously mowed. Exclude any areas indentified in the Plans as new landscaping in accordance with Section 580.

107-2 Operation.

107-2.1 Frequency: Begin litter removal in conjunction with the beginning of the project and continue per the frequency shown in the Plans, unless otherwise directed by the Engineer. Begin mowing when directed by the Engineer and continue per the frequency in the Plans, unless otherwise directed by the Engineer. Continue litter removal and mowing until final acceptance in accordance with 5-11. Mow all areas to obtain a uniform height of 6 inches.

After final acceptance, perform litter removal and mowing until new turf is established in accordance with 570-4 at no cost to the Department. Maintain turf and vegetation height between 6 inches and 12 inches. Do not include seed stalk or wildflowers when measuring height.

Perform litter removal prior to and in conjunction with mowing; however, the Engineer may direct litter pickups in addition to those performed in conjunction with mowing.

Do not mow new turf until a healthy root system is established. In designated wildflower areas, avoid cutting wildflowers when in bloom and when re-seeding.

107-2.2 General: Mow shoulders and medians concurrently so that not more than one mile will be left partially mowed at the conclusion of the working day. Mow turf and vegetation on slopes or around appurtenances concurrent with the mowing operation.

In areas saturated with standing water, mow or cut to the surface of the water using hand labor or other specialized equipment when standard equipment will cause damage.

Do not remove turf or other vegetation cuttings from the right-of-way, or rake or pick up the cuttings unless the cuttings are in the traveled ways, bike lanes, or sidewalk; are obstructing drainage structures; or are the result of cleaning the equipment.

107-2.3 Limitations: Maintain traffic in accordance with Section 102. When mowing within four feet of a travel lane, operate the equipment in the same direction of traffic, unless the adjacent lane is closed to traffic due to construction operations.

Perform all work during daylight hours.

107-2.4 Disposal of Litter and Debris: During each litter removal cycle, bag and remove all litter or piles at the end of each working day. Dispose of litter in accordance with applicable local and state laws. Do not store or stockpile litter within the project limits.

107-3 Method of Measurement.

For each litter removal cycle, the quantity to be paid will be the area, in acres, from which litter has been picked up, removed, and disposed, completed and accepted. The quantity will be determined by calculation using the lengths and widths based on the station to station dimensions shown in the plans.

For each mowing cycle, the quantity to be paid will be the area, in acres, of mowing, completed and accepted. The quantity will be determined by calculation using the lengths and widths based on the station to station dimensions shown in the plans.

107-4 Basis of Payment.

For litter removal, price and payment will be full compensation for all work specified in this section.

For mowing, price and payment will be full compensation for all work specified in this section.

No separate payment will be made for litter removal and mowing after final acceptance.

Payment will be made under:

Item No. 107 - 1- Litter Removal – per acre.

Item No. 107 - 2 - Mowing – per acre

125 EXCAVATION FOR STRUCTURES AND PIPE.
(REV 12-3-12) (FA 2-1-13) (7-13)

SUBARTICLE 125-8.1.1 (Pages 179 – 180) is deleted and the following substituted:

125-8.1.1 General: Backfill in the dry whenever normal dewatering equipment and methods can accomplish the needed dewatering. A LOT is defined as one lift of backfill material placement, not to exceed 500 feet in length or a single run of pipe connecting two successive structures, whichever is less. Backfill for structures and pipe compacted in one operation will be considered as one LOT within the cover zone. Backfill around structures compacted separately from the pipe will be considered as separate LOTs. Backfill on each side of the pipe for the first lift will be considered a separate LOT. Backfill on opposite sides of the pipe for the remaining lifts will be considered separate LOTs, unless the same compactive effort

is applied. Same compactive effort is defined as the same type of equipment (make and model) making the same number of passes on both sides of the pipe. For multiple phase backfill, a LOT shall not extend beyond the limits of the phase.

When placing backfill within trench box each lift of backfill is considered a LOT. Placement of backfill within trench box limits will be considered a complete operation before trench box is moved for next backfill operation. When the trench box is moved for next backfill operation this will start new LOTs for each lift. Follow the density testing frequency in 125-9.3.1.

SUBARTICLE 125-9.2.1 (Pages 183) is deleted and the following substituted:

125-9.2.1 Density: Obtain a minimum QC density in any LOT of 100% of the Standard Proctor maximum density as determined by AASHTO T99, Method C, or the requirements of 125-8.3.3.1 when applicable. When the cover height below the bottom of base under asphalt pavement, below concrete pavement, or below unpaved ground, exceeds 15 inches, compact the pipe backfill to a density of at least 95% of the Standard Proctor maximum density as determined by AASHTO T99, Method C.

For density requirements around drainage structures, obtain a minimum QC density in any LOT of 100% of the Standard Proctor maximum density as determined by AASHTO T99 for a distance of one pipe diameter but not less than 3 feet from the outside face of the structure.

234 SUPERPAVE ASPHALT BASE.
(REV 1-14-13) (FA 1-28-13) (7-13)

ARTICLE 234-1 (Page 215) is deleted and the following substituted:

234-1 Description.

Construct a Superpave Asphalt Concrete base course as defined in these Specifications. Base course mixes are designated as B-12.5. The Contractor may use a Type SP-12.5 mixture, (Traffic Level B or C) in lieu of a Type B-12.5. The Contractor may substitute a SP 12.5 Traffic Level D or E mixture in lieu of Type B-12.5 mixture, not to exceed 500 tons for a project, at no extra cost to the Department, if approved by the Engineer.

SUBARTICLE 234-2.1 (Page 215) is deleted and the following substituted:

234-2.1 General: Use materials that conform to the requirements of Division III. Specific references are as follows:

Superpave PG Asphalt Binder .....Section 916
Coarse Aggregate, Stone, Slag or
Crushed Gravel .....Section 901
Fine Aggregate.....Section 902

SUBARTICLE 234-3.2 (Page 215) is deleted and the following substituted:

234-3.2 Mix Design: Unless otherwise specified, design the mix such that all requirements for a Type SP-12.5, Traffic Level B or C mixture as specified in Section 334 are met.

234-3.2.1 Gradation Classification: Use a fine mix as defined in 334-3.2.2.1.

234-3.2.2 Aggregate Consensus Properties: Meet the aggregate consensus properties at design as specified in 334-3.2.3. Meet the criteria specified for a depth of top of pavement layer from surface of greater than 4 inches.

234-3.2.3 Mix Design Revisions: Meet the requirements of 334-3.3.

320 HOT MIX ASPHALT – PLANT METHODS AND EQUIPMENT. (REV 1-14-13) (FA 1-28-13) (7-13)

SUBARTICLE 320-2.1 (Page 240 – 241) is deleted and the following substituted:

320-2.1 Minimum Producer QC Requirements: Perform as a minimum the following activities:

1. Stockpiles:
    a. Assure materials are placed in the correct stockpile;
    b. Assure good stockpiling techniques;
    c. Inspect stockpiles for separation, contamination, segregation, and other similar items;
    d. Properly identify and label each stockpile.
2. Incoming Aggregate:
    a. Obtain gradations and bulk specific gravity (G_{sb}) values from aggregate supplier for reference;
    b. Determine the gradation of all component materials and routinely compare gradations and G_{sb} values to mix design.
3. Cold Bins:
    a. Calibrate the cold gate/feeder belt for each material;
    b. Determine cold gate/feeder belt settings;
    c. Observe operation of cold feeder for uniformity;
    d. Verify accuracy of all settings;
    e. Verify that the correct components are being used, and that all modifiers or additives or both are being incorporated into the mix.
4. Batch Plants:
    a. Determine percent used and weight to be pulled from each bin to assure compliance with the mix design;
    b. Check mixing time;
    c. Check operations of weigh bucket and scales.
5. Drum Mixer Plants:
    a. Determine aggregate moisture content;
    b. Calibrate the weigh bridge on the charging conveyor.

6. Control Charts: Maintain QC data and charts (updated daily) for all QC Sampling and Testing and make available upon demand. Provide the following charts:

a. All components used to determine the composite pay factor (No. 8 sieve, No. 200 sieve, asphalt binder content, air voids, and density);

b. Gradation of incoming aggregate;

c. Gradation, asphalt binder content and maximum specific gravity (G_{mm}) of RAP;

d. Any other test result or material characteristic (as determined by the Contractor) necessary for process control.

The above listed minimum activities are to be considered normal activities necessary to control the production of hot mix asphalt at an acceptable quality level. Depending on the type of process or materials, some of the activities listed may not be necessary and in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. When the process varies from the defined process average and variability targets, the frequency of these activities will be increased until the proper conditions have been restored.

ARTICLE 320-7 (Page 247) is deleted and the following substituted:

320-7 Transportation of the Mixture.

Transport the mix in trucks of tight construction, which prevents the loss of material and the excessive loss of heat and previously cleaned of all foreign material. After cleaning, thinly coat the inside surface of the truck bodies with soapy water or an asphalt release agent as needed to prevent the mixture from adhering to the beds. Do not allow excess liquid to pond in the truck body. Do not use a release agent that will contaminate, degrade, or alter the characteristics of the asphalt mix or is hazardous or detrimental to the environment. Petroleum derivatives (such as diesel fuel), solvents, and any product that dissolves asphalt are prohibited. Provide each truck with a tarpaulin or other waterproof cover mounted in such a manner that it can cover the entire load when required. When in place, overlap the waterproof cover on all sides so that it can be tied down. Cover each load during cool and cloudy weather and at any time it appears rain is likely during transit with a tarpaulin or waterproof cover. Cover and tie down all loads of friction course mixtures.

330 HOT MIX ASPHALT – GENERAL CONSTRUCTION REQUIREMENTS. (REV 11-20-12) (FA 1-28-13) (7-13)

SUBARTICLE 330-3.2.2 (Page 253) is deleted and the following substituted:

330-3.2.2 Ambient Air Temperature: Place the mixture only when the air temperature in the shade and away from artificial heat meets requirements of Table 330-1. The minimum ambient temperature requirement may be reduced by 5ºF when using warm mix technology, if mutually agreed to by both the Engineer and the Contractor.

Table 330-1

Ambient Air Temperature Requirements for Paving	
Layer Thickness or Asphalt Binder Type	Minimum Temperature (°F)
≤ 1 inch	50
Any mixture > 1 inch containing a PG asphalt binder having a high temperature designation ≥ 76°C	45
Any mixture > 1 inch containing a PG asphalt binder having a high temperature designation < 76°C	40
FC-5[(1)]	65

[(1)]As an exception, place the mixture at temperatures no lower than 60ºF, only when approved by the Engineer based on the Contractor's demonstrated ability to achieve a satisfactory surface texture and appearance of the finished surface. The minimum ambient temperature may be further reduced to 55ºF when using warm mix technology, if agreed to by both the Engineer and the Contractor.

334 SUPERPAVE ASPHALT CONCRETE.
(REV 1-14-13) (FA 1-28-13) (7-13)

SECTION 334 (Pages 263 – 279) is deleted and the following substituted:

SECTION 334
SUPERPAVE ASPHALT CONCRETE

334-1 Description.

334-1.1 General: Construct a Superpave Asphalt Concrete pavement with the type of mixture specified in the Contract Documents, or when offered as alternates, as selected. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of Section 320 for plant and equipment. Meet the general construction requirements of Section 330, except as modified herein, including the provision for Quality Control (QC) Plans and QC Systems as specified in Section 105.

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 18,000 pound Equivalent Single Axle Loads (ESAL's). The five traffic levels are as shown in Table 334-1.

Table 334-1 Superpave Traffic Levels	
Traffic Level	Traffic Level ($1x10^6$ ESAL's)
A	<0.3
B	0.3 to <3
C	3 to <10
D	10 to <30
E	≥30

The traffic levels for the project are as specified in the Contract Documents. A Type SP mix one traffic level higher than the traffic level specified in the Contract Documents may be substituted, at no cost to the Department (i.e., Traffic Level B may be substituted for Traffic Level A, etc.).

334-1.3 Gradation Classification: The Superpave mixes are classified as either coarse or fine, depending on the overall gradation of the mixture. Coarse and fine mixes are defined in 334-3.2.2.

The equivalent AASHTO nominal maximum aggregate size Superpave mixes are as follows:

Type SP-9.5..... 9.5 mm
Type SP-12.5..... 12.5 mm
Type SP-19.0..... 19.0 mm

334-1.4 Thickness: The total thickness of the Type SP asphalt layers will be the plan thickness as shown in the Contract Documents. Before paving, propose a thickness for each individual layer meeting the requirements of this specification, which when combined with other layers (as applicable) will equal the plan thickness. For construction purposes, the plan thickness and individual layer thickness will be converted to spread rate based on the maximum specific gravity of the asphalt mix being used, as well as the minimum density level, as shown in the following equation:

$$\text{Spread rate (lbs/yd}^2\text{)} = t \times G_{mm} \times 43.3$$

Where: t = Thickness (in.) (plan thickness or individual layer thickness)

G_{mm} = Maximum specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-3.2. For target purposes only, spread rate calculations should be rounded to the nearest whole number.

Note: Plan quantities are based on a G_{mm} of 2.540, corresponding to a spread rate of 110 lbs/yd^2-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

334-1.4.1 Layer Thicknesses - Fine Mixes: The allowable layer thicknesses for fine Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5.....1 to 1-1/2 inches
Type SP-12.5..... 1-1/2 to 2-1/2 inches
Type SP-19.0..... 2 to 3 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the top two structural layers, two layers maximum.

Type SP-9.5 – May not be used on Traffic Level D and E applications.

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.2 Layer Thicknesses - Coarse Mixes: The allowable layer thicknesses for coarse Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5.....1-1/2 to 2 inches
Type SP-12.5..... 2 to 3 inches
Type SP-19.0.....3 to 3-1/2 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on coarse mixes when used as a structural course:

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.3 Additional Requirements: The following requirements also apply to coarse and fine Type SP Asphalt Concrete mixtures:

1. A minimum 1-1/2 inch initial lift is required over an Asphalt Rubber Membrane Interlayer (ARMI).

2. When construction includes the paving of adjacent shoulders (less than or equal to 5 feet wide), the layer thickness for the upper pavement layer and shoulder must be the same and paved in a single pass, unless called for differently in the Contract Documents.

3. All overbuild layers must be fine Type SP Asphalt Concrete designed at the traffic level as stated in the Contract Documents. Use the minimum and maximum layer thicknesses as specified above unless called for differently in the Contract Documents. On variable thickness overbuild layers, the minimum and maximum allowable thicknesses will be as specified below, unless called for differently in the Contract Documents.

Type SP-9.5..... 3/8 to 2 inches
Type SP-12.5..... 1/2 to 3 inches
Type SP-19.0..... 1-1/2 to 3-1/2 inches

4. Variable thickness overbuild layers constructed using a Type SP-9.5 or SP-12.5 mixtures may be tapered to zero thickness provided the contract documents require a minimum of 1-1/2 inches of dense-graded mix placed over the variable thickness overbuild layer.

334-2 Materials.

334-2.1 General Requirements: Meet the material requirements specified in Division III. Specific references are as follows:

Superpave PG Asphalt Binder .....Section 916
Coarse Aggregate.....Section 901
Fine Aggregate.....Section 902

334-2.2 Superpave Asphalt Binder: Unless specified otherwise in the Contract Documents, use a PG 67-22 asphalt binder. In addition, meet the requirements of 334-2.3.

334-2.3 Reclaimed Asphalt Pavement (RAP) Material:

334-2.3.1 General requirements: RAP may be used as a component of the asphalt mixture subject to the following requirements:

1. When using a PG 76-22 (PMA), or PG 76-22 (ARB), or PG 82-22 (PMA) asphalt binder, limit the amount of RAP material used in the mix to a maximum of 20% by weight of total aggregate. As an exception, amounts greater than 20% RAP by weight of total aggregate can be used if no more than 20% by weight of the total asphalt binder comes from the RAP material.

2. Assume full responsibility for the design, production and construction of asphalt mixes which incorporate RAP as a component material.

3. Use RAP from a Department approved stockpile or millings from a Department project..

4. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

5. Provide RAP material having a minimum average asphalt binder content of 4.0% by weight of RAP. As an exception, when using fractionated RAP, the minimum average asphalt binder content for the coarse portion of the RAP shall be 2.5% by weight of the coarse portion of the RAP. The coarse portion of the RAP shall be the portion of the RAP retained on the No. 4 sieve. The Engineer may sample the stockpiles to verify that this requirement is met.

334-2.3.2 Material Characterization for Mix Design: Assume responsibility for establishing the asphalt binder content, gradation, and bulk specific gravity (G_{sb}) of the RAP material based on a representative sampling of the material by roadway cores or stockpile samples. For roadway core samples, assume responsibility for the degradation that will occur during the milling operation.

334-2.3.3 RAP Stockpile Approval: Prior to the incorporation of RAP into the asphalt mixture, stockpile the RAP material and obtain approval for the stockpile by one of the following methods:

1. Continuous stockpile: When RAP is obtained from one or multiple sources and is either processed, blended, or fractionated, and stockpiled in a continuous manner, assure an adequate number of test results are obtained for stockpile approval. Test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. In addition, address in the QC Plan the details and specifics of the processing, sampling, testing and actions to be taken.

2. Non-continuous single stockpile: When an individual stockpile is being constructed, obtain representative samples at random locations and test the RAP material for gradation and asphalt content at a minimum frequency of one sample per 1000 tons with a minimum of six test results. Test the RAP material for G_{mm} (for G_{sb} determination) at a minimum frequency of one sample per 5000 tons with a minimum of two test results. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled material. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

Determine the asphalt binder content and gradation of the RAP material in accordance with FM 5-563 and FM 1-T 030, respectively. Establish the G_{sb} of the RAP material by using one of the following methods:

a. Calculate the G_{sb} value based upon the effective specific gravity (G_{se}) of the RAP material, determined on the basis of the asphalt binder content and maximum specific gravity (G_{mm}) of the RAP material. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b. Measure the G_{sb} of the RAP aggregate, in accordance with FM 1-T 084 and FM 1-T 085. Obtain the aggregate by using a solvent extraction method.

334-2.3.4 Pavement Coring Report: When the Contract includes milling of the existing asphalt pavement, the Pavement Coring Report may be available on the Department's website.

334-2.3.5 Asphalt Binder for Mixes with RAP: Select the appropriate asphalt binder grade based on Table 334-2. Obtain a sample of the mixture for the Engineer within the first 1,000 tons of production and at a continuing frequency of one sample per 4,000 tons of mix. The Engineer reserves the right to change the asphalt binder type and grade at design based on the characteristics of the RAP asphalt binder, and reserves the right to make changes during production.

Table 334-2
Asphalt Binder Grade for Mixes Containing RAP

Percent RAP	Asphalt Binder Grade
0 - 15	PG 67-22
16 - 30	PG 58-22
>30	PG 52-28

334-2.4 Recycled Crushed Glass: Recycled crushed glass may be used as a component of the asphalt mixture subject to the following requirements:

1. Consider the recycled crushed glass a local material and meet all requirements specified in 902-6.
2. Limit the amount of recycled crushed glass to a maximum of 15% by weight of total aggregate.
3. Use an asphalt binder that contains a minimum of 0.5% anti-stripping agent by weight of binder. The anti-strip additive shall be one of the products listed on the Qualified Products List (QPL). The anti-strip additive shall be introduced into the asphalt binder by the supplier during loading.
4. Do not use recycled crushed glass in friction course mixtures or in structural course mixtures which are to be used as the final wearing surface.

334-3 General Composition of Mixture.

334-3.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the mix design. Aggregates from various sources may be combined.

334-3.2 Mix Design:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R 35-09, except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. For Traffic Level B through E mix designs, include representative samples of all component materials, including asphalt binder. Allow the State Materials Engineer a maximum of four weeks to either conditionally verify or reject the mix as designed.

Do not use more than three mix designs per nominal maximum aggregate size per traffic level per binder grade per year, where the year starts at the Notice to Proceed. Exceeding this limitation will result in a maximum Composite Pay Factor (CPF) of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is: http://www.dot.state.fl.us/Specificationsoffice/implemented/URLinSpecs/files/WarmMixAsphalt.pdf .

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements

defined in this specification and conform to the gradation requirements at design as defined in AASHTO M 323-07, Table 3. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification: Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M 323-07, Table-3, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M 323-07, Table 4. Coarse mixes are defined as having a combined aggregate gradation that passes below the primary control sieve control point and below the maximum density line for all sieve sizes smaller than the primary control sieve. Fine mixes are defined as having a gradation that passes above the primary control sieve control point and above the maximum density line for all sieve sizes smaller than the primary control sieve and larger than the No. 100 sieve. Use a fine mix for Traffic Levels A through C; use either a coarse mix or fine mix for Traffic Levels D and E.

334-3.2.3 Aggregate Consensus Properties: For Traffic Level C through E mixtures, meet the following consensus properties at design for the aggregate blend. Aggregate consensus properties do not apply to Traffic Level A and B mixtures.

334-3.2.3.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D 5821-01 (2006), meet the percentage of fractured faces requirements specified in AASHTO M 323-07, Table 5.

334-3.2.3.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T 304-11, Method A, meet the uncompacted void content of fine aggregate specified in AASHTO M 323-07, Table 5.

334-3.2.3.3 Flat and Elongated Particles: When tested in accordance with ASTM D 4791-10, (with the exception that the material passing the 3/8 inch sieve and retained on the No. 4 sieve shall be included), meet the requirements specified in AASHTO M 323-07, Table 5. Measure the aggregate using the ratio of 5:1, comparing the length (longest dimension) to the thickness (shortest dimension) of the aggregate particles.

334-3.2.3.4 Sand Equivalent: When tested in accordance with AASHTO T 176-08, meet the sand equivalent requirements specified in AASHTO M 323-07, Table 5.

334-3.2.4 Gyratory Compaction: Compact the design mixture in accordance with AASHTO T 312-11, with the following exception: use the number of gyrations at N_{design} as defined in Table 334-3. Measure the inside diameter of gyratory molds in accordance with AASHTO T 312-11.

Table 334-3
Gyratory Compaction Requirements

Traffic Level	N_{design} Number of Gyrations
A	50
B	65
C	75
D	100
E	100

334-3.2.5 Design Criteria: Meet the requirements for nominal maximum aggregate size as defined in AASHTO M 323-07, as well as for relative density, VMA, VFA,

and dust-to-binder ratio as specified in AASHTO M 323-07, Table 6. Use a dust-to-binder ratio of 0.8 to 1.6 for coarse mixes. $N_{initial}$ and $N_{maximum}$ requirements are not applicable.

334-3.2.6 Moisture Susceptibility:

1. For Traffic Level A and B mixtures, use a liquid anti-strip additive, at a rate of 0.5% by weight of the asphalt binder. The anti-strip additive must be listed on the QPL. Other rates of anti-strip additive may be used upon approval of the Engineer.

2. For Traffic Level C through E mixtures, test 4 inch specimens in accordance with FM 1-T 283. Provide a mixture having a retained tensile strength ratio of at least 0.80 and a minimum tensile strength (unconditioned) of 100 psi. If necessary, add a liquid anti-stripping agent and/or hydrated lime (meeting the requirements of Section 337) in order to meet these criteria. The anti-strip additive must be listed on the QPL.

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).
2. The source and description of the materials to be used.
3. The Department source number and the Department product code of the aggregate components furnished from a Department approved source.
4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.
5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.
6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.
7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.
8. A target temperature for the mixture at the plant (mixing temperature) and a target temperature for the mixture at the roadway (compaction temperature) in accordance with 320-6.3. Do not exceed a target temperature of 340°F for PG 82-22 (PMA) asphalt binders, 330°F for PG 76-22 (PMA) and PG 76-22 (ARB) asphalt binders, and 315°F for unmodified asphalt binders.
9. Provide the physical properties achieved at four different asphalt binder contents. One of which must be at the optimum asphalt content, and must conform to all specified physical requirements.
10. The name of the Construction Training Qualification Program (CTQP) Qualified Mix Designer.
11. The ignition oven calibration factor.
12. The warm mix technology, if used.

334-3.3 Mix Design Revisions: During production, the Contractor may request a target value revision to a mix design, subject to meeting the following requirements: (1) the target change falls within the limits defined in Table 334-4, (2) appropriate data exists demonstrating that the mix complies with production air voids specification criteria, and (3) the mixture gradation meets the basic gradation requirements defined in 334-3.2.2.

Table 334-4 Limits for Potential Adjustments to Mix Design Target Values	
Characteristic	Limit from Original Mix Design
No. 8 sieve and Coarser	± 5.0%
No. 16 sieve	± 4.0%
No. 30 sieve	± 4.0%
No. 50 sieve	± 3.0%
No. 100 sieve	± 3.0%
No. 200 sieve	± 1.0%
Asphalt Binder Content (1)	± 0.3%
Each Component of Aggregate Blend (2)	± 5.0 %
(1) Reductions to the asphalt binder content will not be permitted if the VMA during production is lower than 1.0% below the design criteria. (2) Revisions to FC-5 mixtures to be determined by the Engineer.	

Submit all requests for revisions to mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until the Engineer authorizes a change. In no case will the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required if aggregate sources change, or for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

334-4 Contractor Process Control (PC).

Assume full responsibility for controlling all operations and processes such that the requirements of these Specifications are met at all times. Perform any tests necessary at the plant and roadway for process control purposes. Enter all PC test data into the Department's Laboratory Information Management System (LIMS) database. The Engineer will not use these test results in the acceptance payment decision.

Address in the QC Plan how PC failures will be handled. When a PC failure occurs, investigate, at a minimum, the production process, testing equipment and/or sampling methods to determine the cause of the failure, and make any necessary changes to assure compliance with these Specifications. Obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up PC sample also fails to meet Specification requirements, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the QC Manager.

334-5 Acceptance of the Mixture.

334-5.1 General: The mixture will be accepted at the plant with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b), and volumetrics (volumetrics is defined as air voids at N_{design}). The mixture will be accepted on the roadway with respect to density of roadway cores. Acceptance will be on a LOT by LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. Acceptance of the mixture will be based on Contractor QC test results that have been verified by the Department.

334-5.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1-T 168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for QC, one for Verification testing and one for Resolution testing; each sample at approximately 35 pounds. The split samples for Verification testing and Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12 inches x 8 inches x 4 inches. Provide, label and safely store sample boxes in a manner agreed upon by the Engineer for future testing.

The asphalt content of the mixture will be determined in accordance with FM 5-563. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T 312-11 and FM 1-T 209. Measure the inside diameter of gyratory molds in accordance with FM 5-585. Prior to testing volumetric samples, condition the test-sized sample for one hour, plus or minus five minutes, at the target roadway compaction temperature in a shallow, flat pan, such that the mixture temperature at the end of the one hour conditioning period is within plus or minus 20°F of the roadway compaction temperature. Test for roadway density in accordance with FM 1-T 166.

334-5.1.2 Acceptance Testing Exceptions: When the total combined quantity of hot mix asphalt for the project, as indicated in the Plans for Type SP and Type FC mixtures only, is less than 2000 tons, the Engineer will accept the mix on the basis of visual inspection. The Engineer may require the Contractor to run process control tests for informational purposes, as defined in 334-4, or may run independent verification tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, any asphalt layer placed on subgrade (regardless of type), miscellaneous asphalt pavement, shared use paths, crossovers, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. Density testing for acceptance will not be performed on asphalt courses placed on bridge decks or approach slabs; compact these courses in static mode only per the requirements of 330-7.7. In addition, density testing for acceptance will not be performed on the following areas when they are less than 1,000 feet (continuous) in length: turning lanes, acceleration lanes, deceleration lanes, shoulders, parallel parking lanes or ramps. Do not perform density testing for acceptance in situations where the areas requiring density testing is less than 50 tons within a sublot.

Density testing for acceptance will not be performed in intersections. The limits of the intersection will be from stop bar to stop bar for both the mainline and side streets. A random core location that occurs within the intersection shall be moved forward or backward from the intersection at the direction of the Engineer.

Where density testing for acceptance is not required, compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure (equipment and pattern) as approved by the Engineer or with Standard Rolling Procedure as specified in 330-7.2. In the event that the rolling procedure deviates from the procedure approved by the Engineer, or the Standard Rolling Procedure, placement of the mix shall be stopped.

The density pay factor (as defined in 334-8.2) for areas not requiring density testing for acceptance will be paid at the same density pay factor as for the areas

requiring density testing within the same LOT. If the entire LOT does not require density testing for acceptance, the LOT will be paid at a density pay factor of 1.00.

334-5.2 Full LOTs: Each LOT will be defined (as selected by the Contractor prior to the start of the LOT) as either (1) 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each, or (2) 4,000 tons, with each LOT subdivided into four equal sublots of 1,000 tons each. As an exception to this, the initial LOT of all new mix designs shall be defined as 2,000 tons, subdivided into four equal sublots of 500 tons each. Before the beginning of a LOT, the Engineer will develop a random sampling plan for each sublot and direct the Contractor on sample points, based on tonnage, for each sublot during construction.

334-5.3 Partial LOTs: A partial LOT is defined as a LOT size that is less than a full LOT. A partial LOT may occur due to the following:

l. The completion of a given mix type or mix design on a project.

2. Closure of the LOT due to time. LOTs will be closed 30 calendar days after the start of the LOT. Time periods other than 30 calendar days may be used if agreed to by both the Engineer and the Contractor.

3. A LOT is terminated per 334-5.4.4.

All partial LOTs will be evaluated based on the number of tests available, and will not be redefined. If a LOT is closed before the first plant random sample is obtained, then the LOT will be visually accepted by the Engineer and the LOT pay factor will be 1.00.

334-5.4 QC Sampling and Testing: Obtain all samples randomly as directed by the Engineer.

Should the Engineer determine that the QC requirements are not being met or that unsatisfactory results are being obtained, or should any instances of falsification of test data occur, approval of the Contractor's QC Plan will be suspended and production will be stopped.

334-5.4.1 Lost or Missing Verification/Resolution Samples: In the event that any of the Verification and/or Resolution samples that are in the custody of the Contractor are lost, damaged, destroyed, or are otherwise unavailable for testing, the minimum possible pay factor for each quality characteristic as described in 334-8.2 will be applied to the entire LOT in question, unless called for otherwise by the Engineer. Specifically, if the LOT in question has more than two sublots, the pay factor for each quality characteristic will be 0.55. If the LOT has two or less sublots, the pay factor for each quality characteristic will be 0.80. In either event, the material in question will also be evaluated in accordance with 334-5.9.5.

If any of the Verification and/or Resolution samples that are in the custody of the Department are lost, damaged, destroyed or are otherwise unavailable for testing, the corresponding QC test result will be considered verified, and payment will be based upon the Contractor's data.

334-5.4.2 Plant Sampling and Testing Requirements: Obtain one random sample of mix per sublot in accordance with 334-5.1.1 as directed by the Engineer. Test the QC split sample for gradation, asphalt binder content and volumetrics in accordance with 334-5.1.1. Complete all QC testing within one working day from the time the samples were obtained.

334-5.4.3 Roadway Sampling and Testing Requirements: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. Test these QC samples for density (G_{mb}) in accordance with 334-5.1.1. Obtain a minimum of three cores per sublot at random locations as identified by the Engineer in situations where the sublot/LOT was closed or terminated before the random numbers were reached or where it is impractical to cut five cores per sublot. Do not obtain cores

any closer than 12 inches from an unsupported edge. The Engineer may adjust randomly generated core locations for safety purposes or as the Engineer deems necessary. Maintain traffic during the coring operation; core the roadway, patch the core holes (within three days of coring); and trim the cores to the proper thickness prior to density testing.

Density for the sublot shall be based on the average value for the cores cut from the sublot with the target density being the maximum specific gravity (G_{mm}) of the sublot. Once the average density of a sublot has been determined, do not retest the samples unless approved by the Engineer. Ensure proper handling and storage of all cores until the LOT in question has been accepted.

334-5.4.4 Individual Test Tolerances for QC Testing: Terminate the LOT if any of the following QC failures occur:

1) An individual test result of a sublot for air voids does not meet the requirements of Table 334-5,

2) The average sublot density does not meet the requirements of Table 334-5,

3) Two consecutive test results within the same LOT for gradation or asphalt binder content do not meet the requirements of Table 334-5,

4) Two core densities for coarse mixes within a sublot are less than 91.00% of G_{mm}.

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the QC Manager and/or Asphalt Plant Level II technician responsible for the decision to resume production after a QC failure, as identified in 105-8.6.4. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a QC failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future QC failures.

Address any material represented by a failing test result in accordance with 334-5.9.5. Any LOT terminated under this subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for each quality characteristic.

In the event that a G_{mm} test result differs by more than 0.040 from the mix design G_{mm}, investigate the causes of the discrepancy and report the findings and proposed actions to the Engineer.

Table 334-5
Master Production Range

Characteristic	Tolerance [1]
Asphalt Binder Content (%)	Target ±0.55
Passing No. 200 Sieve (%)	Target ±1.50
Air Voids (%) Coarse Graded	2.00 - 6.00
Air Voids (%) Fine Graded	2.30 – 6.00
Density (% G_{mm}) [2]	

Table 334-5 Master Production Range	
Characteristic	Tolerance [1]
Coarse Graded (minimum)	93.00
Fine Graded (minimum)	90.00
[1] Tolerances for sample size of n = 1 from the verified mix design [2] Based on an average of 5 randomly located cores	

334-5.5 Verification Testing: In order to determine the validity of the Contractor's QC test results prior to their use in the Acceptance decision, the Engineer will run verification tests.

334-5.5.1 Plant Testing: At the completion of each LOT, the Engineer will test a minimum of one Verification split sample randomly selected from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed. Verification samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

The Verification test results will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-6.

Table 334-6 Between-Laboratory Precision Values	
Property	Maximum Difference
G_{mm}	0.016
G_{mb} (gyratory compacted samples)	0.022
Gmb (roadway cores – fine graded mixture)	0.015
Gmb (roadway cores – coarse graded mixture)	0.018
P_b	0.44%
P_{-200}	FM 1-T 030 (Figure 2)
P_{-8}	FM 1-T 030 (Figure 2)

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.6.

334-5.5.2 Roadway Testing: At the completion of each LOT, the Engineer will determine the density (G_{mb}) of each core (previously tested by QC) as described in 334-5.1.1 from the same sublot as the plant samples. For situations where roadway density is not required for the random sublot chosen, then another sublot shall be randomly chosen for roadway density cores only. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed.

The individual Verification test results will be compared with individual QC test results by the Engineer based on the between-laboratory precision values given in Table 334-6.

If each of the core test results compare favorably, then the LOT will be accepted with respect to density, with payment based on the Contractor's QC test data for the LOT.

If any of the results do not compare favorably, then the core samples from the LOT will be sent to the Resolution laboratory for testing as specified in 334-5.6.

334-5.6 Resolution System:

334-5.6.1 Plant Samples: In the event of an unfavorable comparison between the Contractor's QC test results and the Engineer's Verification test results on any of the properties identified in Table 334-6, the Resolution laboratory will test all of the split samples from the LOT for only the property (or properties) in question. Resolution samples shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. In lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1.

334-5.6.2 Roadway Samples: In the event of an unfavorable comparison between the Contractor's QC test data and the Engineer's Verification test data on the density results, the Resolution laboratory will test all of the cores from the LOT. Testing will be as described in 334-5.1.1. Any damaged roadway cores will not be included in the evaluation; replace damaged cores with additional cores at the direction of the Engineer.

334-5.6.3 Resolution Determination: The Resolution test results (for the property or properties in question) will be compared with the QC test results based on the between-laboratory precision values shown in Table 334-6.

If the Resolution laboratory results compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the QC results, and the Department will bear the costs associated with Resolution testing. No additional compensation, either monetary or time, will be made for the impacts of any such testing.

If the Resolution laboratory results do not compare favorably with all of the QC results, then acceptance and payment for the LOT will be based on the Resolution test data for the LOT, and the costs of the Resolution testing will be deducted from monthly estimates. No additional time will be granted for the impacts of any such testing. In addition, in the event that the application of the Resolution test data results in a failure to meet the requirements of Table 334-5, address any material represented by the failing test result in accordance with 334-5.9.5.

In the event of an unfavorable comparison between the Resolution test results and QC test results, make the necessary adjustments to assure that future comparisons are favorable.

334-5.7 Independent Verification (IV) Testing:

334-5.7.1 Plant: The Contractor shall provide sample boxes and take samples as directed by the Engineer for IV testing. Obtain enough material for three complete sets of tests (two samples for IV testing by the Engineer and one sample for testing by the Contractor). If agreed upon by both the Engineer and the Contractor, only one sample for IV testing by the

Engineer may be obtained. IV samples will be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. The Contractor's split sample, if tested immediately after sampling, shall be reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. If the Contractor's sample is not tested immediately after sampling, then the sample shall be reheated at the target roadway compaction temperature for 1-1/2 hours, plus or minus 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1. For the IV and Contractor's samples, in lieu of the 1-1/2 hours reheating procedure, the mixture may be reheated to within plus or minus 20°F of the roadway compaction temperature using a microwave oven. Stir the mixture as necessary during the reheating process to maintain temperature uniformity. Subsequently, condition and test the mixture as described in 334-5.1.1. The Contractor's test results shall be provided to the Engineer within one working day from the time the sample was obtained.

If any of the IV test results do not meet the requirements of Table 334-5, then a comparison of the IV test results and the Contractor's test results, if available, will be made. If a comparison of the IV test results and the Contractor's test results meets the precision values of Table 334-6 for the material properties in question, or if the Contractor's test results are not available, then the IV test results are considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

If a comparison of the IV test results and the Contractor's test results does not meet the precision values of Table 334-6 for the material properties in question, then the second IV sample shall be tested by the Engineer for the material properties in question. If a comparison between the first and second IV test results does not meet the precision values of Table 334-6 for the material properties in question, then the first IV test results are considered unverified for the material properties in question and no action shall be taken.

If a comparison between the first and second IV test results meets the precision values of Table 334-6 for the material properties in question, then the first IV sample is considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.9.5.

The Engineer has the option to use the IV sample for comparison testing as specified in 334-6.

334-5.7.2 Roadway: Obtain five 6 inch diameter roadway cores within 24 hours of placement, as directed by the Engineer, for IV testing. In situations where it is impractical to cut five cores per sublot, obtain a minimum of three cores per sublot at random locations, as identified by the Engineer. These independent cores will be obtained from the same LOTs and sublots as the Independent Verification Plant samples, or as directed by the Engineer. The density of these cores will be obtained as described in 334-5.1.1. If the average of the results for the sublot does not meet the requirements of Table 334-5 for density, then a comparison of the IV G_{mm} test results and the Contractor's G_{mm} test results, if available, will be made in accordance

with the procedure provided in 334-5.7.1. Address any material represented by the failing test results in accordance with 334-5.9.5.

334-5.8 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-9.

334-5.9 Minimum Acceptable Quality Levels:

334-5.9.1 Pay Factors Below 0.90: In the event that an individual pay factor for any quality characteristic of a LOT falls below 0.90, take steps to correct the situation and report the actions to the Engineer. In the event that the pay factor for the same quality characteristic for two consecutive LOTs is below 0.90, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.9.2 CPFs Less Than 0.90 and Greater Than or Equal to 0.80: If the CPF for the LOT is less than 0.90 and greater than or equal to 0.80, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.9.3 CPFs Less Than 0.80 and Greater Than or Equal to 0.75: If the CPF for the LOT is less than 0.80 and greater than or equal to 0.75, address the defective material in accordance with 334-5.9.5.

334-5.9.4 CPFs Less Than 0.75: If the CPF for the LOT is less than 0.75, remove and replace the defective LOT at no cost to the Department, or as approved by the Engineer.

334-5.9.5 Defective Material: Assume responsibility for removing and replacing all defective material placed on the project, at no cost to the Department.

As an exception to the above and upon approval of the Engineer, obtain an engineering analysis by an independent laboratory (as approved by the Engineer) to determine the disposition of the material. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida.

The Engineer may determine that an engineering analysis is not necessary or may perform an engineering analysis to determine the disposition of the material.

Any material that remains in place will be accepted with a CPF as determined by 334-8, or as determined by the Engineer.

If the defective material is due to a gradation, asphalt binder content or density failure, upon the approval of the Engineer the Contractor may perform delineation tests on roadway cores in lieu of an engineering analysis to determine the limits of the defective material that may require removal and replacement. Prior to any delineation testing, all sampling locations shall be approved by the Engineer. All delineation sampling and testing shall be monitored and verified by the Engineer. For materials that are defective due to air voids, an engineering analysis is required.

When evaluating defective material by engineering analysis or delineation testing, at a minimum, evaluate all material located between passing QC, PC or IV test results. Exceptions to this requirement shall be approved by the Engineer.

334-6 Comparison Testing.

At the start of the project (unless waived by the Engineer) and at other times as determined necessary by the Engineer, provide split samples for comparison testing with the Engineer. The purpose of these tests is to verify that the testing equipment is functioning properly and that the testing procedures are being performed correctly. In the event that the Engineer determines that there is a problem with the Contractor's testing equipment and/or testing procedures, immediately correct the problem to the Engineer's satisfaction. In the event that the problem is not immediately corrected, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.

If so agreed to by both the Contractor and the Engineer, the split sample used for comparison testing may also be used for the QC sample. The split sample used for comparison testing must also meet the requirements for IV testing described in 334-5.7.

334-7 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons. The pay quantity will be based on the project average spread rate, excluding overbuild, limited to a maximum of 105% of the spread rate determined in accordance with 334-1.4 or as set by the Engineer. The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer.

The bid price for the asphalt mix will include the cost of the liquid asphalt and the tack coat application as directed in 300-8. There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. For the calculation of unit price adjustments of bituminous material, the average asphalt content will be based on the percentage specified in 9-2.1.2. The weight will be determined as provided in 320-3.2 (including the provisions for the automatic recordation system).

Prepare a Certification of Quantities, using the Department's current approved form, for the certified Superpave asphalt concrete pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the roadway per Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

334-8 Basis of Payment.

334-8.1 General: Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

For materials accepted in accordance with 334-5, based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for the following individual quality characteristics: pavement density, air voids, asphalt binder content, and the percentage passing the No. 200 and No. 8 sieves. The pay adjustment will be computed by multiplying a CPF for the LOT by the bid price per ton. Perform all calculations using the latest version of the Department's Asphalt Plant Worksheet.

334-8.2 Pay Factors:

334-8.2.1 Partial LOTs: For Partial LOTs where no random sample is obtained due to insufficient tonnage, a CPF of 1.00 shall be applied.

334-8.2.2 Two or Less Sublot Test Results: In the event that two or less sublot test results are available for a LOT, Pay Factors will be determined based on the Small Quantity Pay Table. The Small Quantity Pay Table and Pay Factor calculations are determined in accordance with the instructions contained within the Department's Asphalt Plant Worksheet.

334-8.2.3 Three or More Sublot Test Results: When three or more sublot test results are available for a LOT, the variability-unknown, standard deviation method will be used to determine the estimated percentage of the LOT that is within the specification limits shown in Table 334-7. The Percent Within Limits (PWL) is determined in accordance with the instructions contained within the Department's Asphalt Plant Worksheet.

Table 334-7
Specification Limits

Quality Characteristic	Specification Limits
Passing No. 8 sieve (%)	Target ± 3.1
Passing No. 200 sieve (%)	Target ± 1.0
Asphalt Content (%)	Target ± 0.40
Air Voids - Coarse Mixes (%)	4.00 ± 1.40
Air Voids - Fine Mixes (%)	4.00 ± 1.20
Density - Coarse Mixes (% of G_{mm}):	94.50 ± 1.30
Density - Fine Mixes (% of G_{mm}):	93.00 + 2.00, - 1.20 (1)

Note (1): If the Engineer (or Contract Documents) limits compaction to the static mode only, or for all one-inch thick lifts, compaction shall be in the static mode. No vibratory mode in the vertical direction will be allowed. Other vibratory modes will be allowed, if approved by the Engineer. In either case, the specification limits will be as follows: 92.00 + 3.00, -1.20%of G_{mm}. No additional compensation, cost or time, shall be made.

334-8.2.3.1 Pay Factors: Pay Factors will be calculated by using the following equation:

$$\text{Pay Factor} = (55 + 0.5 \times \text{PWL}) / 100$$

The PWL is determined in accordance with the instructions contained within the Department's Asphalt Plant Worksheet.

334-8.3 Composite Pay Factor (CPF): A CPF for the LOT will be calculated based on the individual Pay Factorss with the following weighting applied: 35% Density (D), 25% Air Voids (V_a), 25% asphalt binder content (P_b), 10% Passing No. 200 (P_{-200}) and 5% Passing No. 8 (P_{-8}). Calculate the CPF by using the following formula:

$$\text{CPF} = [(0.350 \times \text{PF D}) + (0.250 \times \text{PF } V_a) + (0.250 \times \text{PF } P_b) + (0.100 \times \text{PF } P_{-200}) + (0.050 \times \text{PF } P_{-8})]$$

Where the Pay Factor for each quality characteristic is determined in either 334-8.2.2 or 334-8.2.3, depending on the number of sublot tests. Note that the number after each multiplication will be rounded to the nearest 0.01.

The pay adjustment shall be computed by multiplying the CPF for the LOT by the bid price per ton.

334-8.4 Payment: Payment will be made under:

Item No. 334- 1- Superpave Asphaltic Concrete - per ton.

336 ASPHALT RUBBER BINDER.
(REV 1-15-13) (FA 1-28-13) (7-13)

ARTICLE 336-3 (Page 280) is deleted and the following substituted:

336-3 Asphalt Rubber Binder.

Thoroughly mix and react the asphalt binder and ground tire rubber in accordance with the requirements of Table 336-1. Accomplish blending of the asphalt binder and ground tire rubber at the project site or asphalt plant, or at the supplier's terminal.

Table 336-1	
Asphalt Rubber Binder	
Binder Type	ARB 20
Minimum Ground Tire Rubber (by weight of asphalt binder)	20%
Binder Grade	PG 67-22
Temperature Range	335 - 375°F
Minimum Reaction Time	30 minutes
Unit Weight @ 60ºF(1)	8.8 lbs/gal.
Viscosity Range(2)	15.0 - 20.0 Poises @ 350°F(3)

(1) Conversions to standard 60ºF are as specified in 300-9.3.
(2) FM 5-548, Viscosity of Asphalt Rubber by Rotational (Dip-N-Read) Viscometer or AASHTO T 316, Viscosity Determination of Asphalt Binder Using Rotational Viscometer.
(3) Binders with values higher than 20.0 Poises should be used with caution and only after consulting with the supplier as to any special handling procedures, including pumping capabilities.
NOTE: The Contractor may adjust the minimum reaction time if approved by the Engineer depending upon the temperature, size of the ground tire rubber and viscosity measurement determined from the asphalt rubber binder material prior to or during production. Apply the asphalt rubber binder for use in membrane interlayers within a period of six hours, unless some form of corrective action such as cooling and reheating is approved by the Engineer.

337 ASPHALT CONCRETE FRICTION COURSES.
(REV 1-14-13) (FA 1-28-13) (7-13)

SECTION 337 (Pages 284 – 292) is deleted and the following substituted:

SECTION 337
ASPHALT CONCRETE FRICTION COURSES

337-1 Description.

Construct an asphalt concrete friction course pavement with the type of mixture specified in the Contract Documents, or when offered as alternates, as selected. This Section specifies mixes designated as FC-5, FC-9.5, and FC-12.5.

Meet the plant and equipment requirements of Section 320, as modified herein. Meet the general construction requirements of Section 330, as modified herein.

337-2 Materials.

337-2.1 General Requirements: Meet the requirements specified in Division III as modified herein. The Engineer will base continuing approval of material sources on field performance. Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is: http://www.dot.state.fl.us/Specificationsoffice/implemented/URLinSpecs/files/WarmMixAsphalt.pdf .

337-2.2 Asphalt Binder: Meet the requirements of Section 916, and any additional requirements or modifications specified herein for the various mixtures. For projects with a total quantity of FC-5, FC-9.5, or FC-12.5 less than 500 tons, the Contractor may elect to substitute a PG 76-22 (PMA) or PG 82-22 (PMA) for the PG 76-22 (ARB), meeting the requirements of Section 916.

337-2.3 Coarse Aggregate: Meet the requirements of Section 901, and any additional requirements or modifications specified herein for the various mixtures.

337-2.4 Fine Aggregate: Meet the requirements of Section 902, and any additional requirements or modifications specified herein for the various mixtures.

337-2.5 Hydrated Lime: Meet the requirements of AASHTO M 303-89 (2010), Type 1.

Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

337-2.6 Liquid Anti-strip Additive: Meet the requirements of 916-4 and be listed on the Department's Qualified Products List (QPL).

337-2.7 Fiber Stabilizing Additive (Required for FC-5 only): Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

337-2.7.1 Mineral Fibers: Use mineral fibers (made from virgin basalt, diabase, or slag) treated with a cationic sizing agent to enhance the disbursement of the fiber, as well as to increase adhesion of the fiber surface to the bitumen. Meet the following requirements for physical properties:

1. Size Analysis
   - Average fiber length: 0.25 inch (maximum)
   - Average fiber thickness: 0.0002 inch (maximum)
2. Shot Content (ASTM C612)
   - Percent passing No. 60 Sieve: 90 - 100
   - Percent passing No. 230 Sieve: 65 - 100

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-2.7.2 Cellulose Fibers: Use cellulose fibers meeting the following requirements:

1. Fiber length: 0.25 inch (maximum)
2. Sieve Analysis
   - a. Alpine Sieve Method
     - Percent passing No. 100 sieve: 60-80
   - b. Ro-Tap Sieve Method
     - Percent passing No. 20 sieve: 80-95
     - Percent passing No. 40 sieve: 45-85
     - Percent passing No. 100 sieve: 5-40

3. Ash Content: 18% non-volatiles (plus or minus 5%)
4. pH: 7.5 (plus or minus 1.0)
5. Oil Absorption: 5.0% (plus or minus 1.0) (times fiber weight)
6. Moisture Content: 5.0% by weight (maximum)

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-3 General Composition of Mixes.

337-3.1 General: Use a bituminous mixture composed of aggregate (coarse, fine, or a mixture thereof), asphalt binder, and in some cases, fibers and/or hydrated lime. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mix meets the requirements of this Section.

337-3.2 Specific Component Requirements by Mix:

337-3.2.1 FC-5:

337-3.2.1.1 Aggregates: Use an aggregate blend which consists of either 100% crushed granite, 100% crushed Oolitic limestone or 100% other crushed materials (as approved by the Engineer for friction courses per Rule 14-103.005, Florida Administrative Code).

Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% silica material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is: ftp://ftp.dot.state.fl.us/fdot/smo/website/sources/frictioncourse.pdf .

337-3.2.1.2 Asphalt Binder: Use an asphalt binder as called for in the Contract Documents meeting the requirements of Section 916.

337-3.2.1.3 Hydrated Lime: Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate to mixes containing granite.

337-3.2.1.4 Liquid Anti-strip Additive: Use a liquid anti-strip additive at a rate of 0.5% by weight of the asphalt binder for mixtures containing limestone aggregate. Other rates of anti-strip additive may be used upon approval of the Engineer.

337-3.2.1.5 Fiber Stabilizing Additive: Add either mineral fibers at a dosage rate of 0.4% by weight of the total mix, or cellulose fibers at a dosage rate of 0.3% by weight of total mix.

337-3.2.2 FC-9.5 and FC-12.5:

337-3.2.2.1: Aggregates: Use an aggregate blend that consists of crushed granite, crushed Oolitic limestone, other crushed materials (as approved by the Engineer for friction courses per Rule 14-103.005, Florida Administrative Code), or a combination of the above. Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% silica material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use. As an exception, mixes that contain a minimum of 60% crushed granite may either contain: 1) up to 40% fine aggregate from other sources or 2) a combination of up to 20% RAP and the remaining fine aggregate from other sources.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is: ftp://ftp.dot.state.fl.us/fdot/smo/website/sources/frictioncourse.pdf .

337-3.2.2.2: Asphalt Binder: Use an asphalt binder as called for in the

Contract Documents meeting the requirements of Section 916.

337-3.3 Grading Requirements:

337-3.3.1 FC-5: Use a mixture having a gradation at design within the ranges shown in Table 337-1.

Table 337-1
FC-5 Gradation Design Range

3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
100	85-100	55-75	15-25	5-10	--	--	--	--	2-4

337-3.3.2 FC-9.5: Meet the design gradation requirements for a SP-9.5 Superpave fine mix as defined in 334-3.2.2.

337-3.3.3 FC-12.5: Meet the design gradation requirements for a SP-12.5 Superpave fine mix as defined in 334-3.2.2.

337-4 Mix Design.

337-4.1 FC-5: The Department will design the FC-5 mixtures. Furnish the materials and all appropriate information (source, gradation, etc.) as specified in 334-3.2.7. The Department will have two weeks to design the mix.

The Department will establish the design binder content for FC-5 within the following ranges based on aggregate type:

Aggregate Type	Binder Content
Crushed Granite	5.5 - 7.0
Crushed Limestone (Oolitic)	6.5 - 8.0

337-4.2 FC-9.5 and FC-12.5: Provide a mix design conforming to the requirements of 334-3.2 unless otherwise designated in the plans.

337-4.3 Revision of Mix Design: For FC-5, FC-9.5 and FC-12.5, meet the requirements of 334-3.3. For FC-5, all revisions must fall within the gradation limits defined in Table 337-1.

337-5 Contractor's Process Control.

Provide the necessary process control of the friction course mix and construction in accordance with the applicable provisions of 320-2, 330-2 and 334-4.

The Engineer will monitor the spread rate periodically to ensure uniform thickness. Provide quality control procedures for daily monitoring and control of spread rate variability. If the spread rate varies by more than 5% of the spread rate set by the Engineer in accordance with 337-8, immediately make all corrections necessary to bring the spread rate into the acceptable range.

337-6 Acceptance of the Mixture.

337-6.1 FC-9.5 and FC-12.5: Meet the requirements of 334-5.

337-6.2 FC-5: Meet the requirements of 334-5 with the following exceptions:

1. The mixture will be accepted with respect to gradation ($P_{-3/8}$, P_{-4}, and P_{-8}), and asphalt binder content (P_b) only.

2. Testing in accordance with AASHTO T 312-11 and FM 1-T 209 (and

conditioning prior to testing) will not be required as part of 334-5.1.1.

3. The standard LOT size of FC-5 will be 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each.

4. The Between-Laboratory Precision Values described in Table 334-6 are modified to include ($P_{-3/8}$, P_{-4}, and P_{-8}) with a maximum difference per FM 1-T 030 (Figure 2).

5. Table 334-5 (Master Production Range) is replaced by Table 337-2.

6. The mixture will be accepted on the roadway with respect to surface tolerance in accordance with 334-5.8. No density testing will be required for these mixtures.

Table 337-2
FC-5 Master Production Range

Characteristic	Tolerance (1)
Asphalt Binder Content (%)	Target ± 0.60
Passing 3/8 inch Sieve (%)	Target ± 7.50
Passing No. 4 Sieve (%)	Target ± 6.00
Passing No. 8 Sieve (%)	Target ± 3.50
(1) Tolerances for sample size of n = 1 from the verified mix design	

337-6.2.1 Individual Test Tolerances for FC-5 Production: Terminate the LOT if any of the following Quality Control (QC) failures occur:

1) An individual test result of a sublot for asphalt binder content does not meet the requirements of Table 337-2,

2) Two consecutive test results within the same LOT for gradation on any of the following sieve sizes ($P_{-3/8}$, P_{-4}, and P_{-8}) do not meet the requirements of Table 337-2. The two consecutive failures must be on the same sieve.

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the QC Managers and/or Asphalt Plant Level II technicians responsible for the decision to resume production after a quality control failure, as identified in 105-8.6.4. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a QC failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future QC failures.

Address any material represented by a failing test result in accordance with 334-5.9.5. Any LOT terminated under this Subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 337-12.3) for each quality characteristic.

337-7 Special Construction Requirements.

337-7.1 Hot Storage of FC-5 Mixtures: When using surge or storage bins in the normal production of FC-5, do not leave the mixture in the surge or storage bin for more than one hour.

337-7.2 Longitudinal Grade Controls for Open-Graded Friction Courses: On FC-5, use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

337-7.3 Temperature Requirements for FC-5:

337-7.3.1 Air Temperature at Laydown: Meet the requirements of Table 330-1.

337-7.3.2 Temperature of the Mix: Heat and combine the asphalt binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 320-6.3. Meet all requirements of 330-6.1.3 at the roadway. The target mixing temperature shall be established by the Contractor. The target mixing temperature may be reduced when using warm mix technology.

337-7.4 Compaction of FC-5: Provide two, static steel-wheeled rollers, with an effective compactive weight in the range of 135 to 200 per linear inch (PLI), determined as follows:

$$\text{PLI} = \frac{\text{Total Weight of Roller (pounds)}}{\text{Total Width of Drums (inches)}}$$

(Any variation of this equipment requirement must be approved by the Engineer.) Establish an appropriate rolling pattern for the pavement in order to effectively seat the mixture without crushing the aggregate. In the event that the roller begins to crush the aggregate, reduce the number of coverages or the PLI of the rollers. If the rollers continue to crush the aggregate, use a tandem steel-wheel roller weighing not more than 135 lb/PLI of drum width.

337-7.5 Temperature Requirements for FC-9.5 and FC-12.5:

337-7.5.1 Air Temperature at Laydown: Meet the requirements of Table 330-1.

337-7.5.2 Temperature of the Mix: Heat and combine the asphalt binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 320-6.3. Meet all requirements of 330-6.1.3 at the roadway.

337-7.6 Prevention of Adhesion: To minimize adhesion to the drum during the rolling operations, the Contractor may add a small amount of liquid detergent to the water in the roller.

At intersections and in other areas where the pavement may be subjected to cross-traffic before it has cooled, spray the approaches with water to wet the tires of the approaching vehicles before they cross the pavement.

337-7.7 Transportation Requirements of Friction Course Mixtures: Cover all loads of friction course mixtures with a tarpaulin, or waterproof cover, meeting requirements of 320-7.

337-8 Thickness of Friction Courses.

337-8.1 FC-12.5 and FC-9.5: The thickness of the friction course layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate as defined in 334-1.4.

Plan quantities are based on a G_{mm} of 2.540, corresponding to a spread rate of 110 lbs/yd^2-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

337-8.2 FC-5: The total thickness of the FC-5 layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate based on the combined aggregate bulk specific gravity of the asphalt mix being used as shown in the following equation:

$$\text{Spread rate (lbs/yd}^2\text{)} = t \times G_{sb} \times 40.5$$

Where: t = Thickness (in.) (Plan thickness)

G_{sb} = Combined aggregate bulk specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-3.2.

Plan quantities are based on a G_{sb} of 2.635, corresponding to a spread rate of 80 lbs/yd^2. Pay quantities will be based on the actual combined aggregate bulk specific gravity (G_{sb}) of the mix being used.

337-9 Special Equipment Requirements for FC-5.

337-9.1 Fiber Supply System: Use a separate feed system to accurately proportion the required quantity of mineral fibers into the mixture in such a manner that uniform distribution is obtained. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. Control the proportion of fibers to within plus or minus 10% of the amount of fibers required. Provide flow indicators or sensing devices for the fiber system, interlocked with plant controls so that the mixture production will be interrupted if introduction of the fiber fails.

When a batch plant is used, add the fiber to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by 8 to 12 seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Ensure that the fibers are uniformly distributed prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the fiber with the aggregate prior to the addition of the asphalt rubber. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2 Hydrated Lime Supply System: For FC-5 mixes containing granite, use a separate feed system to accurately proportion the required quantity of hydrated lime into the mixture in such a manner that uniform coating of the aggregate is obtained prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes and to ensure that all mixture produced is properly treated with hydrated lime. Control the proportion of hydrated lime to within plus or minus 10% of the amount of hydrated lime required. Provide and interlock flow indicators or sensing devices for the hydrated lime system with plant controls so that the mixture production will be interrupted if introduction of the hydrated lime fails. The addition of the hydrated lime to the aggregate may be accomplished by Method A or B as follows:

337-9.2.1 Method A - Dry Form: Add hydrated lime in a dry form to the mixture according to the type of asphalt plant being used.

When a batch plant is used, add the hydrated lime to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by eight to twelve seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Uniformly distribute the hydrated lime prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the hydrated lime to the aggregate prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2.2 Method B - Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate.

Provide a solution consisting of hydrated lime and water in concentrations as directed by the Engineer. Use a plant equipped to blend and maintain the hydrated lime in suspension and to mix it with the aggregates uniformly in the proportions specified.

337-9.3 Hydrated Lime Pretreatment: For FC-5 mixes containing granite, as an alternative to 337-9.2, pretreat the aggregate with hydrated lime prior to incorporating the aggregate into the mixture. Use a feed system to accurately proportion the aggregate and required quantity of hydrated lime, and mix them in such a manner that uniform coating of the aggregate is obtained. Control the proportion of hydrated lime to within plus or minus 10% of the amount required. Aggregate pretreated with hydrated lime in this manner shall be incorporated into the asphalt mixture within 45 days of pretreatment.

337-9.3.1 Hydrated Lime Pretreatment Methods: Pretreat the aggregate using one of the following two methods:

Pretreatment Method A - Dry Form: Add the required quantity of hydrated lime in a dry form to the aggregate. Assure that the aggregate at the time of pretreatment contains a minimum of 3% moisture over saturated surface dry (SSD) conditions. Utilize equipment to accurately proportion the aggregate and hydrated lime and mix them in such a manner as to provide a uniform coating.

Pretreatment Method B - Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and water in a concentration to provide effective treatment. Use equipment to blend and maintain the hydrated lime in suspension, to accurately proportion the aggregate and hydrated lime/water slurry, and to mix them to provide a uniform coating.

337-9.3.2 Blending QC Records: Maintain adequate QC records for the Engineer's review for all pretreatment activities. Include as a minimum the following information (for each batch or day's run of pretreatment): pretreatment date, aggregate certification information, certified test results for the hydrated lime, aggregate moisture content prior to blending, as-blended quantities of aggregate and hydrated lime, project number, customer name, and shipping date.

337-9.3.3 Certification: In addition to the aggregate certification, provide a certification with each load of material delivered to the hot mix asphalt plant, that the material has been pretreated in conformance with these specifications. Include also the date the material was pretreated.

337-10 Failing Material.

Meet the requirements of 334-5.9. For FC-5, use the Master Production Range defined in Table 337-2 in lieu of Table 334-5.

337-11 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons. The pay quantity will be based on the project average spread rate, limited to a maximum of 105% of the spread rate determined in accordance with 337-8 or as set by the Engineer. The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer.

The bid price for the asphalt mix will include the cost of the asphalt binder (asphalt rubber (or polymer), asphalt cement, ground tire rubber, anti-stripping agent, blending and

handling) and the tack coat application as directed in 300-8, as well as fiber stabilizing additive and hydrated lime (if required). There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. The weight will be determined as provided in 320-3.2 (including the provisions for the automatic recordation system).

Prepare a Certification of Quantities, using the Department's current approved form, for the certified asphalt concrete friction course pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the roadway per Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

337-12 Basis of Payment.

337-12.1 General: Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

Based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for individual quality characteristics. The pay adjustment will be computed by multiplying a Composite Pay Factor for the LOT by the bid price per ton. Perform all calculations with the Department's Asphalt Plant - Pay Factor Worksheets.

337-12.2 FC-9.5 and FC-12.5: Meet the requirements of 334-8.

337-12.3 FC-5: Meet the requirements of 334-8 with the following exceptions:

1. Pay factors will be calculated for asphalt binder content and the percentages passing the 3/8 inch, the No. 4, and the No. 8 sieves only.

2. The Small Quantity Pay Table for FC-5 Mixtures replaces the Small Quantity Pay Table for Dense Graded Mixtures in the Department's Asphalt Plant - Pay Factor Worksheets.

3. Table 337-3 replaces Table 334-7.

4. The Composite Pay Factor equation in 334-8.3 is replaced with the following:

CPF = [(0.20 x PF 3/8 inch) + (0.30 x PF No. 4) + (0.10 x PF No. 8) + (0.40 x PF AC)]

Table 337-3
Specification Limits for FC-5

Quality Characteristic	Specification Limits
Asphalt Binder Content (%)	Target ± 0.45
Passing 3/8 inch sieve (%)	Target ± 6.00
Passing No. 4 sieve (%)	Target ± 4.50
Passing No. 8 sieve (%)	Target ± 2.50

337-12.4 Payment: Payment will be made under:

Item No. 337- 7- Asphaltic Concrete Friction Course - per ton.

346 PORTLAND CEMENT CONCRETE.
(REV 10-9-12) (1-13)

SECTION 346 (Pages 305 – 325) is deleted and the following substituted:

SECTION 346
PORTLAND CEMENT CONCRETE

346-1 Description.

Use concrete composed of a mixture of portland cement, aggregate, water, and, where specified, admixtures, pozzolan and ground granulated blast furnace slag. Deliver the portland cement concrete to the site of placement in a freshly mixed, unhardened state.

Obtain concrete from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3. If the concrete production facility's Quality Control Plan is suspended, the Contractor is solely responsible to obtain the services of another concrete production facility with an accepted Quality Control Plan or await the re-acceptance of the affected concrete production facility's Quality Control Plan prior to the placement of any further concrete on the project. There will be no changes in the contract time or completion dates. Bear all delay costs and other costs associated with the concrete production facility's Quality Control Plan acceptance or re-acceptance.

346-2 Materials.

346-2.1 General: Meet the following requirements:

Coarse Aggregate	Section 901
Fine Aggregate*	Section 902
Portland Cement	Section 921
Water	Section 923
Admixtures**	Section 924
Pozzolans and Slag	Section 929

*Use only silica sand except as provided in 902-5.2.3.

**Use products listed on the Department's Qualified Products List (QPL).

Do not use materials containing hard lumps, crusts or frozen matter, or that is contaminated with dissimilar material in excess of that specified in the above listed Sections.

346-2.2 Types of Cement: Unless a specific type of cement is designated elsewhere, use Type I, Type IP, Type IS, Type II, Type II (MH) or Type III cement in all classes of concrete. Use Type II (MH) for all mass concrete elements.

Use only the types of cements designated for each environmental condition in structural concrete. A mix design for a more aggressive environment may be substituted for a lower aggressive environmental condition.

TABLE 1			
BRIDGE SUPERSTRUCTURES			
Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
Precast Superstructure and Prestressed Elements	Type I or Type III	Type I, Type II, Type III, Type IP, or Type IS	Type II (MH)
Cast In Place	Type I	Type I, Type II, Type IP, or Type IS	Type II (MH)
BRIDGE SUBSTRUCTURE, DRAINAGE STRUCTURES AND OTHER STRUCTURES			
All Elements	Type I or Type III	Type I, Type II, Type IP, or Type IS	Type II (MH)

346-2.3 Pozzolans and Slag: Fly ash or slag materials are required in all classes of concrete. Use fly ash or slag materials as a cement replacement, on an equal weight replacement basis with the following limitations:

(1) Mass Concrete:

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 18% to 50% by weight, except where the core temperature is expected to rise above 165°F. In that case, ensure that the percentage of fly ash is 35% to 50% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 50% to 70% by weight. Ensure that slag is 50% to 55% of total cementitious content by weight when used in combination with silica fume, ultrafine fly ash and/or metakaolin.

c. Fly Ash and Slag - Ensure that there is at least 20% fly ash by weight and 40% portland cement by weight for mixes containing portland cement, fly ash and slag.

(2) Drilled Shaft:

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 33% to 37% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 58% to 62% by weight.

(3) Precast Concrete – Ensure that the precast concrete has a maximum of 25% fly ash or a maximum of 70% slag. In extremely aggressive environments, ensure that the precast concrete has a minimum of 18% fly ash or a minimum of 50% slag.

(4) For all other concrete uses not covered in (1), (2) and (3) above,

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 18% to 30% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 25% to 70% for slightly and moderately aggressive environments and 50% to 70% by weight when used in extremely aggressive environments. Ensure that slag is 50% to 55% of total cementitious content by weight when used in combination with silica fume, ultra fine fly ash and/or metakaolin.

c. Fly Ash and Slag (Ternary Blend) - Ensure that there is at least 20% fly ash by weight and 40% portland cement by weight for mixes containing portland cement, fly ash and slag.

(5) Blended Cements:

a. Type IS - Ensure that the quantity of slag in Type IS is less than or equal to 70% by weight.

b. Type IP - Ensure that the quantity of the pozzolan in Type IP is less than or equal to 40% by weight.

(6) Silica Fume, Metakaolin and Ultrafine Fly Ash - When silica fume, metakaolin or ultrafine fly ash is used, it must be used in combination with fly ash or slag.

a. Silica Fume - Ensure that the quantity of cementitious material replaced with silica fume is 3% to 9% by weight.

b. Metakaolin - Ensure that the quantity of cementitious material replaced with metakaolin is 8% to 12% by weight.

c. Ultrafine Fly Ash - Ensure that the quantity of cementitious material replaced with ultrafine fly ash is 8% to 12% by weight.

d. Cure in accordance with the manufacturer's recommendation and as approved by the Engineer.

346-2.4 Coarse Aggregate Gradation: Produce all concrete using Size No. 57, 67 or 78 coarse aggregate. With the Engineer's approval, Size No. 8 or Size No. 89 may be used either alone or blended with Size No. 57, 67 or 78 coarse aggregate. The Engineer will consider requests for approval of other gradations individually. Submit sufficient statistical data to establish production quality and uniformity of the subject aggregates, and establish the quality and uniformity of the resultant concrete. Furnish aggregate gradations sized larger than nominal maximum size of 1.5 inch as two components.

For Class I and Class II, excluding Class II (Bridge Deck), the coarse and fine aggregate gradation requirements set forth in Sections 901 and 902 are not applicable and the aggregates may be blended; however, the aggregate sources must be approved by the Department. Do not blend the aggregate if the size is smaller than Size No. 78.

346-2.5 Admixtures: Use admixtures in accordance with the requirements of this subarticle. Chemical admixtures not covered in this subarticle may be approved by the Department. Submit statistical evidence supporting successful laboratory and field trial mixes which demonstrate improved concrete quality or handling characteristics.

Use admixtures in accordance with the manufacturer's recommended dosage rate. Dosage rates outside of this range may be used with written recommendation from the admixture producer's technical representative. Do not use admixtures or additives containing calcium chloride (either in the raw materials or introduced during the manufacturing process) in reinforced concrete.

346-2.5.1 Water-Reducer/Water-Reducer Retardant Admixtures: When a water-reducing admixture is used, meet the requirements of a Type A. When a water-reducing and retarding admixture is used, meet the requirements of a Type D.

346-2.5.2 Air Entrainment Admixtures: Use an air entraining admixture in all concrete mixes except counterweight concrete. For precast concrete products, the use of air entraining admixture is optional for Class I and Class II concrete.

346-2.5.3 High Range Water-Reducing Admixtures:

346-2.5.3.1 General: When a high range water-reducing admixture is used, meet the requirements of a Type F or Type I. When a high range water-reducing and retarding admixture is used, meet the requirements of a Type G or Type II. Do not use Type I, II, F or G admixtures in drilled shaft concrete. When silica fume or metakaolin is incorporated into a concrete mix design, use a high range water-reducing admixture Type I, II, F or G.

346-2.5.3.2 Flowing Concrete Admixtures for Precast/Prestressed Concrete: Use a Type I, II, F or G admixture for producing flowing concrete. If Type F or G admixture is used, verify the distribution of aggregates in accordance with ASTM C 1610 except allow for minimal vibration for consolidating the concrete. The maximum allowable difference between the static segregation is less than or equal to 15 percent. Add the flowing concrete admixtures at the concrete production facility.

346-2.5.4 Corrosion Inhibitor Admixture: Use only with concrete containing Type II cement, or Type II (MH) cement, and a water-reducing retardant admixture, Type D, or High Range Water-Reducer retarder admixture, Type G, to normalize the setting time of concrete. Ensure that all admixtures are compatible with the corrosion inhibitor admixture.

346-2.5.5 Accelerating Admixture for Precast Concrete: The use of non-chloride admixtures Type C or Type E is allowed in the manufacturing of precast concrete products that are used in slightly aggressive environments.

346-3 Classification, Strength, Slump and Air Content.

346-3.1 General: The separate classifications of concrete covered by this Section are designated as Class I, Class II, Class III, Class IV, Class V and Class VI. Strength and slump are specified in Table 2. The air content range for all classes of concrete is 1.0 to 6.0%, except for Class IV (Drilled Shaft) which is 0.0 to 6.0%.

Substitution of a higher class concrete in lieu of a lower class concrete may be allowed when the substituted concrete mixes are included as part of the Contractor's Quality Control Plan, or for precast concrete, the Precast Concrete Producer's Quality Control Plan. The substituted higher class concrete must meet or exceed the requirements of the lower class concrete and both classes must contain the same types of mix ingredients. When the compressive strength acceptance data is less than the minimum compressive strength of the higher design mix, notify the Engineer. Acceptance is based on the requirements in Table 2 for the lower class concrete.

TABLE 2

Class of Concrete	Specified Minimum Strength (28-day) (psi)	Target Slump Value (inches) (c)
STRUCTURAL CONCRETE		
I (a)	3,000	3 (b)
I (Pavement)	3,000	2
II (a)	3,400	3 (b)
II (Bridge Deck)	4,500	3 (b)
III (e)	5,000	3 (b)
III (Seal)	3,000	8
IV	5,500	3 (b) (d)
IV (Drilled Shaft)	4,000	8.5
V (Special)	6,000	3 (b) (d)
V	6,500	3 (b) (d)
VI	8,500	3 (b) (d)

(a) For precast three-sided culverts, box culverts, endwalls, inlets, manholes and junction boxes, the target slump value and air content will not apply. The maximum allowable slump is 6 inches, except as noted in (b). The Contractor is permitted to use concrete meeting the requirements of ASTM C 478 4,000 psi in lieu of Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.

(b) The Engineer may allow a higher target slump when a Type F, G, I or II admixture is used, except when flowing concrete is used. The maximum target slump shall be 7 inches.

(c) For a reduction in the target slump for slip-form operations, submit a revision to the mix design to the Engineer.

(d) When the use of silica fume, ultrafine fly ash, or metakaolin is required as a pozzolan in Class IV, Class V, Class V (Special) or Class VI concrete, ensure that the concrete exceeds a resistivity of 29 KOhm-cm at 28 days, when tested in accordance with FM 5-578. Submit three 4 x 8 inch cylindrical test specimens to the Engineer for resistivity testing before mix design approval. Take the resistivity test specimens from the concrete of the laboratory trial batch or from the field trial batch of at least 3 cubic yards. Verify the mix proportioning of the design mix and take representative samples of trial batch concrete for the required plastic and hardened property tests. Cure the field trial batch specimens similar to the standard laboratory curing methods. Submit the resistivity test specimens at least 7 calendar days prior to the scheduled 28 day test. The average resistivity of the three cylinders, eight readings per cylinder, is an indicator of the permeability of the concrete mix.

(e) When precast three-sided culverts, box culverts, endwalls, inlets, manholes or junction boxes require a Class III concrete, the minimum cementitious materials is 470 pounds per cubic yard. Do not apply the air content range and the maximum target slump shall be 6 inches, except as allowed in (b).

346-3.2 Drilled Shaft Concrete: Notify the Engineer at least 48 hours before placing drilled shaft concrete. Obtain slump loss tests results demonstrating that the drilled shaft concrete maintains a slump of at least 5 inches throughout the concrete elapsed time before drilled shaft concrete operations begin, using personnel meeting the requirements of Section 105. The concrete elapsed time is defined in Section 455. Obtain the Engineer's approval for use of slump loss test results including elapsed time before concrete placement begins.

Test each load of concrete for slump to ensure the slump is within the limits of 346-6.4.

If the elapsed time during placement exceeds the slump loss test data, cast cylinders to verify the strength. Provide an engineering analysis preformed by a Professional Engineer, registered in the State of Florida, knowledgeable in the area of foundations, to determine if the shaft is structurally sound and there are no voids in the drilled shaft concrete. At the direction of the Engineer, excavate the drilled shaft for inspection. Obtain approval from the Engineer before placing any additional shafts.

346-3.3 Mass Concrete: When mass concrete is designated in the Contract Documents, provide an analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the selected mix design, casting procedures, and materials.

Use a Specialty Engineer competent in the design and temperature control of concrete in mass elements. The Specialty Engineer shall follow the procedure outlined in

Section 207 of the ACI Manual of Concrete Practice to formulate, implement, administer and monitor a temperature control plan, making adjustments as necessary to ensure compliance with the Contract Documents. The Specialty Engineer shall select the concrete design mix proportions that will generate the lowest maximum temperatures possible to ensure that a 35°F differential temperature between the concrete core and the exterior surface is not exceeded. The mass concrete maximum allowable temperature is 180°F. If either the differential temperature or the maximum allowable temperature is exceeded, the Specialty Engineer shall be available for immediate consultation.

Describe the measures and procedures intended for use to maintain a temperature differential of 35°F or less between the interior core center and exterior surface(s) of the designated mass concrete elements during curing. Submit both the mass concrete mix design and the proposed mass concrete plan to monitor and control the temperature differential to the Engineer for acceptance. Provide temperature monitoring devices to record temperature development between the interior core center and exterior surface(s) of the elements in accordance with the accepted mass concrete plan.

The Specialty Engineer, or a qualified technician employed by the Specialty Engineer, must personally inspect and approve the installation of monitoring devices and verify that the process for recording temperature readings is effective for the first placement of each size and type mass component. Submit to the Engineer for approval the qualification of all technicians employed to inspect or monitor mass concrete placements. For placements other than the first, designate an employee(s) approved by the Specialty Engineer, as qualified to inspect monitoring device installation, to record temperature readings, to be in contact at all times with the Specialty Engineer if adjustments must be made as a result of the temperature differential or the maximum allowable temperature being exceeded, and to immediately implement adjustments to temperature control measures as directed by the Specialty Engineer. Read the monitoring devices and record the readings at intervals no greater than 6 hours. The readings will begin when the mass concrete placement is complete and continue until the maximum temperature differential and the temperature is reached and a decreasing temperature differential is confirmed as defined in the temperature control plan. Do not remove the temperature control mechanisms until the core temperature is within 50°F of the ambient temperature. Furnish a copy of all temperature readings to the Engineer as they are recorded, the determined temperature differentials and a final report within three calendar days of completion of monitoring of each element.

If the 35°F differential or the 180°F maximum allowable temperature has been exceeded, take immediate action as directed by the Specialty Engineer to retard further growth of the temperature differential. Describe methods of preventing thermal shock in the temperature control plan. Use a Specialty Engineer to revise the previously accepted plan to ensure compliance on future placements. Do not place any mass concrete until the Engineer has accepted the mass concrete plan(s). When mass concrete temperature differentials or maximum allowable temperature has been exceeded, provide all analyses and test results deemed necessary by the Engineer for determining the structural integrity and durability of the mass concrete element, to the satisfaction of the Engineer. The Department will make no compensation, either monetary or time, for the analyses or tests or any impacts upon the project.

346-3.4 Flowing Concrete for Precast/Prestressed Concrete: Produce flowing concrete mix with target slump of 9 inches.

Subsequent to the laboratory trial batch, perform a field demonstration of the proposed mix design by production and placement of at least three batches, 3 cubic yard minimum size each, of concrete containing flowing concrete HRWR admixture. Take representative samples from each batch and perform slump, air content, density (unit weight), and temperature tests on these samples. Cast specimens from each sample for compressive strength tests. Record the ambient air temperature during the test. Ensure that the concrete properties are within the required specification limits. The plants that are producing concrete with batch sizes of less than 3 cubic yards are required to produce and place at least a total amount of 9 cubic yards and perform the aforementioned tests on at least three randomly selected batches.

Determine the workability of the demonstration concrete batches by performing the slump tests on the samples taken at 15 minute intervals from each batch. Continue sampling and testing until the slump measures 6 inches or less. From the plot of slump versus time, determine the time for each batch when the slump is at 7.5 inches. The shortest time period determined from three consecutive batches, at 7.5 inches slump, is considered the cutoff time of the proposed concrete mix. For production concrete, ensure that the time between the batching and depositing of each load of concrete is less than the cutoff time of the mix and also does not exceed the allowable time limit specified in this Section.

Ensure that the demonstration concrete is mixed, delivered, placed, consolidated and cured in accordance with the proposed method and sequence. Produce the flowing concrete batches at slumps between 7.5 inches to 10.5 inches.

Perform inspection of the demonstration concrete during batching, delivery, placement and post placement. During placement, ensure that the concrete batches meet all plastic property requirements of the specifications and maintain their cohesive nature without excessive bleeding, segregation, or abnormal retardation.

Dispose of concrete produced for demonstration purposes at no expense to the Department. Subject to the Engineer's approval, the Contractor may incorporate this concrete into non-reinforced concrete items and may be included for payment, provided it meets Contract requirements for slump, entrained air, and strength.

After removal of the forms, perform the post-placement inspection of the in-place concrete. Observe for any signs of honeycombs, cracks, aggregate segregation or any other surface defects and ensure that the hardened concrete is free from these deficiencies. The Engineer may require saw cutting of the mock-up products to verify the uniform distribution of the aggregates within the saw cut surfaces and around the reinforcing steel and prestressing strands. The Engineer will require saw cutting of the demonstration mock-up products for plants that are demonstrating the use of the flowing concrete for the first time. Obtain core samples from different locations of mock-up products to inspect the aggregate distribution in each sample and compare it with the aggregate distribution of other core samples. Perform surface resistivity tests on the core samples or test cylinders at 28 days.

Submit the results of the laboratory trial batch tests and field demonstration of verified test data and inspection reports to the Engineer, along with certification stating that the results of the laboratory trial batch tests and field demonstration tests indicate that the proposed concrete mix design meets the requirements of the specifications. For the proposed mix design, state the anticipated maximum time limit between the batching and when the concrete of each batch is deposited during the production.

Upon the review and verification of the laboratory trial batch, field demonstration test data, inspection reports and contractor's certification statement, the Department will approve the proposed mix design.

The Department may approve proposed flowing concrete mixes, centrally mixed at the placement site, without the production of demonstration batches, provided that the proposed mix meets the following two criteria:

(1) A previously approved flowing concrete mix of the same class has demonstrated satisfactory performance under the proposed job placing conditions with a minimum of fifteen consecutive Department acceptance tests, which met all plastic and hardened concrete test requirements.

(2) The cementitious materials and chemical admixtures, including the flowing concrete HRWR admixture, used in the proposed mix are the same materials from the same source used in the previously approved mix, (1) above.

Do not produce or place concrete until the design mixes have been approved.

346-4 Composition of Concrete.

346-4.1 Master Proportion Table: Proportion the materials used to produce the various classes of concrete in accordance with Table 3:

TABLE 3

Class of Concrete	Minimum Total Cementitious Materials Content pounds per cubic yard	Maximum Water to Cementitious Materials Ratio pounds per pounds*
I	470	0.53
I (Pavement)	470	0.50
II	470	0.53
II (Bridge Deck)	611	0.44
III	611	0.44
III (Seal)	611	0.53
IV	658	0.41**
IV (Drilled Shaft)	658	0.41
V (Special)	752	0.37**
V	752	0.37**
VI	752	0.37**

*The calculation of the water to cementitious materials ratio (w/cm) is based on the total cementitious material including cement and any supplemental cementitious materials that are used in the mix.
**When the use of silica fume or metakaolin is required, the maximum water to cementitious material ratio will be 0.35. When the use of ultrafine fly ash is required, the maximum water to cementitious material ratio will be 0.30.

346-4.2 Chloride Content Limits for Concrete Construction:

346-4.2.1 General: Use the following maximum chloride content limits for the concrete application and/or exposure environment shown:

TABLE 4

Application/Exposure Environment		Maximum Allowable Chloride Content, pounds per cubic yard
Non Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

346-4.2.2 Control Level for Corrective Action: If chloride test results exceed the limits of Table 4, suspend concrete placement immediately for every mix design represented by the failing test results, until corrective measures are made. Perform an engineering analysis to demonstrate that the material meets the intended service life of the structure on all concrete represented by the failing chloride test results. Supply this information within 30 business days of the failing test results from a Professional Engineer, registered in the State of Florida and knowledgeable in the areas of corrosion and corrosion control.

346-5 Sampling and Testing Methods.

Perform concrete sampling and testing in accordance with the following methods:

TABLE 5	
Description	Method
Slump of Hydraulic Cement Concrete	ASTM C 143
Air Content of Freshly Mixed Concrete by the Pressure Method*	ASTM C 231
Air Content of Freshly Mixed Concrete by the Volumetric Method*	ASTM C 173
Making and Curing Test Specimens in the Field**	ASTM C 31
Compressive Strength of Cylindrical Concrete Specimens***	ASTM C 39
Obtaining and Testing Drilled Core and Sawed Beams of Concrete	ASTM C 42
Initial Sampling of Concrete from Revolving Drum Truck Mixers or Agitators	FM 5-501
Low Levels of Chloride in Concrete and Raw Materials	FM 5-516
Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete	ASTM C 138
Temperature of Freshly Mixed Portland Cement Concrete	ASTM C 1064
Sampling Freshly Mixed Concrete****	ASTM C 172
Static Segregation of Self Consolidating Concrete using Column Techniques	ASTM C 1610
Slump Flow of Self Consolidating Concrete	ASTM C 1611
Passing Ability of Self Consolidating Concrete by J-Ring	ASTM C 1621
Concrete Resistivity as an Electrical Indicator of its Permeability	FM 5-578

TABLE 5	
Description	Method
*Use the same type of meter for QC tests as the Department uses for Verification testing. When using pressure type meters, use an aggregate correction factor determined by the concrete producer for each mix design to be tested. Record and certify test results for correction factors for each type of aggregate at the concrete production facility. ** Provide curing facilities that have the capacity to store all QC, Verification, "hold" and Independent Verification cylinders simultaneously for the initial curing. ***The Verification technician will use the same size cylinders as the Quality Control technician. **** Take the test sample from the middle portion of the batch in lieu of collecting and compositing samples from two or more portions, as described in ASTM C 172.	

346-6 Control of Quality.

346-6.1 General: Develop a Quality Control Plan (QCP) as specified in Section 105. Meet the requirements of the approved QCP and Contract Documents. Ensure the QCP includes the necessary requirements to control the quality of the concrete.

Perform QC activities to ensure materials, methods, techniques, personnel, procedures and processes utilized during production meet the specified requirements. For precast/prestressed operations, ensure that the QC testing is performed by the producer.

Accept the responsibility for QC inspections on all phases of work. Ensure all materials and workmanship incorporated into the project meet the requirements of the Contract Documents.

Ensure the QCP includes any anticipated requirements for adjusting and controlling the concrete at the placement site. Include the testing procedures that will be implemented to control the quality of the concrete and ensure that concrete placed is within the tolerance range. Also, include provisions for the addition of water to concrete delivered to the placement site at designated level areas, to ensure the allowable amount of water stated on the concrete delivery ticket is correct and the maximum water to cementitious materials ratio on the approved design mix is not exceeded. Ensure the anticipated ranges of jobsite water additions are described and the proposed methods of measuring water for concrete adjustments are included.

Failure to meet the requirements of this Specification or the QCP will automatically void the concrete portion of the QCP. To obtain QCP re-approval, implement corrective actions as approved by the Engineer. The Engineer may allow the Contractor to continue any ongoing concrete placement but the Engineer will not accept concrete for any new placement until the QCP re-approval is given by the Engineer.

346-6.2 Concrete Design Mix: Provide concrete that has been produced in accordance with a Department approved design mix, in a uniform mass free from balls and lumps.

For slump target values in excess of 6 inches or self consolidating concrete, utilize a grate over the conveyance equipment to capture any lumps or balls that may be present in the mix. The grate must cover the entire opening of the conveyance equipment and have an opening that is a maximum of 2 1/2 inches in any one direction. Remove the lumps or balls from the grate and discard them. Discharge the concrete in a manner satisfactory to the Engineer. Perform demonstration batches to ensure complete and thorough placements in complex elements, when requested by the Engineer.

Do not place concretes of different compositions such that the plastic concretes may combine, except where the plans require concrete both with and without silica fume, ultrafine fly ash, metakaolin or calcium nitrite in a continuous placement. Produce these concretes using separate design mixes. For example, designate the mix with calcium nitrite as the original mix and the mix without calcium nitrite as the redesigned mix. Ensure that both mixes

contain the same cement, fly ash or slag, coarse and fine aggregates and compatible admixtures. Submit both mixes for approval as separate mix designs, both meeting all requirements of this Section. Ensure that the redesigned mix exhibits plastic and hardened qualities which are additionally approved by the Engineer as suitable for placement with the original mix. The Engineer will approve the redesigned mix for commingling with the original mix and for a specific project application only. Alternately, place a construction joint at the location of the change in concretes.

346-6.3 Delivery Certification: Ensure that an electronic delivery ticket is furnished with each batch of concrete before unloading at the placement site. The delivery ticket may be proprietary software or in the form of an electronic spreadsheet, but shall be printed. Ensure that the materials and quantities incorporated into the batch of concrete are printed on the delivery ticket. Include the following information on the Delivery Ticket:

(1) Arrival time at jobsite,
(2) Time that concrete mix has been completely discharged,
(3) Number of revolutions upon arrival at the jobsite,
(4) Total gallons of water added at the jobsite,
(5) Additional mixing revolutions when water is added,
(6) Total number of revolutions.

Items 3 through 6 do not apply to non-agitating concrete transporting vehicles.

Ensure the batcher responsible for production of the batch of concrete signs the delivery ticket, certifying the batch of concrete was produced in accordance with the Contract Documents.

Sign the delivery ticket certifying that the design mix maximum specified water to cementitious materials ratio was not exceeded due to any jobsite adjustments to the batch of concrete, and that the batch of concrete was delivered and placed in accordance with the Contract Documents.

346-6.4 Plastic Property Tolerances: Do not place concrete with a slump more than plus or minus 1.5 inches from the target slump value specified in Table 2.

Reject concrete with slump or air content that does not fall within the specified tolerances and immediately notify the concrete production facility that an adjustment of the concrete mixture is required. If a load does not fall within the tolerances, test each subsequent load and the first adjusted load. If failing concrete is not rejected or adjustments are not implemented, the Engineer may reject the concrete and terminate further production until the corrections are implemented.

Do not allow concrete to remain in a transporting vehicle to reduce slump. Water may be added only upon arrival of the concrete to the jobsite and not thereafter.

346-7 Mixing and Delivering Concrete.

346-7.1 General Requirements: Operate all concrete mixers at speeds and volumes per the manufacturer's design or recommendation as stipulated on the mixer rating plate.

346-7.2 Transit Truck Mixing: When water is added at the jobsite, mix the concrete 30 additional drum mixing revolutions. Do not add water after the total number of drum mixing revolutions exceeds 130, do not make additional mix adjustments. Discharge all concrete from truck mixers before total drum revolutions exceed 300. Seek approval from the Engineer prior to using a central mixer and depositing the batch into a truck mixer.

346-7.2.1 Transit Time: Ensure compliance with Table 6 between the initial introduction of water into the mix and completely discharging all of the concrete from the truck:

TABLE 6	
Maximum Allowable Time	
Non-Agitator Trucks	Agitator Trucks
45 minutes	60 minutes
75 minutes*	90 minutes*
*When a water-reducing and retarding admixture (Type D, Type G or Type II) is used.	

346-7.2.2 Placement Time: All the concrete in a load must be in its final placement position a maximum of 15 minutes after the transit time has expired unless a time extension is approved in advance by the Engineer.

346-7.3 On-site Batching and Mixing: Include provisions in the QCP for the mixing at the site. Use a mixer of sufficient capacity to prevent delays that may be detrimental to the quality of the work. Ensure that the accuracy of batching equipment is in accordance with requirements of this Section.

346-7.4 Concreting in Cold Weather: Do not mix or place concrete when the air temperature is below 45ºF. Protect the fresh concrete from freezing in accordance with Section 400. The requirements of concreting in cold weather are not applicable to precast concrete mixing and placement operations occurring in a temperature controlled environment.

346-7.5 Concreting in Hot Weather: Hot weather concreting is defined as the production, placing and curing of concrete when the concrete temperature at placing exceeds 86ºF but is less than 100ºF.

Unless the specified hot weather concreting measures are in effect, reject concrete exceeding 86ºF at the time of placement. Regardless of special measures taken, reject concrete exceeding 100ºF. Predict the concrete temperatures at placement time and implement hot weather measures to avoid production shutdown.

346-7.6 Adding Water to Concrete at the Placement Site: Perform an initial slump test before the addition of water at the jobsite. If the slump, as delivered, is outside the tolerance range, reject the load. If the slump is within the tolerance range, that load may be adjusted by adding water provided the addition of water does not exceed the water to cementitious materials ratio as defined by the mix design. After adding water, perform a slump test to confirm the concrete is within the slump tolerance range. If an adjustment is made at the concrete production facility, perform a slump test on the next load to ensure the concrete is within the slump tolerance range. Do not place concrete represented by slump test results outside of the tolerance range. Include water missing from the water storage tanks upon arrival at the project site in the jobsite water added.

346-7.7 Sample Location: Obtain acceptance samples from the point of final placement. Describe in the QCP the method to sample the plastic concrete at the point of final placement.

Where concrete buckets are used to discharge concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge of the bucket. When the concrete is discharged directly from the mixer into the bucket and the bucket is discharged within 20 minutes, samples may be obtained from the discharge of the mixer.

Where conveyor belts, troughs, pumps, or chutes are used to transport concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge end of the entire conveyor belt, trough, pump, or chute system.

Where concrete is placed in a drilled shaft or other element using a tremie pipe and a concrete pump, samples will be obtained from the discharge of the pump line at the location of the tremie hopper.

For all other placement methods, prior to each placement, obtain Department approval for sampling at the discharge of the mixer in lieu of sampling at the point of final placement. Describe the sampling correlation procedure in the QCP. Once the comparative sampling correlation is approved by the Engineer, apply this correlation to the plastic properties tolerances for samples obtained from the discharge of mixer.

Where a concrete pump is used to deposit concrete directly into a drilled shaft which is a wet excavation without the use of a tremie, or other applications as approved by the Engineer, ensure the discharge end of the pump line remains immersed in the concrete at all times after starting concrete placement.

346-8 Plastic Concrete Sampling and Testing.

QC tests include air content, temperature, slump, and preparing compressive strength cylinders for testing at later dates. In addition, calculate the water to cementitious materials ratio in accordance with FM 5-501 for compliance to the approved mix design.

Ensure that each truck has a rating plate and a valid mixer identification card issued by the Department. Ensure that the revolution counter on the mixer is working properly, and calibration of the water dispenser has been performed within the last twelve months. Reject any concrete batches that are delivered in trucks that do not have mixer identification cards. Remove the mixer identification card when a truck mixer is discovered to be in noncompliance and the mixer deficiencies cannot be repaired immediately. When the mixer identification card is removed for noncompliance, make note of the deficiency or deficiencies found, and forward the card to the District Materials and Research Engineer who has Producer QC Plan acceptance authority.

Perform plastic concrete tests on the initial delivery of each concrete design mix each day. Ensure QC technicians meeting the requirements of Section 105 are present and performing tests throughout the placement operation. Ensure one technician is present and performing tests throughout the placement operation at each placement site. If a project has multiple concrete placements at the same time, identify the number of technicians in the Quality Control Plan to ensure minimum sampling and testing frequencies are met. Ensure that the equipment used for delivery, placement and finishing meets the requirements of this Specification.

When a truck designated for QC testing arrives at the discharge site, a subsequent truck may also discharge once a representative sample has been collected from the QC truck and while awaiting the results of QC testing. Reject non-complying loads at the jobsite. Ensure that corrections are made on subsequent loads. Immediately cease concrete discharge of all trucks if the QC truck has failing test. Perform plastic properties tests on all trucks prior to the first corrected truck and the corrected truck. When more than one truck is discharging into a pump simultaneously, only the truck designated for QC testing may discharge into the pump to obtain a representative sample of concrete from the QC truck only.

Furnish sufficient concrete of each design mix as required by the Engineer for verification testing. When the Engineer's verification test results do not compare with the QC plastic properties test results, within the limits defined by the Independent Assurance (IA)

checklist comparison criteria, located in Materials Manual Chapter 5, disposition of the concrete will be at the option of the Contractor.

On concrete placements consisting of only one load of concrete, perform initial sampling and testing in accordance with this Section. The acceptance sample and plastic properties tests may be taken from the initial portion of the load.

If any of the QC plastic properties tests fail, reject the remainder of that load, and any other loads that have begun discharging, terminate the LOT and notify the Engineer. Make cylinders representing that LOT from the same sample of concrete.

Following termination of a LOT, obtain samples from a new load, and perform plastic properties tests until such time as the water to cementitious materials ratio, air content, temperature and slump comply with the Specification requirements. Initiate a new LOT once the testing indicates compliance with Specification requirements.

Suspend production when any five loads in two days of production of the same design mix are outside the specified tolerances. Make the necessary revisions to concrete operations and increase the frequency of QC testing in the QCP to bring the concrete within allowable tolerances. Obtain the Engineer's approval of the revisions before resuming production. After production resumes, obtain the Engineer's approval before returning to the normal frequency of QC testing.

If concrete placement stops for more than 90 minutes, perform initial plastic properties testing on the next batch and continue the LOT. Cylinders cast for that LOT will represent the entire LOT.

When the Department performs Independent Verification, the Contractor may perform the same tests on the concrete at the same time. The Department will compare results based on the Independent Assurance Checklist tolerances.

When the Department's Independent Verification test results do not meet the requirements of this Section, the Engineer may require the Contractor to revise the QCP.

346-9 Acceptance Sampling and Testing.

346-9.1 General: Perform plastic properties tests in accordance with 346-8 and cast a set of three QC cylinders, for all structural concrete incorporated into the project. Take these acceptance samples randomly as determined by a random number generator (acceptable to the Department). The Department will independently perform verification plastic properties tests and cast a set of verification cylinders. The verification cylinders will be the same size cylinder selected by the Contractor, from a separate sample from the same load of concrete as the Contractor's QC sample.

The Department may perform inspections in lieu of plastic properties tests of the precast plants producing Class I and II concrete, except for Incidental Precast plants.

For each set of QC cylinders verified by the Department, cast one additional cylinder from the same sample, and identify it as the QC "hold" cylinder. The Department will also cast one additional "hold" cylinder from each Verification sample. All cylinders will be clearly identified as outlined in the Sample/Lot Numbering System instructions located on the State Materials Office website. Deliver the QC samples, including the QC "hold" cylinder to the final curing facility in accordance with ASTM C 31. At this same time, the Department will deliver the Verification samples, including the Verification "hold" cylinder, to their final curing facility.

Test the QC laboratory cured samples for compressive strength at the age of 28 days, or any other specified age, in a laboratory meeting and maintaining at all times the qualification requirements listed in Section 105.

The QC testing laboratory will input the compressive strength test results into the Department's sample tracking database within 24 hours. When the QC testing laboratory cannot input the compressive strength test results into the Department's sample tracking database within 24 hours, the QC testing laboratory will notify the Verification testing laboratory within 24 hours of testing the cylinder and provide the Verification testing laboratory the compressive strength test results. Ensure the compressive strength results are input into the Department's sample tracking database within 72 hours of determining the compressive strength of the cylinders.

The Department will compare the Verification sample results with the corresponding QC sample results. In the event that one set of compressive strength data for a set of cylinders falls outside the range of the other set of cylinders, use the lower Range of Average Compressive Strength to determine the comparison criteria. Based on this comparison, the Department will determine if the Comparison Criteria as shown in Table 7 has been met. When the difference between QC and Verification is less than or equal to the Comparison Criteria, the QC data is verified. When the difference between QC and Verification data exceeds the Comparison Criteria, the Engineer will initiate the resolution procedure.

Table 7	
Range of Average Compressive Strength	Comparison Criteria
Less than 3500 psi	420 psi
3,501 – 4,500 psi	590 psi
4,501 – 6,500 psi	910 psi
6,501 – 8,500 psi	1,275 psi
Greater than 8,500 psi	1,360 psi

346-9.2 Sampling Frequency:

As a minimum, sample and test concrete of each design mix for water to cementitious materials ratio, air content, temperature, slump and compressive strength once per LOT as defined by Table 8. When a mix design is used for a different application, the LOT is defined by the application. When more than one concrete production facility is used for the same mix design, describe the method of sampling, testing and LOT numbering in the QC Plan. The Engineer will randomly verify one of every four consecutive LOTs of each design mix based on a random number generator. The Department may perform Independent Verification testing to verify compliance with specification requirements. All QC activities, calculations, and inspections will be randomly confirmed by the Department.

TABLE 8	
Class Concrete*	Maximum LOT Size
I	one day's production
I (Pavement)	2,000 square yards, or one day's production, whichever is less

TABLE 8	
Class Concrete*	Maximum LOT Size
II, II (Bridge Deck), III, IV, V (Special), V, VI	50 cubic yards, or one day's production, whichever is less
IV (Drilled Shaft)	50 cubic yards, or two hours between the end of one placement and the start of the next placement, whichever is less
III (Seal)	Each Seal placement
*For any class of concrete used for roadway barrier wall, the lot size is defined as 100 cubic yards, or one day's production, whichever is less.	

346-9.2.1 Reduced Frequency for Acceptance Tests: The LOT size may represent 100 cubic yards when produced at the same mix design at the same concrete production facility for the same prime contractor and subcontractor on a given Contract. Submit test results indicating the average compressive strength is greater than two standard deviations above the specified minimum strength for that class of concrete. Base calculations on a minimum of ten consecutive strength test results for a Class IV or higher; or a minimum of five consecutive strength results for a Class III or lower.

The average of the consecutive compressive strength test results, based on the class of concrete, can be established using historical data from a previous Department project. The tests from the previous Department project must be within the last 60 calendar days or may also be established by a succession of samples on the current project. Only one sample can be taken from each LOT. Test data must be from a laboratory meeting the requirements of Section 105. Obtain Department approval before beginning reduced frequency LOT's.

If at any time a strength test is not verified or the average strength of the previous ten or five consecutive samples based on the class of concrete from the same mix design and the same production facility is less than the specified minimum plus two standard deviations, return to the maximum production quantity represented by the LOT as defined in Table 8. Notify the Engineer that the maximum production rate is reinstated. In order to reinitiate reduced frequency, submit a new set of strength test results.

346-9.3 Strength Test Definition: The strength test of a LOT is defined as the average of the compressive strengths tests of three cylinders cast from the same sample of concrete from the LOT.

346-9.4 Acceptance of Concrete:

Ensure that the hardened concrete strength test results are obtained in accordance with 346-9.3. Do not discard a cylinder strength test result based on low strength (strength below the specified minimum strength as per the provisions of this Section).

When one of the three QC cylinders from a LOT is lost, missing, damaged or destroyed, determination of compressive strength will be made by averaging the remaining two cylinders. If more than one QC cylinder from a LOT is lost, missing, damaged or destroyed, the Contractor will core the structure at no additional expense to the Department to determine the compressive strength. Acceptance of LOT may be based on verification data at the discretion of the Engineer. Obtain the approval of the Engineer to core, and of the core location prior to coring.

For each QC cylinder that is lost, missing, damaged or destroyed, payment for that LOT will be reduced by $750.00 per 1,000 psi of the specified design strength [Example:

loss of two Class IV (Drill Shaft) QC cylinders that has no verification data will require the element to be cored and a pay reduction will be assessed (4,000 psi / 1,000 psi) x $750 x 2 = $6,000]. This reduction will be in addition to any pay adjustment for low strength.

When QC compressive strength test results are not verified, the resolution procedure will be used to accept or reject the concrete. Maintain the "hold" cylinders until the verification of the compressive strength test results.

When QC test results are verified, the Engineer will accept the concrete based on QC test results. The Engineer will accept at full pay only LOTs of concrete represented by plastic property results which meet the requirements of the approved mix design and strength test results which equal or exceed the respective specified minimum strength.

346-9.5 Resolution Procedure: The Department may initiate an IA review of sampling and testing methods. The resolution procedure may consist of, but need not be limited to, a review of sampling and testing of fresh concrete, calculation of water to cementitious materials ratio, handling of cylinders, curing procedures and compressive strength testing. Core samples of the hardened concrete may be required.

The Engineer will determine through the resolution procedure whether the QC strength test results or the verification strength test are deemed to be the most accurate. When the Engineer cannot determine which strength test results are the most accurate, the concrete represented by the four consecutive LOTs will be evaluated based on the QC data. The Engineer will inform the QC and the Verification lab within three calendar days of the acceptance compressive strength test to transport their "hold" cylinders to the resolution lab. The QC and Verification laboratories will transport their own hold cylinder to the resolution testing laboratory within 72 hours after the Engineer notifies the Contractor that a resolution is required. In addition, the Engineer will ensure that the QC and verification "hold" cylinders are tested within seven calendar days of the acceptance strength tests.

The resolution investigation will determine the strength test results for each of the four or less LOTs. When the QC strength test results are deemed to be the most accurate, the QC strength test results will represent the four or less consecutive LOTs and the Department will pay for the resolution testing and investigation. When the verification strength test results are deemed to be the most accurate, the Department will assess a $1,000 pay reduction for the cost of the Resolution Investigation.

The results of the resolution procedure will be forwarded to the Contractor within five working days after completion of the investigation. If the Department finds deficiencies based on the Contractor's QCP, the Engineer may suspend that part of the QCP. When the QC plan is suspended, submit corrective actions for approval to the Engineer. The Engineer may take up to five working days to review corrective actions to the QCP. The Engineer will not allow changes to contract time or completion dates. Incur all delay costs and other costs associated with QC plan suspension and re-approval.

346-9.6 Small Quantities of Concrete: When a project has a total plan quantity of less than 50 cubic yards, that concrete will be accepted based on the satisfactory compressive strength of the QC cylinders. Provide certification to the Engineer that the concrete was batched and placed in accordance with the Contract Documents. Submit a quality control plan for the concrete placement operation in accordance with Section 105. In addition, the Engineer may conduct Independent Verification (IV) testing as identified in 346-9. Evaluate the concrete in accordance with 346-10 at the discretion of the Engineer.

346-10 Investigation of Low Strength Concrete for Structural Adequacy.

346-10.1 General: When a concrete acceptance strength test result falls more than 500 psi below the specified minimum strength and the Department determines that an investigation is necessary, make an investigation into the structural adequacy of the LOT of concrete represented by that acceptance strength test result at no additional expense to the Department. The Engineer may also require the Contractor to perform additional strength testing as necessary to determine structural adequacy of the concrete.

Furnish either a structural analysis performed by the Specialty Engineer to establish strength adequacy or drilled core samples as specified in 346-10.3 to determine the in-place strength of the LOT of concrete in question at no additional expense to the Department. Obtain the Engineer's approval before taking any core samples. When the concrete is deemed to have low strength, obtain and test the cores and report the data to the Engineer within 10 calendar days of the 28 day compressive strength tests. Core strength test results obtained from the structure will be accepted by both the Contractor and the Department as the in-place strength of the LOT of concrete in question. The core strength test results will be final and used in lieu of the cylinder strength test results for determination of structural adequacy and any pay adjustment. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. This will be accepted as the actual measured value.

346-10.2 Determination of Structural Adequacy: If core strength test results are less than 500 psi below the specified minimum strength, consider the concrete represented by the cores structurally adequate. If the core strength test results are more than 500 psi below the specified minimum strength, the Department will consider the concrete represented by the cores structurally questionable. Submit a structural analysis performed by the Specialty Engineer. If the results of the structural analysis indicate adequate strength to serve its intended purpose with adequate durability, and is approved by the Department, the Contractor may leave the concrete in place subject to the requirements of 346-11, otherwise, remove and replace the LOT of concrete in question at no additional expense to the Department.

346-10.3 Coring for Determination of Structural Adequacy: Notify the Engineer 48 hours prior to taking core samples. The Engineer will select the size and location of the drilled cores so that the structure is not impaired and does not sustain permanent damage after repairing the core holes. Sample three undamaged cores taken from the same approximate location where the questionable concrete is represented by the low strength concrete test cylinders. Repair core holes after samples are taken.

346-10.4 Core Conditioning and Testing: Test the cores in accordance with ASTM C 42. Test the cores after obtaining the samples within seven calendar days.

346-11 Pay Adjustments for Low Strength Concrete.

346-11.1 General: Any LOT of concrete failing to meet the specified minimum strength as defined in 346-3, 346-9, 346-10 and satisfactorily meeting all other requirements of the Contract Documents, including structural adequacy, the Engineer will individually reduce the price of each low strength LOT in accordance with this Section.

346-11.2 Basis for Pay Adjustments: When an acceptance strength test result falls more than 500 psi below the specified minimum strength, core samples may be obtained in accordance with ASTM C 42 from the respective LOT of concrete represented by the low acceptance strength test result for determining pay adjustments. A price adjustment will be applied to the certified invoice price the Contractor paid for the concrete or the precast product.

Do not core hardened concrete for determining pay adjustments when the 28 day acceptance cylinder strength test results are less than 500 psi below the specified minimum strength.

The results of strength tests of the drilled cores, subject to 346-11.5 and 346-11.6, will be used as the acceptance results and will be used in lieu of the cylinder strength test results for determining pay adjustments.

In precast operations, excluding prestressed, ensure that the producer submits acceptable core sample test results to the Engineer. The producer may elect to use the products in accordance with 346-11. Otherwise, replace the concrete in question at no additional cost to the Department. For prestressed concrete, core sample testing is not allowed for pay adjustment. The results of the cylinder strength tests will be used to determine material acceptance and pay adjustment.

346-11.3 Coring for Determination of Pay Adjustments: Obtain the cores in accordance with 346-10.3.

346-11.4 Core Conditioning and Testing: Test the cores in accordance with 346-10.4.

346-11.5 Core Strength Representing Equivalent 28 Day Strength: For cores tested no later than 42 calendar days after the concrete was cast, the Engineer will accept the core strengths obtained as representing the equivalent 28 day strength of the LOT of concrete in question. The Engineer will calculate the strength value to be the average of the compressive strengths of the three individual cores. The Engineer will accept this strength at its actual measured value.

346-11.6 Core Strength Adjustments: For cores tested later than 42 calendar days after the concrete was cast, the Engineer will establish the equivalency between 28 day strength and strength at ages after 42 calendar days. The Engineer will relate the strength at the actual test age to 28 day strength for the design mix represented by the cores using the following relationship:

346-11.6.1 Portland Cement Concrete without Pozzolan or Slag:

Equivalent 28 Day Strength, f'c (28) = 1/F (Average Core Strength) x 100, where:

$F = 4.4 + 39.1 (\ln x) - 3.1 (\ln x)^2$ (Type I Cement)

$F = -17.8 + 46.3 (\ln x) - 3.3 (\ln x)^2$ (Type II Cement)

$F = 48.5 + 19.4 (\ln x) - 1.4 (\ln x)^2$ (Type III Cement)

x = number of days since the concrete was placed
ln = natural log

346-11.6.2 Pozzolanic-Cement Concrete:

Equivalent 28 day compressive strength = $f'_c(28)$, where:

$$f_c'(28) = 0.490 \; f_c'(t) e^{\left(\frac{8.31}{t}\right)^{0.276}} \quad \text{(Type I Cement)}$$

$$f_c'(28) = 0.730 \; f_c'(t) e^{\left(\frac{2.89}{t}\right)^{0.514}} \quad \text{(Type II Cement)}$$

$$f_c'(28) = 0.483 \; f_c'(t) e^{\left(\frac{5.38}{t}\right)^{0.191}} \quad \text{(Type III Cement)}$$

$f'_c(t)$ = Average Core Strength at time t (psi)
t = time compressive strength was measured (days)

346-11.6.3 Slag-Cement Concrete:

Equivalent 28 day compressive strength = $f'_C(28)$, where:

$$f_c'(28) = 0.794 \quad f_c'(t)\, e^{\left(\frac{7.06}{t}\right)^{1.06}} \quad \text{(Type I Cement)}$$

$$f_c'(28) = 0.730 \quad f_c'(t)\, e^{\left(\frac{6.02}{t}\right)^{0.747}} \quad \text{(Type II Cement)}$$

$$f_c'(28) = 0.826 \quad f_c'(t)\, e^{\left(\frac{2.36}{t}\right)^{0.672}} \quad \text{(Type III Cement)}$$

$f'_c(t)$ = Average Core Strength at time t (psi)

t = time compressive strength was measured (days)

346-11.7 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete accepted by the Department and represented by either cylinder or core strength test results below the specified minimum strength, in accordance with the following:

Reduction in Pay is equal to the reduction in percentage of concrete cylinder strength (specified minimum strength minus actual strength divided by specified minimum strength).

For the elements that payments are based on the per foot basis, the Engineer will adjust the price reduction from cubic yards basis to per foot basis, determine the total linear feet of the elements that are affected by low strength concrete samples and apply the adjusted price reduction accordingly.

346-12 Pay Reduction for Plastic Properties.

A rejected load in accordance with 346-6.4 is defined as the entire quantity of concrete contained within a single ready mix truck or other single delivery vehicle regardless of what percentage of the load was placed. If concrete fails a plastic properties test and is thereby a rejected load but its placement continues after completion of a plastic properties test having a failing result, payment for the concrete will be reduced.

The pay reduction for cast-in-place concrete will be twice the invoice price per cubic yard of the quantity of concrete in the rejected load.

The pay reduction for placing a rejected load of concrete into a precast product will be applied to that percentage of the precast product that is composed of the concrete in the rejected load. The percentage will be converted to a reduction factor which is a numerical value greater than zero but not greater than one. The precast product payment reduction will be twice the Contractor's billed price from the Producer for the precast product multiplied by the reduction factor.

If the Engineer authorizes placement of the concrete, even though plastic properties require rejection, there will be no pay reduction based on plastic properties failures; however, any other pay reductions will apply.

347 PORTLAND CEMENT CONCRETE – CLASS NS.
(REV 10-9-12) (1-13)

SECTION347 (Pages 326 – 329) is deleted and the following substituted:

SECTION 347
PORTLAND CEMENT CONCRETE - CLASS NS

347-1 Description.

The requirements of this Section are applicable to concrete designated as Class NS hereinafter referred to as concrete. Use concrete composed of a mixture of portland cement, aggregates, and water, with or without chemical admixtures, slag, or pozzolanic materials. Deliver concrete to placement site in a freshly mixed, unhardened state. Ensure the concrete is placed and cured in a manner to ensure that the strength and durability of the concrete is maintained.

347-2 Materials.

347-2.1 General: Certify that all materials used in concrete are from Department approved sources, and free from frozen or other detrimental matter.

Meet the following requirements:

Portland Cement	Section 921
Coarse Aggregate	Section 901
Fine Aggregate	Section 902
Water	Section 923
Chemical Admixtures	Section 924
Pozzolans and Slag	Section 929

347-2.2 Admixture Requirements: Chemical admixtures may be added at the dosage rates recommended by the manufacturer.

347-2.3 Substitution of Materials: Approved material sources may be substituted for similar materials indicated on the originally approved mix design. Use originally approved mix components and proportions, when unsatisfactory test results are obtained from the use of the substituted material(s).

347-2.4 Material Storage: Use a concrete production facility that meets the following requirements:

347-2.4.1 Cementitious Materials Storage: Provide a separate and clearly labeled weatherproof facility to store each brand or type of cementitious material without mixing or contamination. Provide a suitable, safe and convenient means of collecting cementitious material samples at each storage facility.

347-2.4.2 Aggregate Storage: Provide suitable bins, stockpiles or silos to store and identify aggregates without mixing, segregating or contaminating different grades or types of materials. Identify Department approved pit number and aggregate type/gradation. Handle the aggregates in a manner to minimize segregation and meet the specification requirements when recovered from storage. Continuously and uniformly sprinkle coarse aggregate with water, for 24 hours preceding introduction into the concrete mix. Maintain stored aggregates in a well-drained condition to minimize free water content. Provide access for the Engineer to sample the aggregates from the recovery side of the storage facility.

347-3 Production, Mixing and Delivery.

347-3.1 Concrete Production Requirements: Deliver concrete from a production facility that is certified by the National Ready-Mixed Concrete Association (NRMCA) or approved by the District Materials Office. The District Materials Office may inspect the concrete production facility's to verify compliance with the Specifications. Produce concrete utilizing equipment that is in good operating condition and operated in a manner to ensure a consistent product. Within two hours prior to each day's batching, ensure that the concrete production facility determines the free moisture for the coarse and fine aggregates. On concrete placements expected to exceed three hours, perform an additional moisture test approximately half way through the batching operations and adjust batch proportions accordingly.

Ensure that the calibration of the measuring devices of the concrete production facilities meets the requirements of Chapter 531 of the Florida Statutes. At least quarterly, ensure that all scales, meters and other weighing or measuring devices are checked for accuracy by a qualified representative of a scale company registered with the Bureau of Weights and Measures of the Florida Department of Agriculture. Have the accuracy of admixture measuring dispensers certified annually by the admixture supplier.

When Volumetric Mixers are used, deliver concrete in accordance with the requirements of Volumetric Mixer Manufactures Bureau (VMMB) and ensure that the vehicle has a VMMB registered rating plate.

Substitution of structural concrete in lieu of non-structural concrete may be used if approved by the Engineer. If structural concrete is used in lieu of non-structural concrete, obtain the concrete from a production facility meeting the requirements of Section 346. Acceptance is based on the requirements of Section 347.

347-3.2 Mixers: Ensure that mixers are capable of combining the components of concrete into a thoroughly mixed and uniform mass, free from balls or lumps of cementitious materials, and capable of discharging the concrete uniformly. Operate concrete mixers at speeds per the manufacturer's design. Do not exceed the manufacturer's rated capacity for the volume of mixed concrete in the mixer, mixing drum, or container.

347-3.3 Delivery: The maximum allowable mixing and agitation time of concrete is 120 minutes.

347-3.4 Small Quantities of Concrete: With approval of the District Materials Engineer, small quantities of concrete, less than 3 cubic yards placed in one day and less than 0.5 cubic yards placed in a single placement may be accepted using a pre-bagged mixture. The Engineer will verify that the pre-bagged mixture is prepared in accordance with the manufacturer's recommendations and will meet the requirements of this Specification.

347-4 Control of Quality.

347-4.1 Concrete Mix Design: Before producing any concrete, submit the proposed mix design to the Engineer on a form provided by the Department. A similar form containing the same information may be used. Also submit three compressive strength test results tested in accordance with ASTM C 39 demonstrating the mix meets the minimum 28 day compressive strength requirement. The test results must be within twelve months of the submittal of the mix design. Use only concrete mix designs having prior approval of the Engineer.

Materials may be adjusted provided that the theoretical yield requirement of the approved mix design is met. Show all required original approved design mix data and batch adjustments and substituted material on the Department concrete delivery ticket. The Engineer

may disqualify any concrete production facility for non-compliance with Specification requirements.

347-4.2 Sampling and Testing: The Engineer may sample and test the concrete at their discretion to verify its quality. The minimum 28-day compressive strength requirement for this concrete is 2,500 psi.

347-4.3 Records: Maintain the following records for review for at least three years after final acceptance of the project:

1. Approved concrete mix designs.
2. Materials source (delivery tickets, certifications, certified mill test reports).
3. A copy of the scale company or testing agency report showing the observed deviations from quantities checked during calibration of the scales and meters.
4. A copy of the documentation certifying the admixture weighing/measuring devices.
5. Recent NRMCA, VMMB or Department inspection records certifying the plant or truck can produce concrete and documentation showing that action has been taken to correct deficiencies noted during the inspections.

347-5 Certification and Acceptance.

347-5.1 General: Furnish a Delivery Ticket with each batch of concrete before unloading at the placement site. The Department will provide an example of the Delivery Ticket Form. The concrete producer may use an alternate form provided that it contains the required information. Record material quantities incorporated into the mix on the Delivery Ticket. Ensure that the Batcher responsible for producing the concrete, certifies that the batch was produced in accordance with Specification requirements, signs the Delivery Ticket. Sign the Delivery Ticket certifying that the concrete was batched, delivered and placed in accordance with these Specifications.

Acceptance by the Department will be by Certification on the Delivery Ticket, as described herein, by the Batcher and the Contractor. The Engineer will hold the Contractor responsible for rejecting loads of concrete that do not meet the minimum compressive strength requirements. Delineate and replace, at no cost to the Department, all concrete that does not meet the 28-day compressive strength requirements or has any cracking greater than 1/4 inch in width or 1/4 inch in vertical displacement. Any spalling or flaking off of the surface layer that exposes the rough, pitted aggregate surface in excess of 10 square inches is to be removed and replaced in accordance with 347-5.2. Sidewalk, ditch pavement, slope pavement, Traffic Separator, or curb and gutter having any intersecting cracks visible in the dry concrete (regardless of size) will be removed and replaced in accordance with 347-5.2.

At the sole option of the Department, the Engineer may accept concrete at a reduced pay when it is determined that the concrete will serve its intended function.

If any uncontrolled cracks appear during the life of the Contract unacceptable to the Engineer, remove and replace the concrete in accordance with 347-5.2 at no expense to the Department.

347-5.2 Remedial Action: Remedial action will be the removal and replacement of all concrete to the full depth and width.

Sidewalk, Curb and Gutter, Ditch Pavement and Traffic Separator: Begin saw cutting 2 1/2 feet either side or above and below the crack or at the nearest joint, remove and replace the 5 foot section encompassing the crack.

Slope Pavement: Saw cut each scored joint above and below the crack and replace the entire section between the saw cuts, ensuring the section removed and replaced encompasses the crack.

350 CEMENT CONCRETE PAVEMENT.
(REV 11-15-12) (FA 1-28-13) (7-13)

SUBARTICLE 350-2 (Page 329) is deleted and the following substituted:

350-2 Materials.

Meet the following requirements:

Concrete, Class I or Class I (Pavement)	Section 346
Grinding Concrete Pavement	Section 352
Curing Materials	Section 925
Embedded Items	Section 931
Joint Seal	Section 932

For concrete pavement placed using the slip-form method of construction, utilize Concrete Class I (Pavement). For concrete pavement placed by hand in constructed forms, utilize Concrete Class I or Concrete Class I (Pavement). LOT size for the use of either material shall be as stated in Section 346 for Concrete Class I (Pavement).

353 CONCRETE PAVEMENT SLAB REPLACEMENT.
(REV 2-14-13) (FA 2-15-13) (7-13)

ARTICLE 353-11 (Page 351) is deleted and the following substituted:

353-11 Method of Measurement.

The pay quantity will be the volume, in cubic yards, of concrete placed and accepted determined by calculation. The quantity will be calculated using field-measured horizontal dimensions and thickness of the removed slab.

400 CONCRETE STRUCTURES.
(REV 9-5-12) (FA 10-26-12) (7-13)

SECTION 400 (Pages 357 – 395) is deleted and the following substituted:

SECTION 400
CONCRETE STRUCTURES

400-1 Description.

Construct concrete structures and other concrete members, with the exception of pavement and incidental concrete construction (which are specified in other Sections).

Refer to Section 450 for prestressed construction requirements additional to the requirements of this Section.

For precast concrete structures meet the requirements of Section 450 for inserts and lifting devices, handling, storage, shipping, and erection.

Obtain incidental precast products from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

400-2 Materials.

Meet the following requirements:

Concrete	Sections 346 and 347
Penetrant Sealer	Section 413
High Molecular Weight Methacrylate (HMWM)**	Section 413
Reinforcing Steel	Section 415
Water	Section 923
Curing Materials*	Section 925
Epoxy Bonding Compounds**	Sections 926 and 937
Joint Materials**	Section 932
Bearing Pads	Section 932
Non-Shrink Grout**	Section 934
Class 5 Applied Finish Coatings**	Section 975
Galvanizing Compound**	Section 562
Dowel Bar Assembly**	Section 931
Filter Fabric	Section 985

*The Engineer will allow clean sand and sawdust for certain curing, when and as specified.

**Use products listed on the Department's Qualified Products List (QPL).

400-3 Depth of Footing.

Refer to Section 455, "D. SPREAD FOOTINGS".

400-4 Falsework.

400-4.1 Plans: At the Engineer's request, furnish detailed plans for falsework or centering to the Department. The Contractor is responsible for results obtained by using these plans.

400-4.2 Design and Erection: Design and construct all falsework to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Use screw jacks or hardwood wedges to take up any settlement in the framework, either before or during the placing of concrete. If any weakness develops and the centering shows undue settlement or distortion, stop the work, remove any masonry affected, and strengthen the falsework before resuming work. Support falsework which cannot be founded on a satisfactory footing on piling. Space, drive, and remove the piling in an approved manner.

400-4.3 Camber: Provide camber to correct for settlement and deflection of falsework. Give bridges permanent camber only when shown in the plans.

400-5 Forms.

400-5.1 General: Provide forms, either of wood or metal, that are as follows: (a) externally secured and braced where feasible; (b) substantial and unyielding; (c) of adequate strength to contain the concrete without bulging between supports and without apparent deviation from the neat lines, contours, and shapes shown in the plans. Design forms to withstand the additional forces of vibration without apparent deviation from the desired shape or position. Assemble forms to be mortar-tight. If using lumber forms, construct them of dressed wood of uniform thickness. Use form liners on wooden forms where Class 3 surface finish is specified. Construct assembled forms to render a concrete surface of smooth, uniform finish. Make provisions to remove forms without injury to concrete surfaces. Remove blocks and bracing with the forms, and do not leave any portion of the forms in the concrete. Use the same form system for a type of work throughout.

400-5.2 Inspection and Approval: Do not place concrete in a form until the form has been inspected and approved. Although the Engineer inspects and approves the forms, the Contractor is responsible for obtaining satisfactory concrete surfaces, free from warping, bulging, or other objectionable defects. Pay special attention to the ties and bracing. Where the forms appear to be insufficiently braced or unsatisfactorily built, stop and correct defects to the satisfaction of the Engineer.

400-5.3 Non-metallic Form Materials:

400-5.3.1 Lumber: For all surfaces, use lumber that is not less than 3/4 inch in thickness, dressed, and free of knot holes, loose knots, cracks, splits, warps, and other defects. Proportion the spacing of studs, joists, and wales to exclude warps and bulges and to produce true and accurate concrete surfaces. Only use structurally sound lumber.

400-5.3.2 Form Liners: Use form liners of durable, abrasion resistant materials that are unaffected by water. Use liners with a hard surface texture capable of rendering concrete surfaces of a smooth, uniform texture, without grain marks, patterns, or blemishes. Use form liner material of sufficient thickness to eliminate the reflection of irregularities, undesirable patterns, and marks from the forms to the surfaces. Replace liners as necessary to produce a consistent concrete surface texture. Use form liners in large sheets and with true, tight-fitted joints which are logically located. Obtain the Engineer's approval of the layout of sheets. Do not use liners which have been patched. Use liner material of the same stock throughout.

400-5.3.3 Plywood: The Contractor may use plywood of not less than 5/8 inch in thickness manufactured with waterproof glue or protected with an approved impervious coating. Do not use pieces with bulged plies or raveled, untrue edges.

400-5.4 Special Requirements:

400-5.4.1 Re-entrant Angles: Use chamfered forms for exterior concrete corners and filleted forms for interior concrete corners. Use chamfers and fillets that are 3/4 by 3/4 inch

and are mill-dressed on all sides to uniform dimensions. The Contractor may use plastic or metal chamfers and fillets provided they perform satisfactorily in producing uniform, smooth concrete corner surfaces without honeycomb.

400-5.4.2 Handrails and Parapets: Construct barriers and parapets in accordance with Section 521.

400-5.4.3 End-bent Caps: Do not place forms for end-bent caps until the embankment has been constructed to within 12 inches of the bottom of the cap. Place a mass of embankment that is sufficient to produce the subsidence, displacement, and settlement which may result from the construction of the total embankment.

400-5.4.4 Footings: Where footing concrete can be placed in dry excavation, the Contractor may omit cribs, cofferdams, and forms, subject to compliance with the following limitations and conditions:

(a) Use this procedure only in locations not exposed to view from traveled roadways.

(b) Obtain required elevations shown in the plans.

(c) Obtain neat line dimensions shown in the plans.

(d) Fill the entire excavation with concrete to the required elevation of the top of the footing.

(e) The Engineer will determine the volume of footing concrete to be paid for from the neat line dimensions shown in the plans.

400-5.5 Form Alignment, Bracing, and Ties: Construct forms in such manner that they may be adequately secured for alignment, shape, and grade. Use bracing systems, ties, and anchorages that are substantial and sufficient to ensure against apparent deviation from shape, alignment, and grade. Do not drive nails into existing concrete. Do not use bracing systems, ties, and anchorages which unnecessarily deface or mark, or have an injurious or undesirable effect on surfaces that will be a part of the finished surface.

If metal ties and anchorages are to remain in the concrete, construct them so as to permit the removal of metal to at least 1 inch beneath the finished surface of concrete. Use accessories for metal ties and anchorages that allow the removal of metal to the prescribed depth while leaving the smallest possible repairable cavity.

When using wire ties, cut or bend them back from the finished surface of the concrete a minimum of 1 inch. Do not use internal ties of wire when forming surfaces that are exposed to view.

400-5.6 Preparation and Cleaning: Meet the following requirements for the condition of forms at the time of beginning concrete casting:

(a) Treat all forms with an approved form-release agent before placing concrete. Do not use material which adheres to or discolors the concrete.

(b) Clean forms of all concrete laitance from previous use and all dirt, sawdust, shavings, loose wire ties and other debris.

(c) Close and secure all inspection and cleanout holes.

400-5.7 Stay-In-Place Metal Forms:

400-5.7.1 General: Utilization of stay-in-place metal forms is permitted in lieu of removable forms to form concrete bridge decks between beams and between the webs of individual box girders when designated in the plans. Stay-in-place metal forms may be of the cellular, non-cellular or non-cellular with top cover sheet type. The flutes of non-cellular stay-in-place metal forms may be filled with polystyrene foam or concrete. When polystyrene foam is

used to fill the forms, fill form flutes completely; do not allow any portion of the polystyrene foam to extend beyond the limits of the flutes. Ensure that the polystyrene foam remains in its required position within flutes during the entire concrete placement process. Do not use reinforcing steel supports or other accessories in such a manner as to cause damage to the polystyrene foam. Replace all damaged polystyrene foam to the satisfaction of the Engineer.

Apply polymer sheeting to stay-in-place metal forms in accordance with the requirements in the following table. Apply polymer sheeting to all faces and edges (including sheared edges) of support angles used on bridges with Moderately and Extremely Aggressive Superstructure Environmental Classifications (as shown in the Plans). No polymer sheeting is required for beam attachment straps or clips partially embedded in concrete, and for support angles used on bridges with a Slightly Aggressive Superstructure Environmental Classification. Use polymer sheeting materials and application methods as described herein.

Polymer Sheeting Usage Requirements				
Form Type		Superstructure Environmental Classification (as shown in Plans)		
		Slightly Aggressive	Moderately Aggressive	Extremely Aggressive
Non-cellular form with concrete filled flutes		No polymer sheeting required	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side
Non-cellular form with polystyrene foam filled flutes		Polymer sheeting required on inside	Polymer sheeting required on both sides*	Polymer sheeting required on both sides*
Non-cellular form with Top Cover Sheet	Top Cover Sheet	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side
	Non-cellular form	Polymer sheeting required on top side	Polymer sheeting required on both sides*	Polymer sheeting required on both sides*
Cellular form		No polymer sheeting allowed or required	Not permitted	Not permitted
* Polymer sheeting not required on bottom side of form located within box girders and U-beams.				

Prior to using stay-in-place metal forms, submit detailed plans for approval of the forming system, including method of support and attachment and method of protecting the supporting structural steel components from welding effects. Submit design calculations for the forming system, which have been signed and sealed by the Specialty Engineer. Detail stay-in-place metal forms such that they in no way infringe upon the concrete outline of the slab shown on the plans. Use stay-in-place metal forms that provide and maintain the dimensions and configuration of the original slab in regards to thickness and slope.

Do not weld stay-in-place metal form supports and connections to the structural steel components. Do not connect polymer coated angles or other hardware that support polymer coated metal forms to the beam attachment straps or clips by welding. Electrical grounding to reinforcing steel is prohibited.

Protect structural steel components from damage by using a shield to guard against weld splatter, weld overrun, arc strikes, or other damaging effects of the welding

process. Upon completion of welding, rest the metal form support flush on the supporting steel component. Should any weld spatter, weld overrun, arc strike, or other effects of the welding process be evident or occur to the structural steel component, immediately stop in-place welding of the metal form supports for the remainder of the work. In this event, weld all metal form supports off of the structure and erect the forms after prefabrication, or use an alternate approved method of attaching the form supports. Remove improper weldment, repair the supporting steel component for any improper welding. Perform all required verification and testing at no expense to the Department and to the satisfaction of the Engineer.

Do not use stay-in-place metal forms until the forming system has been approved by the Engineer. The Contractor is responsible for the performance of the stay-in-place forms.

Structures designed, detailed, and dimensioned for the use of removable forms: Where stay-in-place metal forms are permitted, the Contractor is responsible and shall obtain the approval of the Engineer for any changes in design, etc. to accommodate the use of stay-in-place forms. The Engineer will compute pay quantities of the various components of the structure which are paid on a cubic yard basis from the design dimensions shown on the plans with no allowance for changes in deflection or dimensions necessary to accommodate the stay-in-place forms or concrete to fill the form flutes. The Engineer will limit pay quantities of other Contract items that the Contractor increases to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Submit all changes in design details of bridge structural members that support stay-in-place forms, showing all revisions necessary to enable the supporting components to withstand any additional weight of the forms and the weight of any extra concrete that may be required to fill the forms. Include with the design calculations a comparative analysis of the stresses in the supporting components as detailed on the Contract plans and as modified to support the forms. Use the identical method of analysis in each case, and do not allow the stresses in the modified components to exceed those of the component as detailed in the Contract plans. Include with the design the adjusted cambers for any changes in deflection over those shown on the original plans. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain the additional strength by adding strands to the pre-stressed beams or by adding steel material to increase the section modulus of steel girders. Substantiate the added strength by the comparative calculations. Do not use stay-in-place forms until the forming system and all necessary design revisions of supporting members have been approved by the Engineer.

Structures designed, detailed, and dimensioned for the use of stay-in-place metal forms:

Prior to using stay-in-place metal forms, submit detailed plans for approval of the forming system (including method of support and attachment) together with design calculations. Include an analysis of the actual unit weight of the proposed forming system over the projected plan area of the metal forms. If the weight thus calculated exceeds the weight allowance for stay-in-place metal forms and concrete required to fill the forms shown on the plans, then modify the supporting components to support the excess weight as specified by the Contractor’s Specialty Engineer.

For all structures utilizing structural steel supporting components, paint the vertical sides of the top flange prior to installation of the stay-in-place metal forms in accordance with Section 560.

For non-polymer sheeting form surfaces, use zinc paint coating in accordance with Section 562 to all accessories cut from galvanized sheets, which are not embedded in concrete.

400-5.7.2 Design: Meet the following criteria for the design of stay-in-place bridge deck forms:

1. The maximum self weight of the stay in place metal forms, plus the weight of the concrete or expanded polystyrene required to fill the form flutes (where used), shall not exceed 20 psf.

2. Design the forms on the basis of dead load of form, reinforcement, and plastic concrete plus 50 lb/ft^2 for construction loads. Use a unit working stress in the steel sheet of not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 psi.

3. Do not allow deflection under the weight of the forms, reinforcement, and plastic concrete to exceed 1/180 of the form span or 1/2 inch, whichever is less, for form spans of 10 feet or less, or 1/240 of the form span or 3/4 inch, whichever is less, for form spans greater than 10 feet. In all cases, do not use a total loading (psf) that is less than 20 plus the product of the deck thickness measured in inches times 12.5.

4. Use a design span of the form equal to the clear span of the form plus 2 inches. Measure the span parallel to the form flutes.

5. Compute physical design properties in accordance with requirements of the AISI Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.

6. For all reinforcement, maintain the design concrete cover required by the plans.

7. Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

8. Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

9. Do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

10. Secure forms to the supporting members by means other than welding directly to the member.

400-5.7.3 Materials:

400-5.7.3.1 Metal Forms: Fabricate stay-in-place metal forms and supports from steel meeting the requirements of ASTM A 653 having a coating designation G165. Do not use form materials that are less than 0.03 inch uncoated thickness.

400-5.7.3.2 Polymer Sheeting: Use polymer sheeting comprised of at least 85% ethylene acrylic acid copolymer capable of being applied to both G165 and G210 steel sheet as described in ASTM A 742. Ensure that the polymer sheeting has a nominal thickness of 12 mils as manufactured and a minimum thickness of 10 mils after lamination to the steel sheet. Ensure that the polymer sheeting remains free of holes, tears and discontinuities and sufficiently flexible to withstand the forming process without any detrimental effects to bond, durability or performance. Ensure that the polymer sheeting is UV stabilized and contains antioxidants.

Ensure that the as-manufactured polymer sheeting (prior to application) has an Oxidative Induction Time (OIT) of 60 to 75 minutes at 170°C in air when tested according to ASTM D 3895. Perform additional OIT tests on samples taken from the

finished product (polymer sheeting applied to forms) resulting in a minimum OIT according to ASTM D 3895 of 32 minutes at 170°C in air. Ensure that the polymer sheeting adheres to galvanized metal sufficient to prevent undercutting at penetrations made through the polymer sheeting or metal forms to the satisfaction of the Engineer. Ensure that edges subjected to shear cutting are coated by the form manufacturer with two coats of a compatible liquid coating repair material before delivery to the site. Ensure that steel used to produce polymer laminated metal forms is appropriately cleaned and prepared per NCCA (National Coil Coating Association) standard continuous coil coating practices. Ensure that pretreatment for use in conjunction with the manufacturer's polymer sheeting material is approved as compatible by the polymer sheeting manufacturer. Apply pretreatment in accordance with the polymer sheeting manufacturer's procedures. Apply polymer sheeting in accordance with the manufacturer's recommendations and procedures. Ensure that all steel has the polymer sheeting applied prior to fabrication of the stay-in-place forms and accessories.

Ensure that the screws to be used in the fastening of the stay-in-place laminated metal forms have a corrosion resistant cladding that will not have an adverse effect to the system due to the contact of dissimilar metals.

400-5.7.3.3 Certification: Provide a written certification from the manufacturer stating the product meets the requirements of this specification along with the delivery of the coated forms to the jobsite. Ensure that the certification conform**s** to the requirements of Section 6. Ensure that the manufacturer has a quality control program conforming to ISO 9001:2000 standards.

400-5.7.3.4 Polystyrene Foam: Use polystyrene foam comprised of expanded polystyrene manufactured from virgin resin of sufficient density to support the weight of concrete without deformation. Extrude the polystyrene foam to match the geometry of the flutes and provide a snug fit. Use polystyrene foam that has a density of not less than 0.8 lbs/cubic foot. Use polystyrene foam that has water absorption of less than 2.6% when tested according to ASTM C 272. Provide a written certification from the manufacturer stating the product meets the requirements of this Specification along with the delivery of the product.

400-5.7.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

Do not rest form sheets directly on the top of the stringer of floor beam flanges. Fasten sheets securely to form supports, and maintain a minimum bearing length of 1 inch at each end for metal forms. Place form supports in direct contact with the flange of the stringer or floor beam. Make all attachments for coated metal forms by bolts, clips, screws, or other approved means.

400-5.7.4.1 Form Galvanizing Repairs: For any permanent exposed steel where the galvanized coating has been damaged, thoroughly clean, wire brush, and paint it with two coats of galvanizing compound in accordance with Section 562 to the satisfaction of the Engineer. Do not touch up minor heat discoloration in areas of welds.

400-5.7.4.2 Polymer Sheeting Repairs: Inspect and identify areas for damage to the polymer sheeting and repair with liquid polymer coating similar and compatible with respect to durability, adhesion and appearance in accordance with ASTM A 762, as furnished by the stay-in-place form manufacturer. Ensure that the inspection includes checking the polymer sheeting for cuts, tears, cracking, surface pits, peeling, dirt, grease, oil, stains, rust or bare areas. Reject any panels that show coating blistering, peeling or cracking. Repair all polymer sheeting damage according to the following:

a. Surface Preparation: Ensure that all surfaces to be repaired are clean and free of any deleterious substances. Remove all traces of dirt, soil, oil deposits, greases, and other surface contaminates in accordance with the polymer sheeting and coating manufacturer's written specifications prior to touch-up and recoating.

b. Application Procedures: Ensure that the liquid polymer repair coating is applied to a clean dry surface and in accordance with the manufacturer's written specifications. Apply the repair coating using a suitable paintbrush or other means acceptable to the Engineer. Apply a first coat of product to the surface at 2-4 mils in thickness. Let the first coat air dry. Apply a second coat to form a complete layer and increase the thickness, immediately after verifying the first coat is dry to the touch (15 - 25 minutes depending on the local air drying temperature and atmospheric conditions). Apply the second coat at the same coating thickness as the first at 2-4 mils. Ensure that the total dry film thickness of the two coats is not less than 6 mils. Apply additional coats in this same manner until desired coating thickness is achieved.

400-5.7.5 Placing of Concrete: Vibrate concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, valleys and ends of form sheets. Use approved pouring sequences. Do not use calcium chloride or any other admixture containing chloride salts in the concrete.

400-5.7.6 Inspection: The Engineer will observe the Contractor's method of construction during all phases of the construction of the bridge deck slab, including the installation of the metal form system; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement, and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, remove at least one section of the metal forms in each span for this purpose. Do this as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the procedures are obtaining the desired results. Remove an additional section in any span if the Engineer determines that there has been any change in the concrete mix or in the procedures warranting additional inspection.

If, in the Engineer's judgment, inspection is needed to check for defects in the bottom of the deck or to verify soundness, sound the metal forms with a hammer as directed by the Engineer after the deck concrete has been in place a minimum of two days. If sounding discloses areas of doubtful soundness to the Engineer, remove the metal forms from such areas for visual inspection after the concrete has attained adequate strength. Remove metal bridge deck forms at no expense to the Department.

At locations where sections of the metal forms have been removed, the Engineer will not require the Contractor to replace the metal forms. Repair the adjacent metal forms and supports to present a neat appearance and to ensure their satisfactory retention and where they are polymer sheeted, coat all exposed surfaces of stay-in-place metal form system elements that are not coated or are damaged with a field applied liquid polymer coating as specified in 400-5.7.4.2. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work, repair the concrete as directed, and provide a General Surface Finish in accordance with 400-15. If the Engineer determines that the concrete where the form is removed is unsatisfactory, remove additional metal forms as necessary to inspect and repair the slab, and modify the method of

construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed, at no expense to the Department.

If the method of construction and the results of the inspections as outlined above indicate that sound concrete has been obtained throughout the slabs, the amount of sounding and form removal may be reduced when approved by the Engineer.

Corrosion of assembly screws will not be considered a structural or aesthetic problem and is considered acceptable.

Provide the facilities for the safe and convenient conduct of the inspection procedures.

400-5.8 Stay-In-Place Concrete Forms:

400-5.8.1 General: Permanent stay-in-place precast reinforced concrete forms may be used in lieu of removable forms to form concrete bridge deck slabs subject to the conditions contained herein. Precast reinforced concrete stay-in-place forms are not permitted to construct a composite concrete deck. Do not use precast prestressed concrete stay-in-place forms to form any permanent bridge decks.

When detailed plans for structures are dimensioned for the use of removable forms, provide additional slab thickness, elevation changes, changes in design, etc. to accommodate the use of stay-in-place forms, subject to the Engineer's approval. The Engineer will compute pay quantities of the various component members of the structure which are paid on a cubic yard basis from the design dimensions shown on the plans with no allowance for changes in deflection and changes in dimensions necessary to accommodate the stay-in-place forms. The Engineer will limit pay quantities of other Contract items which are increased to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Prior to using stay-in-place forms, submit for approval detailed plans of the forming system and design calculations. Indicate on the plans the form panel sizes, placing patterns, type of mastic or felt bearing material and type and method of caulking between panels. Also, submit appropriate changes in design details of structural members supporting stay-in-place forms showing any revisions necessary to enable the supporting components to withstand the additional weight of the forms and perform equally as contemplated in the plans. All calculations and details submitted shall be sealed by the Contractor's Engineer of Record. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain this strength by adding additional strands to prestressed girders or increasing the section modulus for steel girders. Do not use stay-in-place forms until the forming system and any necessary design revisions of supporting structural members have been approved by the Engineer. The Department is not responsible for the performance of the stay-in-place forms by its approval.

400-5.8.2 Materials: Construct permanent concrete forms of precast reinforced concrete with a Class 3 Surface Finish. As a minimum, use the same class of concrete and 28-day minimum compressive strength as being used to construct the bridge deck. Use welded steel wire reinforcement meeting the requirements of Section 931.

400-5.8.3 Design: Use the following criteria for the design of permanent bridge deck forms:

(1) Design the forms on the basis of deadload of form, reinforcement, and plastic concrete plus an unfactored live load of 50 psf for construction loads. Meet the AASHTO design requirements for service loads and ultimate loads as applicable.

(2) Deflection under the weight of the forms, reinforcement, and the plastic concrete shall not exceed 1/180 of the form span or 1/2 inch, whichever is less. In all cases, do not use a loading that is less than 120 psf total.

(3) Use a design span of the form equal to the clear span of the form between supports. Measure the span of concrete forms parallel to the centerline of the form panels.

(4) Compute physical design properties of concrete forms in accordance with current AASHTO design procedures.

(5) Ensure that all steel reinforcement contained in the cast-in-place concrete has the minimum cover shown on the plans or not less than 1 inch, whichever is greater. Measure the minimum cover normal to the plane of the bottom of the cast-in-place concrete. For stay-in-place concrete forms with other than plane surfaces in contact with the cast-in-place concrete, such as regularly spaced geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete, meet the following special requirements:

(a) Space geometrical shapes projecting above the bottom plane of the cast-in-place concrete used to provide support for reinforcement no closer than 3 feet apart and of sufficient height to maintain the required concrete cover on the bottom mat of reinforcing steel.

(b) Construct all other geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete to provide a minimum vertical clearance of 3/4 inch between the closest surface of the projections and the secondary longitudinal reinforcing steel in the deck slab.

(c) Do not allow a minimum horizontal distance from the surface of any transverse reinforcing steel to surfaces of the stay-in-place form of less than 1 1/2 inches.

For all steel reinforcement for the stay-in-place form panels, provide a minimum of 1 inch concrete cover except that, for construction in a salt or other corrosive environment, provide a minimum of 1 1/2 inches concrete cover.

(6) Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck. Measure the minimum cover of the bottom mat of steel normal to the top of the precast concrete form panel.

(7) Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

(8) Do not use permanent concrete bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

(9) Do not allow the maximum weight of the concrete form to exceed 40 lb/ft^2 of form surface.

400-5.8.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

For concrete forms, provide a minimum bearing length of at least 1 1/2 inches but not exceeding 2 1/2 inches. Support concrete forms on the beams or girders by continuous layers of an approved mastic or felt bearing material that will provide a mortar tight uniform bearing. Use a mastic or felt bearing material that has a minimum width of 1 inch and a maximum width of 1 1/2 inches. Seal joints between concrete form panels with caulking, tape, or other approved method.

400-5.8.5 Placing of Concrete: Place the concrete in accordance with the requirements of 400-5.7.5. Immediately prior to placing the slab concrete, saturate concrete stay-in-place form panels with water.

400-5.8.6 Inspection: Inspect the concrete in accordance with the requirements of 400-5.7.6.

After the deck concrete has been in place for a minimum period of two days, inspect the forms for cracks and excessive form deflection, and test for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. Remove, for visual inspection, form panels found to be cracked that show evidence of leakage and form panels which have a deflection greater than adjacent panels by 1/2 inch or more which show signs of leakage. If sounding discloses areas of doubtful soundness to the Engineer, remove the form panels from such areas for visual inspection after the concrete has attained adequate strength. Remove permanent bridge deck form panels at no expense to the Department.

At locations where sections of the forms have been removed, the Engineer will not require the forms to be replaced. Repair the adjacent forms and supports to present a neat appearance and to ensure their satisfactory retention. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work, repair the concrete as directed and provide a General Surface Finish in accordance with 400-15. If the concrete where the form is removed is unsatisfactory, as determined by the Engineer, additional forms shall be removed as necessary to inspect and repair the slab, and modify the methods of construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed at no expense to the Department.

If the methods of construction and the results of the inspections as outlined above indicate that the Contractor has obtained sound concrete throughout the slabs, the Contractor may moderate the amount of sounding and form removal, when approved.

Provide all facilities for the safe and convenient conduct of the inspection procedures.

400-6 Underdrain and Weep Holes.

Provide weep holes in all abutments and retaining walls.

Provide a continuous underdrain for box culverts in accordance with Design Standard Index No. 289. Provide weep holes that are at least 3 inches in diameter and not more than 10 feet apart. Place the outlet ends of the weep holes just above the ground line in front of abutments and retaining walls. Cover the exterior openings of all weep holes with galvanized wire mesh and a minimum of 2 cubic feet of clean, broken stone or gravel wrapped in Type D 3 filter fabric, to allow free drainage but prevent the fill from washing through.

400-7 Placing Concrete.

400-7.1Weather Restrictions:

400-7.1.1 Concreting in Cold Weather: Do not place concrete when the air temperature at placement is below 45ºF.

Meet the air temperature requirements for mixing and placing concrete in cold weather as specified in Section 346. During the curing period, if NOAA predicts the ambient temperature to fall below 35ºF for 12 hours or more or to fall below 30ºF for more than 4 hours, enclose the structure in such a way that the air temperature within the enclosure can be

kept above 50ºF for a period of 3 days after placing the concrete or until the concrete reaches a minimum compressive strength of 1,500 psi.

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.1.2 Concreting in Hot Weather: Meet the temperature requirements and special measures for mixing and placing concrete in hot weather as specified in Section 346.

When the temperature of the concrete as placed exceeds 75ºF, incorporate in the concrete mix a water-reducing retarder or water reducer if allowed by Section 346.

Spray reinforcing steel and metal forms with cool fresh water just prior to placing the concrete in a method approved by the Engineer.

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.1.3 Wind Velocity Restrictions: Do not place concrete for bridge decks if the forecast of average wind velocity at any time during the planned hours of concrete placement exceeds 15 mph. Obtain weather forecasts from the National Weather Service "Hourly Weather Graph" for the city closest to the project site.

400-7.2 Lighting Requirements: Provide adequate lighting for all concrete operations conducted at night. Obtain approval of the lighting system prior to starting the concrete operations.

400-7.3 Inspections before Placing Concrete: Do not place concrete until the depth and character of the foundation and the adequacy of the forms and falsework have been approved by the Engineer. Do not deposit any concrete until all reinforcement is in place and has been inspected and approved by the Engineer.

400-7.4 Exposure to Water: Do not expose concrete other than seal concrete in cofferdams to the action of water before final setting. Do not expose such concrete to the action of salt or brackish water for a period of seven days after placing the concrete. Protect the concrete during this period by keeping salt or brackish water pumped out of cofferdams.

400-7.5 General Requirements for Placing Concrete: Do not place any concrete prior to approval of the Contractors quality control plan in accordance with 105-3. Deposit concrete as nearly as possible in its final position. Do not deposit large quantities at one point and then run or work it along the forms. Take special care to fill each part of the forms, to work coarse aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them.

Use a method and manner of placing concrete that avoids the possibility of segregation or separation of aggregates. If the Engineer determines that the quality of concrete as it reaches its final position is unsatisfactory, remove it and discontinue or adjust the method of placing until the Engineer determines that the quality of the concrete as placed is satisfactory.

Use metal or metal-lined open troughs or chutes with no aluminum parts in contact with the concrete. As an exception, chutes made of aluminum with a protective coating for ready mixed concrete trucks, no longer than 20 feet, may be used. This exception does not apply to any other means of concrete conveyance. Where steep slopes are required, use chutes that are equipped with baffles or are in short lengths that reverse the direction of movement.

Where placing operations would involve dropping the concrete freely more than 5 feet, deposit it through pipes, troughs, or chutes of sheet metal or other approved material. Use troughs, chutes, or pipes with a combined length of more than 30 feet only with the Department's authorization. Keep all troughs, chutes, and pipes clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run or more often if necessary.

Place concrete against supporting material that is moist at the time of concrete placement. If additional water is required, uniformly apply it ahead of the concrete placement as directed by the Engineer. Do not place concrete on supporting material that is frozen. The Contractor may use a moisture barrier in lieu of controlling the foundation grade moisture when approved by the Engineer.

400-7.6 Placing Concrete by Belt Conveyor: Place concrete by means of a belt conveyor system with written Department authorization. Remove conveyor belt systems which produce unsatisfactory results before continuing operations. Take concrete samples for assurance testing at the discharge end of the belt conveyor system. Make available to the Engineer the necessary platform to provide a safe and suitable place for sampling and testing. Remove any concrete placed in an unsatisfactory manner at no expense to the Department before continuing operations.

Use conveyor belt systems that do not exceed a total length of 550 feet, measured from end to end of the total assembly. Arrange the belt assembly so that each section discharges into a vertical hopper arrangement to the next section. To keep segregation to a minimum, situate scrapers over the hopper of each section to remove mortar adhering to the belt and to deposit it into the hopper. Equip the discharge end of the conveyor belt system with a hopper and a chute or suitable deflectors to cause the concrete to drop vertically to the deposit area.

In order to avoid delays due to breakdowns, provide stand-by equipment with an alternate power source prior to the beginning of the placement.

After the beginning of the placement, direct the discharge from the belt conveyor so that the concrete always falls on freshly placed concrete.

400-7.7 Placing Concrete by Pumping: In general, use concrete pumping equipment that is suitable in kind and adequate in capacity for the work proposed. Use a pump discharge line that has a minimum diameter of 4 inches. Use a pump and discharge lines that are constructed so that no aluminum surfaces are in contact with the concrete being pumped. Operate the pump to produce a continuous stream of concrete, without air pockets. When using cement slurry or similar material to lubricate the discharge line when pumping begins, collect such material at the point of discharge. Dispose of the collected slurry in areas provided by the Contractor. Control the pump discharge locations so that the placement locations of the various LOTs of concrete represented by strength test cylinders can be identified in the event the test cylinders indicate deficient strength. When concrete is placed by pumping, take all test samples of concrete at the end of the discharge line, except in accordance with the provisions of Section 346.

400-7.8 Consolidation: Consolidate the concrete by continuous working with a suitable tool in an acceptable manner, or by vibrating as set forth in 400-7.11. When not using vibrators, thoroughly work and compact all thin-section work with a steel slicing rod. Spade all faces, and flush the mortar to the surface by continuously working with a concrete spading implement.

400-7.9 Obstructions: In cases where, because of obstructions, difficulty is encountered in puddling the concrete adjacent to the forms, bring the mortar content of the mix into contact with the interior surfaces by vibrating the forms. Produce the vibrations by striking the outside

surfaces of the forms with wooden mallets or by other satisfactory means. In placing concrete around steel shapes place it only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which place it on both sides to completion. After the concrete has taken its initial set, exercise care to avoid jarring the forms or placing any strain on the ends of projecting reinforcing bars.

400-7.10 Requirements for Successive Layers: Generally, place concrete in continuous horizontal layers, approximately 12 inches thick. To avoid obtaining a plane of separation between batches, do not allow the time before placing the next successive layer to exceed 20 minutes, unless the Engineer determines that adequate fluidity exists in the underlying layer. Generally, leave each layer of concrete unfinished to secure efficient bonding with the overlying layer. To minimize the visibility of joints on exposed faces, finish the top surface of the concrete immediately adjacent to the forms of the exposed face, smoothing with a plaster mason's trowel. Where required, use inset form work to eliminate featheredges and to obtain concrete layers with a minimum thickness of 6 inches. Conduct the operation of depositing and consolidating the concrete so as to form a dense, impervious mass of uniform texture with smooth faces on exposed surfaces. Remove, dispose of, and replace defective concrete as directed by the Engineer and at no expense to the Department.

400-7.11 Vibration of Concrete:

400-7.11.1 General: Consolidate all concrete except seal, steel pile jackets, and concrete for incidental construction by the use of mechanical vibrators.

400-7.11.2 Vibrators: Provide adequate vibrators on the project that are approved by the Engineer before beginning concrete work. Generally, provide vibrators of the internal type. For thin sections, where the forms are especially designed to resist vibration, the Contractor may use external vibrators. Use a vibrator with a minimum frequency of 4,500 impulses per minute with sufficient intensity and duration to cause complete consolidation of the concrete without causing segregation of the materials. For vibrating thin, heavily reinforced sections, use heads of such size to secure proper vibration of the concrete without disturbance of either the reinforcing steel or the forms.

400-7.11.3 Number of Vibrators Required: Use a sufficient number of vibrators to secure the compaction of each batch before the next batch is delivered, without delaying the delivery. In order to avoid delays due to breakdowns, provide at least one stand-by vibrator, with an appropriate power source.

400-7.11.4 Method of Vibration: Use vibrators to consolidate properly placed concrete. Do not use them to move concrete about in the forms. Insert the vibrators in the surface of concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Insert the vibrator at points that are no further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight, and allow it to penetrate into the underlying layer sufficiently so that the two layers are thoroughly consolidated together. After thoroughly consolidating the concrete, withdraw the vibrator slowly to avoid formation of holes.

400-7.11.5 Hand Spading: When necessary in order to secure well-filled forms, free from aggregate pockets, honeycomb, bubbles, etc., spade the concrete by hand, along the surfaces of the forms and in all corners, following the vibration.

400-7.12 Columns: Place concrete in columns in one continuous operation for each lift as shown in the plans.

400-7.13 Slabs and Bridge Decks:

400-7.13.1 Bulkheads, Screed Rails, and Screeding Devices: Strike-off the concrete using an approved metal screed operating on rails or bulkheads. Use devices which do not contain aluminum parts. Prior to placing concrete, provide an approved screed capable of striking-off and screeding the surface of the slab or deck to the required shape. Set all necessary bulkheads and screed rails to the required grade. Use bulkheads, screed rails, and screeding devices that permit vertical profile adjustment to the grade, satisfactory for providing straight transverse slopes, differing transverse slopes broken as shown in the plans and/or transverse slopes with changing grade along the longitudinal length of slab or deck. Locate the screed rails so the entire placement surface can be screeded to grade without using intermediate screed rails, unless approved otherwise by the Engineer.

Use a screed consisting of a truss or heavy beams that will retain it's shape under all working conditions, and a set of rotating drums with a diameter sufficient to carry a 2 inch mortar roll in front of and parallel to the axis of the drums, while making an initial pass. Adjust the drums to prevent mortar buildup forming behind the trailing edges of the drums. For long bridges, as defined in 400-15.2.5.1, provide a device that automatically smoothes the concrete surface to an untextured finish and that is attached to, and is moved by, the rolling drum screed. As an alternate to the drum type screed, a mechanical screed with a metal strike-off may be used. Equip the mechanical screed with mechanical vibrators to provide continuous uniform vibration to the entire length unless otherwise authorized by the Engineer. Small and irregularly shaped areas that cannot be mechanically screeded may be screeded in a manner approved by the Engineer.

400-7.13.2 Screed Demonstration: Subsequent to the placement of all reinforcing steel and prior to placing any slab or deck concrete, demonstrate that the proposed equipment and methods can finish the concrete to the specified grades while maintaining the specified cover over the reinforcement. Provide the demonstration over the entire length and width of the spans to be placed.

400-7.13.3 Screeding Operations: Perform concrete placement and screeding as independently controlled mechanical operations. Ensure that the passing of the screed and forward movement of the screeding equipment are independent of the movement of concrete placement equipment.

Level the concrete in front of the screed as near to the finished grade as possible to prevent the screed from rising off the rail and forming uneven ridges behind the screed. Pass the screed over the slab or deck as many times as necessary to obtain a satisfactory surface and provide a concrete surface true to grade and crown, and free of irregularities.

Do not add water to the concrete surface to assist in finishing operations unless specifically authorized by the Engineer. If the Engineer permits the addition of water, apply only a fog mist, above the concrete surface, by means of approved power driven spray equipment.

For long bridges, as defined in 400-15.2.5.1, do not manually or mechanically float the concrete surface or apply a texture by broom or any other device to the concrete surface produced by the screeding process. Correct isolated surface irregularities in accordance with 400-15.2.5.3.

400-7.13.4 Placing Operations: Select an approved concrete design mix which ensures complete placement of all slab or deck concrete between construction joints before initial set begins in the plastic concrete. On placements of 50 yd^3 or less, the minimum placement rate is 20 yd^3/h. On placements of greater than 50 yd^3, the minimum placement rate is 30 yd^3/h.

The Engineer will not permit slab or deck placements until an acceptable plan for meeting the minimum placement rate is approved.

400-7.13.5 Concrete Decks on Steel Spans: Where concrete decks are placed on steel spans, release the temporary supports under the bridge before placing any concrete.

400-7.13.6 Concrete Decks on T-Beams: For cast-in-place T-beam construction, cast the slabs and beams in one continuous operation. As an exception, where special shear anchorage or keys are provided for in the plans or approved by the Engineer, the beams and slabs may be constructed in successive placements.

400-7.13.7 Diaphragms: Place concrete diaphragms at least 48 hours before the bridge deck slabs are placed unless otherwise indicated in the plans.

400-7.13.8 Weather Protection: Provide an approved means of protecting unhardened concrete from rain. Position the protection system to shield the concrete from rain and running water. Provide a shield impervious to water over the slab or deck concrete, of sufficient size to protect all areas of slab or deck concrete subject to water damage, and include a means of intercepting and diverting water away from freshly placed concrete. Arrange the equipment so that the weather protection system can be erected over unhardened concrete. When there is a possibility of rain during concrete placement operations, place the weather protection system in stand-by readiness, capable of being deployed in a timely manner. Use the weather protection immediately when rain begins so that slab or deck concrete damage will not occur. Do not place concrete during rain.

Assume responsibility for damage to the slab or deck in the case of failure of the weather protection system.

Describe the weather protection materials and methods in the Contractor's quality control plan.

400-7.14 Concrete Box Culverts: In general, place the base slab or footing of concrete box culverts, and allow them to set before constructing the remainder of the culvert. In this case, make suitable provision for longitudinal keys. Construct bottom slabs, footings, and apron walls as a monolith if practicable. Where transverse construction joints are necessary, place them at right angles to the culvert barrel, and make suitable provision for keys.

In the construction of box culverts having walls 6 feet or less in height, the sidewalls and top slab may be constructed as a monolith or may place the concrete in the walls and allow it to set before placing the top slab concrete.

Where the height of the box culvert walls exceed 6 feet, place the walls, and allow the concrete to set at least 12 hours before placing the top slab concrete. In such cases, form keys in the sidewalls.

When casting the walls and top slabs of box culverts as a monolith, ensure that any necessary construction joints are vertical. Design all construction joints with formed keys. Provide keys that are beveled as shown in the plans or as directed, but do not allow the edge of the beveled material forming the key to be less than 1 1/2 inches from the edge of the concrete.

Construct each wingwall, if possible, as a monolith. Ensure that construction joints, where unavoidable, are horizontal and so located that no joints will be visible in the exposed face of the wing above the ground line.

Precast box culvert sections may be used in lieu of cast-in-place box culvert construction provided the provisions in Section 410 are satisfied.

400-8 Seals.

400-8.1 General: Wherever practicable, dewater all foundation excavations, and deposit the concrete in the dry as defined in 455-15.2. Where conditions are encountered which render it impracticable to dewater the foundation before placing concrete, the Engineer may authorize the construction of a concrete foundation seal of the required size. Then, dewater the foundation, and place the balance of the concrete in the dry.

When required to place seal concrete, the Contractor is responsible for the satisfactory performance of the seal in providing a watertight excavation for placing structural concrete. The Department will provide and pay for the seal concrete as an aid to the construction of the structure. Repair seal concrete as necessary to perform its required function at no expense to the Department.

400-8.2 Method of Placing: Carefully place concrete deposited under water in the space in which it is to remain by means of a tremie, a closed-bottom dump bucket of not less than 1 yd^3 capacity, or other approved method. Do not disturb the concrete after depositing it. Deposit all seal concrete in one continuous placement. Do not place any concrete in running water, and ensure that all form work designed to retain concrete under water is watertight.

400-8.3 Use of Tremie: Use a tremie consisting of a tube having a minimum inside diameter of 10 inches, constructed in sections having water-tight joints. Do not allow any aluminum parts to have contact with the concrete. Ensure that the discharge end is entirely seated at all times, and keep the tremie tube full to the bottom of the hopper. When dumping a batch into the hopper, keep the tremie slightly raised (but not out of the concrete at the bottom) until the batch discharges to the bottom of the hopper. Stop the flow by lowering the tremie. Support the tremie such as to permit the free movement of the discharge end over the entire top surface of the work and to permit its being lowered rapidly when necessary to choke off or retard the flow. Provide a continuous, uninterrupted flow until completing the work. Exercise special care to maintain still water at the point of deposit.

400-8.4 Time of Beginning Pumping: Do not commence pumping to dewater a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure, and in no case earlier than 72 hours after placement of the concrete.

400-9 Construction Joints.

400-9.1 Location: Make construction joints only at locations shown in the plans or in the placement schedule, unless otherwise approved in writing. If not detailed in the plans or placement schedule, or in case of emergency, place construction joints as directed.

400-9.2 Provisions for Bond and Transmission of Shear: Use shear key reinforcement where necessary to transmit shear or to bond the two sections together.

400-9.3 Preparations of Surfaces: Before depositing new concrete on or against concrete which has hardened, re-tighten the forms. Roughen the surface of the hardened concrete in a manner that will not leave loosened particles, aggregate, or damaged concrete at the surface. Thoroughly clean the surface of foreign matter and laitance, and saturate it with water.

400-9.4 Placing Concrete: Continuously place concrete from joint to joint. Carefully finish the face edges of all joints which are exposed to view true to line and elevation.

400-9.5 Joints in Sea Water or Brackish Water: For concrete placed in sea water or brackish water, do not place any construction joints between points 2 feet below the mean low water elevation and 6 feet above the mean high water elevation.

400-9.6 Joints in Long Box Culverts: For long concrete box culverts, vertical construction joints may be placed at a spacing not less than 30 feet. When using transverse

construction joints, ensure that longitudinal reinforcing steel is continuous through the joint and that the joint is vertical.

400-9.7 Crack Control Grooves in Concrete Bridge Decks: When the plans require crack control grooves in the top surface of decks, either install a tooled "V" groove prior to initial concrete set or saw a groove using an early entry dry cut saw. When using an early entry dry cut saw, operate in accordance with the manufacturer's recommendations. Commence sawing as soon as the concrete has hardened enough to permit standing on the surface without leaving visible tracks or impressions and before uncontrolled concrete cracks occur.

400-10 Expansion Joints.

400-10.1 General: After meeting the smoothness criteria in 400-15, construct expansion joints to permit absolute freedom of movement. Carefully remove all loose or thin shells of mortar likely to cause a spall with movement at a joint from all expansion joints as soon as possible.

400-10.2 Sealed Joints: Fill expansion joints with a preformed joint filler. Cut the filler to conform to the cross-section of the structure, and furnish it in as few pieces as practicable, using only a single piece in each curb section. Do not use small pieces that would tend to come loose. Prepare joints to be sealed and apply the sealer in accordance with approved manufacturer's directions.

400-10.3 Joint System Installation: Install expansion joints before or after the deck planing required by 400-15.2.5.5 following the manufacturer's instructions. When installed after deck planing, install the edge rail assemblies in the blockouts on a profile tangent between the ends of the deck and/or approach slab to within a plus 0 and minus1/4 inch variation.

When installed before deck planing, install the edge rail assemblies 3/8 inch, plus or minus 1/16 inch, below the top surface of the deck or approach slab to compensate for concrete removal during planing.

400-11 Contact and Bearing Surfaces.

400-11.1 Separation of Surfaces: In general, separate all contact surfaces between superstructure and substructure or end walls and between adjacent superstructure sections by a layer of 55 lb roofing felt.

400-11.2 Finishing of Bearing Surfaces: Construct bearings surfaces (areas) to the tolerances as specified herein and in the other parts of the Contract Documents. When using neoprene bearing pads, finish the concrete surface to a uniform 'rough' texture using a burlap drag, fine bristle broom or float. For metal or high load rotational bearings, fill minor depressions, 1/8 inch maximum, caused by finishing, bush hammering, or grinding with a low-viscosity epoxy meeting the requirements of 926-1, Type F-2, applied by the use of a squeegee. Bearing surfaces may be ground to final position with carborundum. Check all bearing surfaces with a metallic straightedge prior to setting bearings or neoprene pads.

400-11.2.1 Deviation from Specified Elevations for Steel Beam Superstructures: Construct to the elevation shown on the plans plus or minus 0.01 feet and do not exceed a 0.01 feet difference between specified elevations of bearing areas of adjacent bearings measured between the centerlines of bearing areas.

400-11.2.2 Deviation from Specified Elevations for Concrete Beam Superstructures: Construct to the elevation shown on the plans plus or minus 0.02 feet.

400-11.2.3 Projecting Irregularities: Projecting irregularities will not exceed 1/16 inch.

400-11.2.4 Variations in Flatness for Neoprene Pads: In any direction, the pad is to be flat to within 1/16 inch. Pads designated to be sloped are not to deviate from the theoretical slope by the same amount.

400-11.2.5 Variations in Flatness for Metal or High Load Rotational Bearings: Construct the bearing area to the tolerance indicated for the measured length along the orthogonal axes.

Bearing area length up to 30 inches long to plus or minus 1/16 inch.

Bearing area length over 30 inches up to 45 inches long to plus or minus 3/32 inch.

Bearing area length over 45 inches long to plus or minus 1/8 inch.

400-11.3 Bearing Pads: Use bearing pads for seating bridge shoes, ends of beams, and slabs of the types specified or required in the Plans.

Furnish and install composite neoprene pads as detailed in the Plans. Place neoprene pads, where specified or required, directly on masonry surfaces finished in accordance with the requirements of this Article. Ensure that pads, bearing areas of bridge seats, and metal bearing plates are thoroughly cleaned and free from oil, grease, and other foreign materials.

Exercise care in fabrication of related metal parts to avoid producing conditions detrimental to the performance of the pads, such as uneven bearing, excessive bulging, etc.

The Engineer will evaluate the degree of deformation and condition of bearing pads in the completed bridge on or before the final inspection required by 5-10 or when requested by the Contractor. As directed by the Engineer, correct horizontal bearing pad deformations that at the time of inspection exceed 50% of the bearing pad thickness or that the Engineer predicts will exceed 50% of the bearing pad thickness during future high or low temperature periods. Payment for this correction effort will be considered extra work in accordance with 4-3.

400-12 Anchor Bolts and Dowels.

Set anchor bolts and dowels as specified in Section 460.

Galvanize all anchor bolts as specified in Section 962.

400-13 Epoxy Bonding Compounds.

Where epoxy bonding compounds for bonding concrete are specified or required, apply the epoxy bonding materials only to clean, dry, structurally sound concrete surfaces. Provide surface preparation, application, and curing of epoxy bonding compound in strict accordance with the manufacturer's recommendations for each particular application. Use an epoxy bonding compound listed on the Department's Qualified Products List.

400-14 Removal of Forms.

Use the table below as the criterion for minimum time or compressive strength required before removal of forms or supports.

When using the time period criterion, include in the time period all days except days in which the temperature falls below 40ºF.

Use the specified 28-day minimum compressive strength value as stated in 346-3.1 for each Class of Concrete utilized.

Location of Concrete Placement	Minimum Time for Form Removal for any Strength Concrete*	Minimum (%) of 28-day Compressive Strength for Form Removal

Location of Concrete Placement	Minimum Time for Form Removal for any Strength Concrete*	Minimum (%) of 28-day Compressive Strength for Form Removal
(1) Deck slabs, top slabs of culverts and bottom of caps, forms under sidewalks, and safety curb overhangs extending more than 2 feet		
(a) Class II (Bridge Deck)	7 days**	75**
(b) Class II (Other than Bridge Deck)	7 days	75
(c) Class III	7 days	70
(d) Class IV	7 days	60
(e) Class V	7 days	50
(2) Walls, piers, columns, sides of beams and other vertical surfaces	24 hours***	50***
(3) Front face form of curbs	6 hours	70

* For mass concrete, remove forms in accordance with 346-3.3
** Reference 400-16.4
***Do not place additional load on the section until 70% of the specified 28-day concrete strength is attained. Also, refer to 400-7.4.

When using the percent of required strength, cast test cylinders for each mix for compressive strength determination or develop a curing concrete strength versus time curve (S/T Curve) which can be used in lieu of multiple test cylinders to determine when percent of required strength has been met.

Prior to curve use; obtain the Engineer's approval of the S/T Curve and its supporting data. An approved testing laboratory may be used to provide this information with approval of the Engineer. Plot S/T Curves using at least three different elapsed times that begin once test cylinders are cast; however, one of the elapsed times must be prior to the Contractor's intended form removal. Each elapsed time plotted must have a corresponding compressive strength computed by averaging the compressive strength of two test cylinders.

Cure such test cylinders as nearly as practical in the same manner as the concrete in the corresponding structural component, and test them in accordance with ASTM C 39 and ASTM C 31. Perform cylinder casting, curing, and testing at no expense to the Department and under the observation of the Engineer. When the S/T Curve indicates a compressive strength equal to or greater than the percentage of specified strength shown in the table above for form removal, the Contractor may remove the forms. When the ambient air temperature falls 15ºF or more below the ambient air temperature that existed during development of a S/T Curve, use a S/T Curve that corresponds to the lower temperature and that is developed in accordance with this section.

Do not remove forms at any time without the consent of the Engineer. Even when the Engineer provides consent to remove the forms, the Contractor is responsible for the work.

400-15 Finishing Concrete.

400-15.1 General Surface Finish (Required for All Surfaces): After placing and consolidating the concrete, strike-off all exposed surfaces to the lines and grades indicated in the plans in a manner that will leave a surface of uniform texture free of undesirable surface irregularities, cavities, and other defects. Cut back metal ties supporting reinforcement, conduit, and other appurtenances a minimum of 1 inch from finished surface. After removing excess mortar and concrete and while the concrete is still in a workable state, carefully tool all

construction and expansion joints. Leave joint filler exposed for its full length with clean edges. Ensure that finished work in addition to that specified above is compatible and complementary to the class of surface finish required.

Immediately after removing forms from any exposed concrete surface, remove all fins and irregular projections flush with the surface. Clean, saturate with water, and point all holes, tie cavities, honeycomb, chips and spalls with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934, mixed and applied in accordance with the manufacturer's recommendations. Exercise care during the roughening process to prevent additional defacement and damage to the formed surface.

In the event unsatisfactory surfaces are obtained, repair these surfaces by methods approved by the Engineer or the affected concrete will be rejected. Repair any surface or remove rejected concrete at no expense to the Department.

400-15.2 Surface Finishes:

400-15.2.1 General: In addition to the general surface work specified for all exposed concrete surfaces, the Engineer may require one of the classes of surface finish listed below. For all such exposed surfaces, begin finish work for the applicable class specified, along with the general finish work, immediately after removal of the forms. In order to further ensure the required quality of the finish, remove forms no later than the minimum time specified for the forms to remain in place. Satisfactorily repair finished concrete surfaces which are subsequently disfigured or discolored at no expense to the Department.

Provide the required class of surface finish for the various items of structural concrete as shown in the plans.

400-15.2.2 Class 1 Surface Finish: As soon as the pointing has sufficiently set, thoroughly saturate the exposed surfaces with water, and rub them with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water. After the rubbing has produced a smooth surface of uniform color, allow the material which has been ground to a paste to reset under proper curing conditions. Subsequently, as a second operation, re-saturate the concrete surfaces with water, and thoroughly rub them with a fine carborundum stone. Continue this rubbing until the surface has a smooth, fine grain texture of uniform color.

The Contractor may substitute a Class 5 applied finish coating in accordance with 400-15.2.6 as an alternate surface finish on all areas where Class 1 surface finish is specified.

400-15.2.3 Class 2 Surface Finish: As soon as pointing has sufficiently set, thoroughly saturate the exposed concrete surfaces with water and rub them with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water.

After rubbing has produced a smooth surface finish, of uniform color, carefully brush the material which has been ground to a paste to a uniform texture, and allow it to reset under proper curing conditions. Carefully protect these surfaces from disfigurement and discoloration during subsequent construction operations.

400-15.2.4 Class 3 Surface Finish: Where this surface finish is specified, use forms with a form liner. Where specified or required on the plans, use No. 89 coarse aggregate for concrete.

After concrete has been placed in the forms and compacted, finish all exposed surfaces which are not contained by the forms to produce a surface texture as nearly equal to that produced by the form as practicable. Generally, finish unformed surfaces to a smooth, dense surface with a steel trowel.

Perform all work, including general surface finish work, in a manner that will preserve the same surface texture and color produced by the form liner. Pointed areas may be rubbed with a dry carborundum stone.

400-15.2.5 Class 4 Deck Finish:

400-15.2.5.1 General: Apply a Class 4 finish on bridge decks and concrete approach slabs. On Short Bridges (bridges having a length less than or equal to 100 ft), and on Miscellaneous Bridges (Pedestrian, Trail and Movable Spans) regardless of length, meet the finish and smoothness requirements of 400-15.2.5.2 and 400-15.2.5.4. On Long Bridges (bridges having a length greater than 100 ft) meet the finish and smoothness requirements of 400-15.2.5.3 and 400-15.2.5.5. When an existing bridge deck is widened, see the plans for the finish and smoothness requirements of the existing bridge deck and its new widened section. After meeting the screeding requirements of 400-7.13 and curing requirements of 400-16 and the smoothness requirements, herein, groove the bridge deck and approach slabs.

Regardless of bridge length, finish decks with less than 2 1/2 inches of top cover in accordance with the requirements for Short Bridges.

400-15.2.5.2 Plastic Surface Finish for Short and Miscellaneous Bridges: After screeding is completed, check the surface of the plastic concrete with a 10 foot straightedge, positioning and half-lapping the straightedge parallel to the centerline to cover the entire surface. Immediately correct deficiencies of more than 1/8 inch, measured as an ordinate between the surface and the straightedge.

Finish the concrete surface to a uniform texture using a burlap drag, fine bristle broom or float. Finish the deck to a smooth surface having a sandy texture without blemishes, marks or scratches deeper than 1/16 inch.

400-15.2.5.3 Plastic Surface Finish for Long Bridges: Do not moisten, manually float or apply texture to the concrete surface after the screed, with attached smoothing device, has passed unless correction of isolated surface irregularities is warranted and this should be done as soon as possible after screeding while the concrete is plastic. Correct all flaws such as cavities, blemishes, marks, or scratches that will not be removed by planing.

If the Engineer permits the addition of water when correcting flaws, apply moisture to the concrete surface only if required and only in the immediate vicinity of the isolated irregularity. Apply a quantity of moisture not greater than what is needed to facilitate correction of the irregularity and apply only a fog mist, above the concrete surface, by power driven spray equipment approved by the Engineer.

400-15.2.5.4 Smoothness Requirements for Short Bridges and Miscellaneous Bridges (including approach slabs): Perform a final straightedge check with a 10 foot straightedge, positioning and half-lapping the straightedge parallel to the centerline, approximately 5 feet apart to cover the entire surface. Correct all irregularities greater than 3/16 inch measured as an ordinate to the straightedge, by grinding. Perform grinding by the abrasive method using hand or power tools or by machine, to leave a smooth surface within a 1/8 inch tolerance.

400-15.2.5.5 Smoothness Evaluation and Concrete Surface Planing, Long Bridges (including approach slabs): Prior to planing, provide a smoothness evaluation of

the completed bridge deck and exposed concrete surfaces of approach slabs by a computerized Cox California-type profilograph in accordance with the criteria herein and FM 5-558E. Furnish this evaluation through an independent provider approved by the Engineer, using equipment calibrated by the Engineer. All bridge deck and concrete approach slab surfaces to within 2 feet of gutter lines are subject to this smoothness evaluation.

Prior to initial profilograph testing, complete work on the bridge deck and approach slabs. Thoroughly clean and clear the bridge deck and approach slab areas to be evaluated for smoothness of all obstructions and provide the smoothness evaluation. Ensure that no radio transmissions or other activities that might disrupt the automated profilograph equipment are allowed during the evaluation.

Average the Profile Index Value for the bridge deck, including the exposed concrete surfaces of the approach slabs, for the left and right wheel path of each lane. The maximum allowable Profile Index Value for acceptable smoothness is 10 inches per mile utilizing the 0.2 inch blanking band. Apply these criteria to a minimum of 100 feet of each lane. Additionally, correct individual bumps or depressions exceeding a cutoff height of 0.3 inch from a chord of 25 feet (see ASTM E-1274) on the profilograph trace. Ensure that the surface meets a 1/4 inch in 10 feet straightedge check made transversely across the deck and approach slabs if determined necessary by the Engineer. Provide additional profilograph testing as necessary following longitudinal planing and any other actions taken to improve smoothness, until a profile meeting the acceptance criteria is obtained.

Regardless of whether expansion joints are installed before or after deck planing is complete, plane off the concrete deck surface to a minimum depth of 1/4 inch and also meet or exceed the profilograph smoothness criteria. Longitudinally plane the entire bridge deck and exposed concrete surfaces of the approach slabs using a self-propelled planing machine with gang mounted diamond saw cutting blades specifically designed for such work. Use the profilograph generated smoothness data, to establish the optimum planing machine settings. Plane the deck surface to within 2 feet of the gutter line so that there is a smooth transition, without vertical faces or sudden surface discontinuities, from the fully planed surface to the unplaned surface. Use a machine with a minimum wheel base length of 15 feet, constructed and operated in such manner that it does not cause strain or damage to deck or approach slab surfaces, excessive ravels, aggregate fractures or spalling. The equipment shall be approved by the Engineer. Perform longitudinal planing parallel to the roadway centerline, and provide a consistent, textured surface. Clean the surface of all slurry/debris generated during this work concurrently with operation of the machine.

After the deck has been planed the minimum 1/4 inch, reevaluate the surface smoothness using the profilograph testing described above. Perform cycles of planing and profilograph retesting as necessary until the deck and exposed concrete surfaces of approach slabs are in compliance with the smoothness criteria but do not exceed the maximum concrete removal depth of 1/2 inch.

400-15.2.5.6 Grooving: After the concrete surface profile, as required by 400-15.2.5, has been accepted by the Engineer, and prior to opening the bridge to traffic, groove the bridge deck and approach slabs perpendicular to the centerline of the structure. Do not groove the deck surface of pedestrian or trail bridges unless otherwise shown in the Contract Documents. Cut grooves into the hardened concrete using a mechanical saw device which will leave grooves nominally 1/8 inch wide and 3/16 inch deep. Space the grooves apart in random spacing center of grooves in the following sequence: 3/4 inch, 1-1/8 inch, 5/8 inch, 1 inch,

5/8 inch, 1-1/8 inch, 3/4 inch in 6 inch repetitions across the width to be grooved in one pass of the mechanical saw device. One 6 inch sequence may be adjusted by 1/4 sequence increments to accommodate various cutting head widths provided the general pattern is carried out. The tolerance for the width of the grooves is plus 1/16 inch to minus 0 inch and the tolerance for the depth of grooves is plus or minus1/16 inch. The tolerance for the spacing of the grooves is plus or minus1/16 inch.

Cut grooves continuously across the deck or approach slab to within 18 inches of gutter lines at barrier rail, curb line and median divider. At skewed metal expansion joints in bridge deck surfaces, adjust groove cutting by using narrow width cutting heads so that all grooves of the bridge deck surface or approach slab surface end within 6 inches, measured normal to centerline of the joint, leaving no ungrooved surface adjacent to each side of the joint greater than 6 inches in width. Ensure that the minimum distance to the first groove, measured normal from the edge of the concrete joint or from the junction between the concrete and the metal leg of the armored joint angle, is 1 inch. Produce grooves that are continuous across construction joints or other joints in the concrete surface less than 1/2 inch wide. Apply the same procedure described above where the gutter lines at barrier rails, curb lines and median dividers are not parallel to the centerline of the bridge to maintain the 18 inches maximum dimension from the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

400-15.2.6 Class 5 Applied Finish Coating:

400-15.2.6.1 General: Place an applied finish coating upon all concrete surfaces where the plans indicate Class 5 Applied Finish Coating. Apply the finish coating after completion of the general surface work specified for all exposed concrete surfaces. Select an Applied Finish Coating from the Departments Qualified Products List meeting the requirements of Section 975.

400-15.2.6.2 Material: For the coating material, use a commercial product designed specifically for this purpose. Use only coating material that is manufactured by one manufacturer and delivered to the job site in sealed containers bearing the manufacturer's original labels. Submit a copy of the manufacturer's printed instructions to the Engineer.

400-15.2.6.3 Surface Preparation: Prepare the surface prior to the application of an applied finish coating by providing a surface finish in accordance with the requirements of 400-15.1. The Engineer will not require surface voids that are 1/4 inch or less in width and depth to be grouted prior to application of the finish coating. Fill surface void larger than 1/4 inch in width and depth an approved high strength, non metallic, non shrink grout meeting the requirements of Section 934, mixed and applied in accordance with the manufacturer's recommendations. Apply the grout by filling the surface voids using burlap pads, float sponges, or other acceptable methods. As soon as the grout has taken its initial set, brush the surface to remove all loose grout, leaving the surface smooth and free of any voids. Ensure that the surface to be coated is free from efflorescence, flaking coatings, curing compound, dirt, oil, and other substances deleterious to the applied finish coating. Prior to application of the finish coating onto precast or cast-in-place concrete surfaces, test the concrete surface at 30 foot intervals for the presence of curing compound using one or two drops of muriatic acid placed on the concrete surface. If curing compound is present, there will be no reaction between the acid and the concrete. If there is no reaction, remove the compound by pressure washing the concrete surfaces. Prepare the surfaces in accordance with the manufacturer's recommendations, and

ensure that they are in a condition consistent with the manufacturer's requirements. Clean surfaces of existing structures in accordance with 400-19.

400-15.2.6.4 Application: Apply the finish coating utilizing a method recommended by the manufacturer. When applying the finish coating by spraying, supply heavy duty spray equipment capable of maintaining a constant pressure necessary for proper application. Mix and cure all coating materials in accordance with the manufacturer's printed instructions. Apply the finished coating at a rate of 50, plus or minus 10 ft^2/gal.

400-15.2.6.5 Finished Product: Produce a texture of the completed finish coat that is generally similar to that of rubbed concrete. Ensure that the completed finished coating is tightly bonded to the structure and presents a uniform appearance and texture. If necessary, apply additional coats to produce the desired surface texture and uniformity.

Upon failure to adhere positively to the structure without chipping, flaking, or peeling, or to attain the desired surface appearance, remove coatings entirely from the structure, and reapply the finish coating after surface preparation until achieving the desired finished product. Do not allow the average thickness of the completed finish coating to exceed 1/8 inch.

400-15.2.6.6 Material Tests and Certification: Before any portion of any shipment of finish coating is applied on the project, furnish the Engineer with a certificate from the manufacturer attesting that the commercial product furnished conforms to the same formula as that previously subjected to the tests specified in Section 975. In addition, submit the following product analysis, obtained from the manufacturer, for each batch of the material used:

(a) Weight per gallon.
(b) Consistency (Krebs Units).
(c) Weight percent pigment.
(d) Weight percent vehicle solids.
(e) Infra-red spectra of vehicle solution.

400-15.2.7 Final Straightedging for Surfaces to Receive Asphalt Concrete Surface: Test the slab surfaces of poured-in-place decks which are to be surfaced with an asphalt concrete wearing course for trueness with a 10 foot straightedge, as specified above. As an exception, correct only irregularities of more than 1/4 inch measured as an ordinate (either above or below the general contour of the surface). The Engineer will not require belting or brooming of slabs that are to be surfaced with an asphalt concrete wearing course. For curing, meet the requirements specified for other deck slabs.

400-15.2.8 Finishing Bridge Sidewalks: Finish bridge sidewalks in accordance with the applicable requirements of Section 522.

400-16 Curing Concrete.

400-16.1 General: Cure cast-in-place and precast (non-prestressed) concrete as required herein for a minimum duration of 72 hours. If forms are loosened or removed before the 72 hour curing period is complete, expand the curing to cover these surfaces by either coating with curing compound or extending the continuous moist cure area.

Until curing has begun, retain concrete surface moisture at all times by maintaining a surface moisture evaporation rate less than 0.1 lb/ft^2/hr. Periodically, at the site of concrete placement prior to and during the operation, measure the ambient air temperature, relative humidity and wind velocity with industrial grade weather monitoring instruments to determine the on-site evaporation rate. If the evaporation is, or is likely to become 0.1 lb/ft^2/hr or greater, employ measures to prevent moisture loss such as application of evaporation retarder,

application of supplemental moisture by fogging or reduction of the concrete temperature during batching. Compute the evaporation rate by using the nomograph in the ACI manual of Concrete Practice Part 2, Section 308R Guide to Curing Concrete, or by using an evaporation rate calculator approved by the Engineer.

400-16.2 Methods: Except where other curing methods are specified, select from the following options the chosen method(s) for curing all concrete components and indicate the method to be used in the Quality Control Plan.

(a) Continuous Moisture: Place burlap on the surface and keep it continuously saturated for the curing period by means of soaker hoses or automatic sprinklers. Water flow may be metered to cycle repetitively for five minutes on and five minutes off during the 72 hour curing period. Do not apply moisture manually. If side forms are loosened or removed during the curing period, extend the burlap so as to completely shield the sides of the members.

(b) Membrane Curing Compound: Apply a white Type 2 curing compound to all surfaces at a uniform coverage as recommended by the manufacturer but not less than 0.06 gal/yd^2. Allow surfaces covered by the membrane curing compound to remain undisturbed for the curing period. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within one hour. If side forms are loosened during the curing period, maintain surface moisture and remove the forms within one hour and immediately coat the formed surfaces with a membrane curing compound. Bottom surfaces shall be similarly coated after removal of or from the forms.

If curing compound is to be applied by spraying, use a compressor driven sprayer of sufficient size to provide uniform mist. Standby equipment is required in case of mechanical failure and hand held pump-up sprayers may be used only as standby equipment.

(c) Curing Blankets: Curing blankets may be used for curing the top surfaces of members while the member side forms remain in place. Do not use curing blankets which have been torn or punctured. Securely fasten all edges to provide as tight a seal as practical. Should the system fail to maintain a moist condition on the concrete surface, discontinue use of the blankets and continue curing using another method. Keep curing blankets in place for the duration of the curing period.

(d) Accelerated Cure:

(1) General: Accelerated curing of the concrete can be achieved by use of either low pressure steam curing, radiant heat curing or continuous moisture and heat curing. If accelerated curing is completed before the 72 hour curing period has elapsed, continue curing for the remaining part of the 72 hour curing period in accordance with one of the curing methods listed above.

If accelerated curing is used, furnish temperature recording devices that will provide accurate, continuous and permanent records of the time and temperature relationship throughout the entire curing period. Provide one such recording thermometer for each 200 feet of placement length or part thereof. Initially calibrate recording thermometers and recalibrate at least annually.

The preheating period shall equal or exceed the time of initial set as determined by ASTM C 403 and shall not be less than 4 hours. When the ambient air temperature is above 50ºF, allow the member to remain undisturbed in the ambient air for the preheating period. If the ambient air temperature is below 50ºF, apply heat during the preheating period to hold the air surrounding the member at a temperature of 50 to 90ºF.

To prevent moisture loss from exposed surfaces during the preheating period, enclose members as soon as possible after casting or keep the surfaces wet by fog mist or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the member with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire placement.

During the application or removal of the heat, do not allow the temperature rise or fall within the enclosure to exceed 40ºF/hr. Do not allow the curing temperature throughout the enclosure to exceed 160ºF. Maintain the curing temperature within a temperature range of 130 to 160ºF until the concrete has reached the required form removal strength for precast and cast-in-place components or the required release strength for prestressed concrete components.

(2) Low-Pressure Steam: The steam used shall be in a saturated condition. Do not allow steam jets to impinge directly on the concrete, test cylinders, or forms. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average temperature of the enclosure.

(3) Curing with Radiant Heat: Apply radiant heat by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. Do not allow the heating elements to come in direct contact with the concrete or the forms. Distribute sources of heat in a manner that will prevent localized high temperatures above 160ºF. To prevent moisture loss during curing, keep the exposed surfaces wet by fog mist or wet blankets.

(4) Continuous Moisture and Heat: This method consists of heating the enclosure in combination with the continuous moisture method described above.

In addition to the curing blankets, an auxiliary cover for retention of the heat will be required over the entire placement. Support this cover at a sufficient distance above the placement being cured to allow circulation of the heat.

400-16.3 Silica Fume Concrete: Cure silica fume concrete a minimum of 72 hours using continuous moisture cure. No substitution of alternative methods nor reduction in the time period is allowed. After completion of the 72 hour curing period, apply a membrane curing compound to all concrete surfaces. Apply curing compound according to 400-16.2.

400-16.4 Bridge Decks: Cure bridge decks for a duration of seven days. Apply a membrane curing compound to the deck top surface in accordance with 400-16.2 using a compressor driven sprayer. In general, apply curing compound to a concrete deck when the surface is damp and after all pooled water has evaporated. For Short bridges, begin applying curing compound immediately after the initially placed concrete has been floated, straightedged, textured and a damp surface condition exists and continue applying compound as concrete placement progresses with as little interruption as possible until the entire deck surface has been coated with compound. For Long bridges, begin applying curing compound to the initially placed concrete as soon as a damp surface condition exists and continue applying compound as concrete placement progresses with as little interruption as possible until the entire deck surface has been coated with compound. However, for both Short and Long bridges, the elapsed time between the initial placement of deck concrete and the completed application of curing compound must not exceed 120 minutes. The 120 minute limit may be extended by the Engineer if project specific factors (cool temperatures, high humidity, retarding admixtures, etc.) are prolonging wet surface conditions.

Prior to the first deck placement, submit to the Engineer the method that will be used to periodically measure the rate of application of curing compound in, gallons/sq ft as the deck placement progresses. Prior to the placement of each deck, submit to the Engineer the anticipated quantity of curing compound in gallons along with the corresponding square feet of deck to be covered to meet the coverage rate in 400-16.2. Compute the actual quantity of curing compound applied at the conclusion of each deck placement and submit the quantity to the Engineer. Apply the curing compound from a work platform.

Place curing blankets on all exposed surfaces which are not formed as soon as possible with minimal effect on the surface texture. Place the curing blankets with sufficient overlapping seams to form an effective moisture seal. Before using curing blankets, mend tears, splits, or other damage that would make them unsuitable. Discard curing blankets that are not repairable. Wet all curing blankets immediately after satisfactorily placing them and maintain them in a saturated condition throughout the seven day curing period. Supply sufficient quantity of potable water at the job site for wetting the blankets.

Where a bridge deck slab is to be subjected to walking, wheeling or other approved construction traffic within the seven day curing period, protect the curing blankets and the slab surface from damage by placing wooden sheeting, plywood or other approved protective material in the travel areas.

When the ends of the curing blankets are rolled back to permit screeding of adjacent bridge deck slabs, keep the exposed surfaces wet throughout the period of exposure.

Removal of bottom and side forms after 72 hours is acceptable upon compliance with 400-14. Apply membrane curing compound to all surfaces stripped of forms within one hour of loosening. Apply curing compound according to 400-16.2.

400-16.5 Construction Joints: Cure construction joint areas using either the continuous moisture or curing blankets method.

400-16.6 Traffic Barriers, Railings, Parapets and End Post: Ensure concrete is cured in accordance with 400-16.2(b). When construction is by the slip form method, coat all concrete surfaces with a curing compound that meets the requirements of 925-2, either within 30 minutes of extrusion or before the loss of water sheen, whichever occurs first. Ensure a curing compound coating period of not less than seven days after application. Prior to each concrete placement, submit to the Engineer the method that will be used to periodically measure the rate of application in gallons/sq ft. Also, prior to each placement, submit to the Engineer the anticipated quantity of curing compound in gallons that will be used to meet the coverage rate specified in 400-16.2 along with the corresponding square footage of barriers, railings, parapets and end posts to be coated with that quantity. Compute the actual quantity of curing compound that is applied during each concrete placement and submit the quantity to the Engineer. Applied Finish Coatings, that are on the Qualified Products List and that are flagged as permitted for use as a curing compound, may be used in lieu of a curing compound; If an Applied Finish Coating is used in lieu of a curing compound, have a backup system that is in full compliance with 400-16.2(b) available at all times to ensure that an effective alternative system will be immediately available if the Applied Finish Coating cannot be applied within 30 minutes of extrusion or before the loss of water sheen.

400-16.7 Removal of Membrane Curing Compounds: Provide the longest possible curing duration; however, remove curing compound on portions of members to be bonded to other concrete. Compounds may be removed by either sand or water blasting. Water blasting requires the use of potable water and a minimum nozzle pressure of 2,900 psi.

400-17 Protection of Concrete.

400-17.1 Opening to Traffic: Close concrete bridge decks and culverts to traffic for a period of at least 14 days after placing and for such additional times as deemed advisable. In the operation of placing, the Contractor may wheel concrete across previously poured slabs after they have set for 24 hours, provided plank runways are used to keep the loads over the beams.

400-17.2 Storing Materials on Bridge Slabs: Do not store heavy equipment or material, other than light forms or tools, on concrete bridge slabs until 14 days after they have been poured. For all stockpiles, tools, and equipment stored on bridge slabs at any time, obtain prior approval by the Department, and the Engineer will require any such stored materials or equipment to be dispersed in order to avoid overloading any structural part.

400-17.3 Time of Placing Superstructure: In the case of piers or bents with concrete caps, do not place the weight of the superstructure or of beams on the caps until they have reached the age of 10 days.

400-17.4 Alternate Procedure: As an alternate procedure, in lieu of the time delay periods set forth in 400-17.1 and 400-17.3, test beams or cylinders may be cast from representative concrete and cured identically with the concrete in the corresponding structural component. Make the test beams in accordance with ASTM C31 and test them in accordance with ASTM C78. When the test results indicate a minimum flexural strength of 550 psi for beams or the minimum 28 day compressive strength shown in the Plans, concrete bridge decks and culverts may be opened to traffic or the superstructure and beams may be placed on caps. However, regardless of beam or cylinder break results, fully comply with the bridge deck curing provisions of 400-16.4, including the requirement for curing blankets to remain in place for seven days.

400-18 Precast Planks, Slabs, and Girders.

400-18.1 General: Where so shown in the Contract Documents, the Contractor may construct concrete planks, slabs, girders, and other structural elements by precasting. In general, use a method that consists of casting structural elements in a casting yard, curing as specified in 400-16, transporting them to the site of the work, installing them on previously prepared supports and, where so shown in the plans, joining them with poured-in-place slabs or keys. Handle and install precast prestressed members as specified in Section 450.

400-18.2 Casting: Cast precast elements on unyielding beds or pallets. Use special care in casting the bearing surfaces on both the elements and their foundations in order that these surfaces shall coincide when installing the elements. Check bearing surfaces on casting beds with a level and a straightedge prior to the casting. Similarly check corresponding surfaces on the foundations during finishing operations.

400-18.3 Poured-in-Place Keys: Where precast elements are to be joined with poured-in-place keys, carefully align the elements prior to pouring the keys.

400-18.4 Surface Finish: Finish the surface as specified in 400-15, except that where precast slabs and poured-in-place keys form the riding surface, give the entire surface a broomed finish.

400-18.5 Moving, Placing, and Opening to Traffic: Reinforced precast members may be moved from casting beds, placed in the structure, and opened to traffic at the ages shown in the following table:

Handling from casting beds to storage areas	7 days
Placing in structure	14 days

Opening to traffic:

Precast elements..... 14 days
Cast-in-place slabs over precast girders..... 14 days
Cast-in-place keys joining precast slabs ..... 7 days

As an alternate procedure, in lieu of the time delay periods set forth above, test beams may be cast from representative concrete, and cure them identically with the concrete in the corresponding structural component. Test the test beams in accordance with ASTM C 31 and ASTM C 78. When the test results indicate a flexural strength of 550 psi, or more, any of the operations listed above may proceed without completing the corresponding time delay period.

400-18.6 Setting Prestressed Slabs: Before permitting construction equipment on the bridge to erect slab units, submit sketches showing axle loads and spacing and a description of the intended method of setting slab units to the Engineer for approval. Do not use axle loads, spacing, and methods of setting which produce stresses in the slab units greater than the allowable stress.

400-18.7 Protection of Precast Elements: The Contractor is responsible for the safety of precast elements during all stages of construction. The Engineer will reject any precast elements that become cracked, broken, seriously spalled, or structurally impaired. Remove rejected precast elements from the work at no expense to the Department.

400-18.8 Form Material: Form material used to form hollow cores may be left in place. Ensure that the form material is neutral with respect to the generating of products harmful to the physical and structural properties of the concrete. The Contractor is responsible for any detrimental effects resulting from the presence of the form material within the precast element.

400-19 Cleaning and Coating Concrete Surfaces of Existing Structures.

For the purposes of this article, an existing structure is one that was in service prior to the start of the project to which this specification applies. For existing structures, clean concrete surfaces that are designated in the Contract Documents as receiving Class 5 applied finish coating by pressure washing prior to the application of coating. Use pressure washing equipment producing a minimum working pressure of 2,500 psi when measured at or near the nozzle. Do not damage or gouge uncoated concrete surfaces or previously coated concrete surfaces during cleaning operations. Remove all previously applied coating that is no longer adhering to the concrete or that is peeling, flaking or delaminating. Ensure that after the pressure wash cleaning and the removal of non-adherent coating, that the cleaned surfaces are free of efflorescence, grime, mold, mildew, oil or any other contaminants that might prevent proper adhesion of the new coating. After cleaning has been successfully completed, apply Class 5 Applied Finish Coating in accordance with 400-15.2.6 or as otherwise specified in the Plans.

400-20 Approach Slabs.

Construct approach slabs at the bridge ends in accordance with the applicable requirements of Section 350 using Class II (Bridge Deck) concrete. Place the reinforcement as specified in 350-7 and Section 415.

The approach slab may be opened to traffic, vehicular or construction equipment, 14 days after concrete placement or after the prescribed curing period has elapsed and the concrete has attained the required 28 day cylinder strength.

400-21 Disposition of Cracked Concrete.

400-21.1 General: The disposition of cracked concrete is described in this Article and applies to all cast-in-place concrete members, and once installed, to the precast and prestressed concrete members that are produced in accordance with 410, 450, 521, 534, 548 and 641.

400-21.2 Investigation, Documentation and Monitoring: The Engineer will inspect concrete surfaces as soon as surfaces are fully visible after casting, with the exception of surfaces of precast concrete products produced in offsite plants, between 7 and 31 days after the component has been burdened with full dead load, and a minimum of 7 days after the bridge has been opened to full unrestricted traffic. The Engineer will measure the width, length and depth of each crack and establish the precise location of the crack termination points relative to permanent reference points on the member. The Engineer will determine if coring of the concrete is necessary when an accurate measurement of crack depth cannot be determined by use of a mechanical probe. The Engineer will monitor and document the growth of individual cracks at an inspection interval determined by the Engineer to determine if cracks are active or dormant after initial inspection. The Engineer will perform all final bridge deck crack measurements once the deck is free of all debris and before transverse grooves are cut and after planing is complete for decks that require planing.

Provide the access, equipment and personnel needed for the Engineer to safely perform this work at no expense to the Department. Core cracks for use by the Engineer in locations and to depths specified by the Engineer at no expense to the Department.

400-21.3 Classification of Cracks: The Engineer will classify cracks as either nonstructural or structural and determine the cause. In general, nonstructural cracks are cracks 1/2 inch or less deep from the surface of the concrete; however, the Engineer may determine that a crack greater than 1/2 inch deep is nonstructural. In general, structural cracks are cracks that extend deeper than 1/2 inch. A crack that is fully or partially underwater at any time during its service life will be classified as a structural crack unless the Environment note on the General Notes sheet in the plans categorizes the substructure as slightly aggressive, in which case, the nonstructural crack criteria may apply as determined by the Engineer.

Review and comment on the Engineer's crack classification; however, the Engineer will make the final determination.

400-21.4 Nonstructural Cracking Significance: The Engineer will determine the Cracking Significance. The Cracking Significance will be determined on the basis of total crack surface area as a percentage of total concrete surface area. Cracking significance will be categorized as Isolated, Occasional, Moderate or Severe according to the criteria in Tables 1 and 2. Cracking Significance will be determined on a LOT by LOT basis. A LOT will typically be made up of not more than 100 square feet and not less than 25 square feet of concrete surface area for structures other than bridge decks or typically not more than 400 square feet or not less than 100 square feet for bridge decks. A LOT will not extend beyond a single Elevation Range as shown in Table 1 or 2.

Review and comment on the Engineer's determination of Cracking Significance; however, the Engineer will make the final determination.

400-21.5 Repair Method: Repair or remove and replace cracked concrete as directed by the Engineer. Additional compensation or a time extension will not be approved for repair or removal and replacement of cracked concrete when the Engineer determines the cause to be the responsibility of the Contractor.

400-21.5.1 Nonstructural Cracks: Repair each crack using the method as determined by the Engineer for each LOT in accordance with Table 1 or 2. When further investigation is required to determine repair or rejection, either remove and replace the cracked concrete or provide a structural evaluation signed and sealed by the Contractor's Engineer of Record that includes recommended repair methods and a determination of structural capacity and durability to the Engineer. Upon approval by the Engineer, repair the cracked concrete. Upon approval by the Engineer use epoxy injection in accordance with Section 411 to repair cracks in a member inside a dry cofferdam prior to flooding of the cofferdam. "Reject and Replace" in Table 1 or 2 means there is no acceptable repair method.

400-21.5.2 Structural Cracks: Provide a structural evaluation signed and sealed by the Contractor's Engineer of Record that includes recommended repair methods and a determination of structural capacity and durability to the Engineer. Upon approval by the Engineer, repair the cracked concrete. Complete all repairs to cracks in a member inside a cofferdam prior to flooding the cofferdam.

Table 1
DISPOSITION OF CRACKED CONCRETE OTHER THAN BRIDGE DECKS
[see separate Key of Abbreviations and Footnotes for Tables 1 and 2]

Elev. Range	Crack Width Range (inch) [2] x = crack width	Cracking Significance Range per LOT [1]											
		Isolated Less than 0.005%			Occasional 0.005% to<0.017%			Moderate 0.017% to<0.029%			Severe 0.029% or gtr.		
		Environment Category											
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Elevation: 0 to 6 ft AMHW	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)				
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	EI (3)	EI (3)	PS (6)					
	0.008< x ≤ 0.012	NT	PS (6)	EI									
	0.012< x ≤ 0.016	PS (6)	Investigate to Determine Appropriate Repair [4, 5] or Rejection										
	0.016< x ≤ 0.020												
	0.020< x ≤ 0.024									Reject and Replace			
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: More Than 6 ft to 12 ft AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	PS (6)	EI (3)	PS (6)	EI (3)				
	0.008< x ≤ 0.012	NT	PS (6)	EI	EI	EI							
	0.012< x ≤ 0.016	PS (6)	EI	EI	EI								
	0.016< x ≤ 0.020	EI											
	0.020< x ≤ 0.024		Investigate to Determine Appropriate Repair [4, 5] or Rejection							Reject and Replace			
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: Over Land or More Than 12 ft	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	NT	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	0.004< x ≤ 0.008	NT	PS (6)	PS (6)	PS (6)	PS (6)	EI (3)	PS (6)	EI (3)	EI (3)	PS (6)		
	0.008< x ≤	NT	PS	EI	EI	EI	EI	EI	EI				

	0.012		(6)										
	0.012< x ≤ 0.016	PS (6)	EI	EI	EI	EI	EI						
	0.016< x ≤ 0.020	EI	EI	EI	EI								
	0.020< x ≤ 0.024	EI	Investigate to Determine Appropriate Repair (4, 5) or Rejection										
	0.024< x ≤ 0.028										Reject and Replace		
	x > 0.028												

Table 2
DISPOSITION OF CRACKED CONCRETE BRIDGE DECKS
[see separate Key of Abbreviations and Footnotes for Tables 1 and 2]

Elev. Range	Crack Width Range (inch) [2] x = crack width	Cracking Significance Range per LOT [1]											
		Isolated less than 0.005%			Occasional 0.005% to<0.017%			Moderate 0.017% to<0.029%			Severe 0.029% or gtr.		
		Environment Category											
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Elevation: 12 feet or Less AMHW	x ≤ 0.004	NT	NT	NT	NT	NT	NT	NT	NT	NT			
	0.004< x ≤ 0.008	NT	NT	EI/M	NT	NT	EI/M	EI/M	EI/M	EI/M			
	0.008< x ≤ 0.012	NT	NT	EI/M	NT	EI/M	EI/M	EI/M	EI/M				
	0.012< x ≤ 0.016	NT	NT	EI/M	NT	EI/M							
	0.016< x ≤ 0.020	EI/M	EI/M	EI	EI								
	0.020< x ≤ 0.024	EI/M	EI	EI		Investigate to Determine Appropriate Repair [4, 5] or Rejection					Reject and Replace		
	0.024< x ≤ 0.028	EI/M	EI										
	x > 0.028												
Elevation: Over Land or More Than 12 feet AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	NT	NT	NT	NT	NT	NT	NT			
	0.004< x ≤ 0.008	NT	NT	NT	NT	NT	EI/M	NT	EI/M	EI/M			
	0.008< x ≤ 0.012	NT	NT	EI/M	NT	NT	EI/M	EI/M	EI/M				
	0.012< x ≤ 0.016	NT	NT	EI/M	NT	EI/M							
	0.016< x ≤ 0.020	NT	EI/M	EI	EI/M								
	0.020< x ≤ 0.024	NT	EI/M	EI		Investigate to Determine Appropriate Repair [4, 5] or Rejection					Reject and Replace		
	0.024< x ≤ 0.028	NT	EI/M										
	x > 0.028												

Key of Abbreviations and Footnotes for Tables 1 and 2		
Type Abbreviation	Abbreviation	Definition
Repair Method	EI	Epoxy Injection
	M	Methacrylate
	NT	No Treatment Required
	PS	Penetrant Sealer
Environment Category	EA	Extremely Aggressive
	MA	Moderately Aggressive
	SA	Slightly Aggressive
Reference Elevation	AMHW	Above Mean High Water

Footnotes

(1) Cracking Significance Range is determined by computing the ratio of Total Cracked Surface Area (TCSA) to Total Surface Area (TSA) per LOT in percent [(TCSA/TSA) x 100] then by identifying the Cracking Significance Range in which that value falls. TCSA is the sum of the surface areas of the individual cracks in the LOT. The surface area of an individual crack is determined by taking width measurements of the crack at 3 representative locations and then computing their average which is then multiplied by the crack length.

(2) Crack Width Range is determined by computing the width of an individual crack as computed in (1) above and then identifying the range in which that individual crack width falls.

(3) When the Engineer determines that a crack in the 0.004 inch to 0.008 inch width range cannot be injected then for Table 1 use penetrant sealer unless the surface is horizontal, in which case, use methacrylate if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

(4) (a) Perform epoxy injection of cracks in accordance with Section 411. Seal cracks with penetrant sealer or methacrylate as per Section 413. (b) Use only methacrylate or penetrant sealer that is compatible, according to manufacturer's recommendations, with previously applied materials such as curing compound or paint or remove such materials prior to application.

(5) When possible, prior to final acceptance of the project, seal cracks only after it has been determined that no additional growth will occur.

(6) Methacrylate shall be used on horizontal surfaces in lieu of penetrant sealer if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

(7) Unless directed otherwise by the Engineer, repair cracks in bridge decks only after the grinding and grooving required by 400-15.2.5 is fully complete.

400-22 Method of Measurement.

400-22.1 General: The quantities of concrete to be paid for will be the volume, in cubic yards, of each of the various classes shown in the plans, in place, completed and accepted. The quantity of precast anchor beams to be paid for will be the number in place and accepted. The quantity of bridge deck grooving to be paid for will be the area, in square yards of bridge deck and approach slab, completed and accepted. The quantity of bridge deck grooving and planing to be paid for will be the area, in square yards of bridge deck and approach slab, completed and accepted.

Except for precast anchor beams, for any item of work constructed under this Section and for which measurement for payment is not to be made by the volume of concrete, measurement and payment for such work will be as specified in the Section under which the work is specified in detail.

No separate payment will be made for obtaining the required concrete finish.

400-22.2 Calculation of Volume of Concrete:

400-22.2.1 Dimensions: The quantity will be computed by the plan dimensions of the concrete, within the neat lines shown in the plans, except that no deduction will be made for weep holes, deck drains, or encroachment of inlets and pipes in box culverts, and no chamfers, scorings, fillets, or radii 1 1/2 in^2 or less in cross-sectional area will be taken into account.

400-22.2.2 Pay Quantity: The quantity to be paid for will be the original plan quantity, measured as provided in 400-22.2.1, except that where the plans call for an estimated quantity of miscellaneous concrete for contingent use, the contingent concrete will be measured as the actual quantity in place and accepted.

400-22.2.3 Items not Included in Measurement for Payment: No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, expansion-joint material, etc. The volume of all materials embedded in the concrete, such as structural steel, pile heads, etc., except reinforcing steel, will be deducted when computing the volume of concrete to be paid for. For each foot of timber pile embedded, 0.8 ft^3 of concrete will be deducted. The cost of furnishing and placing dowel bars shall be included in the Contract unit price for the concrete.

400-22.2.4 Deck Girders and Beam Spans: In computing the volume of concrete in deck girders and beam spans, the thickness of the slab will be taken as the nominal thickness shown on the drawings and the width will be taken as the horizontal distance measured across the roadway. The volume of haunches over beams will be included in the volume to be paid for.

400-22.2.5 Stay-in-Place Metal Forms: When using stay-in-place metal forms to form the slab of deck girder and beam spans, the volume of concrete will be computed in accordance with the provisions of 400-20.2.4 except that the thickness of the slab over the projected plan area of the stay-in-place metal forms will be taken as the thickness shown on the drawings above the top surface of the forms. The concrete required to fill the form flutes will not be included in the volume of concrete thus computed.

400-22.3 Bridge Deck Grooving: The quantity to be paid for will be plan quantity in square yards, computed, using the area bound by the gutter lines (at barrier rails, curbs and median dividers) and the beginning and end of the bridge or the end of approach slabs, whichever is applicable, constructed, in place and accepted.

400-22.4 Bridge Deck Grooving and Planing: The quantity to be paid for will be plan quantity in square yards, computed, using the area bound by the gutter lines (at barrier rails, curbs and median dividers) and the beginning and end of the bridge or the end of approach slabs, whichever is applicable, constructed, in place and accepted.

400-22.5 Composite Neoprene Pads: The quantity to be paid for will be the original plan quantity, computed using the dimensions of the pads shown in the plans.

400-22.6 Cleaning and Coating Concrete Surfaces: The quantity to be paid for will be the plan quantity in square feet for the areas shown in the plans.

400-23 Basis of Payment.

400-23.1 Concrete:

400-23.1.1 General: Price and payment will be full compensation for each of the various classes of concrete shown in the proposal.

400-23.1.2 Concrete Placed below Plan Depth: Authorized concrete placed in seal or footings 5 feet or less below the elevation of bottom of seal or footing as shown in the plans will be paid for at the Contract price set forth in the proposal under the pay items for substructure concrete.

Authorized concrete used in seal (or in the substructure where no seal is used) at a depth greater than 5 feet below the bottom of seal or footing as shown in the plans will be paid for as Unforeseeable Work.

Such payment will be full compensation for the cofferdam construction, for excavation, and for all other expenses caused by the lowering of the footings.

400-23.1.3 Seal Concrete Required but Not Shown in Plans: When seal concrete is required as provided in 400-8 and there is no seal concrete shown in the plans, it will be paid for as Unforeseeable Work.

400-23.2 Precast Anchor Beams: Price and payment will be full compensation for the beams, including all reinforcing steel and materials necessary to complete the beams in place and accepted.

No separate prices will be allowed for the various types of anchor beams.

400-23.3 Reinforcing Steel: Reinforcing steel will be measured and paid for as provided in Section 415, except that no separate payment will be made for the fabric reinforcement used in concrete jackets on steel piles or reinforcement contained in barriers, traffic separators or parapets. Where so indicated in the plans, the Department will not separately pay for reinforcing steel used in incidental concrete work, but the cost of such reinforcement shall be included in the Contract unit price for the concrete.

400-23.4 Bridge Deck Grooving: Price and payment will be full compensation for all grinding, grooving, equipment, labor, and material required to complete the work in an acceptable manner.

400-23.5 Bridge Deck Grooving and Planing: Price and payment will be full compensation for all grooving, planing, equipment, labor, and material required to complete the work in an acceptable manner.

400-23.6 Composite Neoprene Pads: Price and payment will be full compensation for all work and materials required to complete installation of the pads.

400-23.7 Cleaning and Coating Concrete Surfaces: Price and payment will be full compensation for all work and materials required. The cost of coating new concrete will not be paid for separately, but will be included in the cost of the item to which it is applied.

400-23.8 General: The above prices and payments will be full compensation for all work specified in this Section, including all forms, falsework, joints, weep holes, drains, pipes, conduits, bearing pads, setting anchor bolts and dowels, surface finish, and cleaning up, as shown in the plans or as directed. Where the plans call for water stops, include the cost of the water stops in the Contract unit price for the concrete.

Unless payment is provided under a separate item in the proposal, the above prices and payments will also include all clearing and grubbing; removal of existing structures; excavation, as provided in Section 125; and expansion joint angles and bolts.

The Department will not change the rate of payment for the various classes of concrete in which steel may be used due to the addition or reduction of reinforcing steel.

The Department will not make an allowance for cofferdams, pumping, bracing, or other materials or equipment not becoming a part of the finished structure. The Department will not pay for concrete placed outside the neat lines as shown in the plans.

When using stay-in-place metal forms to form bridge decks, the forms, concrete required to fill the form flutes, attachments, supports, shoring, accessories, and all miscellaneous items or work required to install the forms shall be included in the Contract unit price of the superstructure concrete.

400-23.9 Payment Items:

Payment will be made under:

Item No. 400- 0- Class NS Concrete – per cubic yard.

Item No. 400- 1-	Class I Concrete - per cubic yard.
Item No. 400- 2-	Class II Concrete - per cubic yard.
Item No. 400- 3-	Class III Concrete - per cubic yard.
Item No. 400- 4-	Class IV Concrete - per cubic yard.
Item No. 400- 6-	Precast Anchor Beams - each.
Item No. 400- 7-	Bridge Deck Grooving - per square yard.
Item No. 400- 9-	Bridge Deck Grooving and Planing - per square yard.
Item No. 400-143-	Cleaning and Coating Concrete Surfaces - per square foot.
Item No. 400-147-	Composite Neoprene Pads - per cubic foot.

415 REINFORCING STEEL.
(REV 11-5-12) (FA 11-19-12) (7-13)

SUBARTICLE 415-5.1 (Page 421) is deleted and the following substituted:

415-5.1 General: When tolerances for reinforcing placement and concrete cover are not otherwise specified, the tolerance for bar spacing is plus or minus 1 inch of the plan position and the tolerance for concrete cover is minus 1/4 inch or plus 1/2 inch from the plan dimensions.

416 INSTALLING ADHESIVE-BONDED ANCHORS AND DOWELS FOR STRUCTURAL APPLICATIONS.
(REV 11-1-12) (FA 11-5-12) (7-13)

SUBARTICLE 416-6.1.1 (Page 428) is deleted and the following substituted:

416-6.1.1 Adhesive-Bonded Anchors: Field test installed anchors and dowels for applications connecting traffic railings to bridge decks, approach slabs and concrete pavement using Type HSHV adhesives. The Engineer may also require field testing of installed anchors and dowels for other applications. Any field testing of installed anchors which is required by the Engineer and not quantified in the Contract Documents shall be paid for by the Department unless a failure occurs during the field testing.

Test individual anchors and dowels by proof loading in tension to 85% of the specified bond strength in accordance with Section 937 based on the nominal anchor or dowel diameter and embedment depth, but not more than 90% of the yield strength of the anchor or dowel, unless otherwise shown in the Contract Documents.

425 INLETS, MANHOLES, AND JUNCTION BOXES.
(REV 10-9-12) (1-13)

SECTION 425 (Pages 430 – 432) is deleted and the following substituted:

SECTION 425
INLETS, MANHOLES, AND JUNCTION BOXES

425-1 Description.

Construct inlets, manholes, and junction boxes from reinforced concrete as shown in the Design Standards and the plans. Brick masonry may be used if the structure is circular and constructed in place. Furnish and install the necessary metal frames and gratings. Construct yard drains from concrete meeting the requirements of Section 347. Adjust structures shown in the plans to be adjusted or requiring adjustment for the satisfactory completion of the work.

425-2 Composition and Proportioning.

425-2.1 Concrete: For inlets, manholes, and junction boxes, use Class II or IV concrete, as designated in the plans and Design Standards and as specified in Section 346. For yard drains use concrete as specified in Section 347.

425-2.2 Mortar: For brick masonry, make the mortar by mixing one part portland cement to three parts sand. Miami Oolitic rock screenings may be substituted for the sand, provided the screenings meet the requirements of 902-5.2.3 except for gradation requirements. Use materials passing the No. 8 sieve that are uniformly graded from coarse to fine.

Masonry cement may be used in lieu of the above-specified mortar provided it is delivered in packages properly identified by brand name of manufacturer, net weight of package, and whether it is Type 1 or Type 2, and further provided that it has not been in storage for a period greater than six months.

425-3 Materials.

425-3.1 General: Meet the following requirements:

Sand (for mortar)	902-3.2
Portland Cement	Section 921
Water	Section 923
Reinforcing Steel	931-1.1 and 415-3
Brick and Concrete Masonry Units	Section 949
Castings for Frames and Gratings	962

425-3.2 Gratings, Covers, and Frames: Use gratings and frames fabricated from structural steel or cast iron as designated in the appropriate Design Standard. When “Alt. G” grates are specified in the plans, provide structural steel grates that are galvanized in accordance with the requirements of ASTM A-123.

Use rigid frames and covers either 24 inches or 36 inches or optional three-piece adjustable frames and covers as indicated in Design Standards Index No. 201.

For three-piece adjustable frames, the inner frame may include replaceable resilient seats to support the cover. In addition, the inner frame shall indicate it is adjustable, by clearly having the word “adjustable” imprinted into the exposed portion of the inner frame so ”adjustable” is visible from the roadway after installation.

425-4 Forms.

Design and construct wood or metal forms so that they may be removed without damaging the concrete. Build forms true to line and grade and brace them in a substantial and unyielding manner. Obtain the Engineer's approval before filling them with concrete.

425-5 Precast Inlets, Manholes, and Junction Boxes.

Precast inlets, manholes and junction boxes, designed and fabricated in accordance with the plans, the Design Standards and Section 449 may be substituted for cast-in-place units.

425-6 Construction Methods.

425-6.1 Excavation: Excavate as specified in Section 125.

Where unsuitable material for foundations is encountered, excavate the unsuitable material and backfill with suitable material prior to constructing or setting inlets, manholes and junction boxes.

As an option to the above and with the Engineer's approval, the Contractor may carry the walls down to a depth required for a satisfactory foundation, backfill to 8 inches below the flowline with clean sand and cast a non-reinforced 8 inch floor.

425-6.2 Placing and Curing Concrete: Place the concrete in the forms, to the depth shown in the plans, and thoroughly vibrate it. After the concrete has hardened sufficiently, cover it with suitable material and keep it moist for a period of three days. Finish the traffic surface in accordance with 522-7.2, or with a simulated broom finish approved by the Engineer.

425-6.3 Setting Manhole Castings: After curing the concrete as specified above, set the frame of the casting in a full mortar bed composed of one part portland cement to two parts of fine aggregate.

425-6.3.1 Standard Castings: Set manhole frames in a mortar bed and adjust to grade using brick or concrete grade rings, with a maximum 12 inch adjustment.

425-6.3.2 Optional Adjustable Castings: When using a three-piece adjustable frame and cover, install the frame and cover with brick or concrete grade rings to the base course height. Make adjustments using the inner frame in accordance with the manufacturer's installation recommendations so the inner frame and cover meet the grade and slope of the pavement surface opened to traffic.

425-6.4 Reinforcing Steel: Follow the construction methods for the steel reinforcement as specified in Section 415.

425-6.5 Laying Brick: Saturate all brick with water before laying. Bond the brick thoroughly into the mortar using the shovejoint method to lay the brick. Arrange headers and stretchers so as to bond the mass thoroughly. Finish the joints properly as the work progresses and ensure that they are not less than 1/4 inch or more than 3/4 inch in thickness. Do not use spalls or bats except for shaping around irregular openings or when unavoidable at corners.

425-6.6 Backfilling: Backfill as specified in Section 125, meeting the specific requirements for backfilling and compaction around inlets, manholes, and junction boxes detailed in 125-8.1 and 125-8.2. However, for outfall lines beyond the sidewalk or future sidewalk area, where no vehicular traffic will pass over the pipe, inlets, manholes, and junction boxes, compact backfill as required in 125-9.2.2.

425-6.7 Adjusting Structures: Cut down or extend existing manholes, catch basins, inlets, valve boxes, etc., within the limits of the proposed work, to meet the finished grade of the proposed pavement, or if outside of the proposed pavement area, to the finished grade designated

on the plans for such structures. Use materials and construction methods which meet the requirements specified above to cut down or extend the existing structures.

The Contractor may extend manholes needing to be raised using adjustable extension rings of the type which do not require the removal of the existing manhole frame. Use an extension device that provides positive locking action and permits adjustment in height as well as diameter and meets the approval of the Engineer. When adjusting structures in flexible pavement, restore final road surface in accordance with Standard Index No. 307.

425-7 Method of Measurement.

The quantities to be paid for will be (1) the number of inlets, manholes, junction boxes, and yard drains, completed and accepted; and (2) the number of structures of these types (including also valve boxes) satisfactorily adjusted.

425-8 Basis of Payment.

425-8.1 New Structures: Price and payment will be full compensation for furnishing all materials and completing all work described herein or shown in the plans, including all clearing and grubbing outside the limits of clearing and grubbing as shown in the plans, all excavation except the volume included in the measurement designated to be paid for under the items for the grading work on the project, all backfilling around the structures, the disposal of surplus material, and the furnishing and placing of all gratings, frames, covers, and any other necessary fittings.

425-8.2 Adjusted Structures: When an item of payment for adjusting manholes, valve boxes, or inlets is provided in the proposal, price and payment will be full compensation for the number of such structures designated to be paid for under such separate items, and which are satisfactorily adjusted, at the Contract unit prices each for Adjusting Inlets, Adjusting Manholes, and Adjusting Valve Boxes.

For any of such types of these structures required to be adjusted but for which no separate item of payment is shown in the proposal for the specific type, payment will be made under the item of Adjusting Miscellaneous Structures.

425-8.3 Payment Items: Payment will be made under:

Item No.	425- 1-	Inlets - each.
Item No.	425- 2-	Manholes - each.
Item No.	425- 3-	Junction Boxes - each.
Item No.	425- 4-	Adjusting Inlets - each.
Item No.	425- 5-	Adjusting Manholes - each.
Item No.	425- 6-	Adjusting Valve Boxes - each.
Item No.	425- 8-	Adjusting Miscellaneous Structures - each.
Item No.	425- 10-	Yard Drains - each.

430 PIPE CULVERTS.

(REV 2-4-13) (FA 2-11-13) (7-13)

ARTICLE 430-1 (Page 433) is deleted and the following substituted:

430-1 Description.

Furnish and install drainage pipe and end sections at the locations called for in the Plans. Furnish and construct joints and connections to existing pipes, catch basins, inlets, manholes, walls, etc., as may be required to complete the work.

Construct structural plate pipe culverts or underdrains in accordance with Sections 435 and 440.

For pipe culverts installed by jack & bore, install in accordance with Section 556.

Obtain pipe culverts from a Producer currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

When the producer's Quality Control Program is suspended, accept responsibility of either obtaining drainage products from another producer with an accepted Quality Control Program or await re-approval of the producer's Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the producer's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the producer's Quality Control Program suspension.

SUBARTICLE 430-2.1 (Page 433) is deleted and the following substituted:

430-2.1 Pipe: Meet the following requirements:

Concrete Pipe .....Section 449
Round Rubber Gaskets .....Section 942
Corrugated Steel Pipe and Pipe Arch .....Section 943
Corrugated Aluminum Pipe and Pipe Arch .....Section 945
Corrugated Polyethylene Pipe .....Section 948
Polyvinyl Chloride (PVC) Pipe .....Section 948
Fiberglass Reinforced Polymer Pipe …….Section 948
Polypropylene Pipe …….....Section 948

SUBARTICLE 430-3.2 (Page 433) is deleted and the following substituted:

430-3.2 Side Drain: If the Plans do not designate a type (or types) of pipe, the Contractor may use either a minimum Class I concrete pipe, corrugated steel pipe, corrugated aluminum pipe, corrugated polyethylene pipe, polypropylene pipe, or PVC pipe. If one of the metal types is chosen, use the minimum gage specified in Section 943 for steel pipe or Section 945 for aluminum pipe. When extending existing pipes, construct the pipe extensions of the same size and kind as the existing pipe. Extensions of existing pipes, whose materials are no longer produced, shall be extended with the most similar pipe material available.

Non-reinforced concrete pipe may also be substituted for concrete pipe in side drains, subject to the provisions of 430-3.1.

SUBARTICLE 430-4.1 (Page 434) is deleted and the following substituted:

430-4.1 General: Lay all pipe, true to the lines and grades given, with hubs upgrade and tongue end fully entered into the hub. When pipe with quadrant reinforcement or circular pipe

with elliptical reinforcement is used, install the pipe in a position such that the manufacturer's marks designating "top" and "bottom" of the pipe are not more than five degrees from the vertical plane through the longitudinal axis of the pipe. Do not allow departure from and return to plan alignment and grade to exceed 1/16 inch per foot of nominal pipe length, with a total of not more than 1 inch departure from theoretical line and grade. Take up and relay any pipe that is not in true alignment or which shows any settlement after laying at no additional expense to the Department.

Do not use concrete pipe with lift holes except (1) round pipe which has an inside diameter in excess of 54 inches or (2) any elliptical pipe.

Repair lift holes, if present, with hand-placed, stiff, non-shrink, 1-to-1 mortar of cement and fine sand, after first washing out the hole with water. Completely fill the void created by the lift hole with mortar. Cover the repaired area with a 24 by 24 inch piece of filter fabric secured to the pipe. Use a Type D-3 filter fabric meeting the requirements shown on Design Standards, Index No. 199.

Secure the filter fabric to the pipe using a method that holds the fabric in place until the backfill is placed and compacted. Use grout mixtures, mastics, or strapping devices to secure the fabric to the pipe.

When installing pipes in structures, construct inlet and outlet pipes of the same size and kind as the connecting pipe shown in the Plans. Use the same pipe material within each continuous run of pipe. Extend the pipes through the walls for a distance beyond the outside surface sufficient for the intended connections, and construct the concrete around them neatly to prevent leakage along their outer surface as shown on Design Standards, Index No. 201. Keep the inlet and outlet pipes flush with the inside of the wall. Resilient connectors as specified in 942-3 may be used in lieu of a masonry seal.

Furnish and install a filter fabric jacket around all pipe joints and the joint between the pipe and the structure in accordance with Design Standards, Index Nos. 201 and 280. Use fabric meeting the physical requirements of Type D-3 specified on Design Standards, Index No. 199. Extend the fabric a minimum of 12 inches beyond each side of the joint or both edges of the coupling band, if a coupling band is used. The fabric must have a minimum width of 24 inches, and a length sufficient to provide a minimum overlap of 24 inches. Secure the filter fabric jacket against the outside of the pipe by metal or plastic strapping or by other methods approved by the Engineer.

Meet the following minimum joint standards:

Pipe Application	Minimum Standard
Storm and Cross Drains	Water-tight
Gutter Drain	Water-tight
Side Drains	Soil-tight

When rubber gaskets are to be installed in the pipe joint, the gasket must be the sole element relied on to maintain a tight joint. Soil tight joints must be watertight to 2 psi. Water-tight joints must be water-tight to 5 psi unless a higher pressure rating is required in the Plans.

SUBARTICLE 430-4.6 (Page 435) is deleted and the following substituted:

430-4.6 End Treatment: Place an end treatment at each storm and cross drain, and side drain as shown in the Plans. Refer to the Design Standards for types of end treatment details. As an exception to the above, when concrete mitered end sections are permitted, the Contractor may use reinforced concrete U-endwalls, if shop drawings are submitted to the Engineer for approval prior to use.

Provide end treatments for corrugated polyethylene pipe, polypropylene pipe, and PVC pipe as specified in Section 948, or as detailed in the Plans.

ARTICLE 430-9 (Page 441) is deleted and the following substituted:

430-9 Specific Requirements for Corrugated Polyethylene Pipe, Polypropylene Pipe, and Polyvinyl Chloride (PVC) Pipe.

430-9.1 Field Joints: Use gasketed joints to seal side drain, and storm and cross drain. Use gaskets meeting the requirements of Section 449. Ensure that the pipe manufacturer provides a joint design approved by the Engineer before use.

430-9.2 Installation Requirements Including Trenching, Foundation and Backfilling Operations: Check structure shape regularly during backfilling to verify acceptability of the construction method used.

Replace pipe deflected 5% or more of the certified actual mean diameter of the pipe at final inspection at no cost to the Department.

ARTICLE 430-11 (Pages 441 – 442) is deleted and the following substituted:

430-11 Method of Measurement.

430-11.1 New Pipe Installed by Excavation or Trenching: The quantity of storm and cross drain pipe, storm drain trench, side drain and gutter drain pipe, installed by pipe culvert optional material - excavation or trenching, to be paid for will be plan quantity, in place and accepted. The plan quantity will be determined from the inside wall of the structure as shown in the Plans, along the centerline of the pipe.

430-11.2 New Pipe Installed by Jack & Bore: The quantity of storm and cross drain pipe, storm drain trench, side drain and gutter drain pipe ,installed by pipe culvert optional material - jack & bore, to be paid for will be the plan quantity, in place and accepted. The measurement and payment will be the plan quantity length of the casing or carrier pipe installed by jack & bore.

Carrier pipe installed through/inside the casing is paid for as pipe culvert optional material – excavation or trenching.

430-11.3 Mitered End Section: The quantity of mitered end sections to be paid for will be the number completed and accepted.

ARTICLE 430-12 (Pages 442 – 443) is deleted and the following substituted:

430-12 Basis of Payment.

430-12.1 General: Prices and payments will be full compensation for all work specified in this Section, including all excavation except the volume included in the items for the grading work on the project, and except for other items specified for separate payment in Section 125; all backfilling material and compaction; disposal of surplus material; and all clearing and grubbing outside of the required limits of clearing and grubbing as shown in the Plans.

No payment will be made for failed bore paths, injection of excavatable flowable fill, products taken out of service, or incomplete installations. Payment will include all work and materials necessary for jack & bore, including boring, backfilling, flowable fill, and restoration materials necessary for a complete and accepted installation.

No payment will be made for jack & bore until a Bore Path Report has been delivered to the Engineer.

430-12.2 Removing Existing Pipe: When existing pipe is removed and replaced with new pipe approximately at the same location, the cost of excavating and removing the old pipe and of its disposal will be included in the Contract unit price for clearing and grubbing.

430-12.3 Site Restoration: The cost of restoring the site, as specified in 125-11, that is disturbed, solely for the purpose of constructing pipe culvert, will be included in the Contract unit price for the pipe culvert, unless designated specifically to be paid for under other items.

430-12.4 Plugging Pipes: The cost of temporarily plugging a pipe culvert, either proposed or existing, will be incidental to the contract unit price for new pipe culvert.

The cost of filling and/or plugging an existing pipe culvert that is to be permanently placed out of service will be paid for at the contract unit price for filling and plugging pipe, per cubic yard. Price and payment will be full compensation for flowable fill, masonry, concrete, mortar, and all labor and materials necessary to complete the work.

When the project includes no quantities for new pipe culverts, and temporary plugs are required for existing pipe culverts, the cost will be considered as extra work, in accordance with 4-3.5.

430-12.5 Desilting Pipe: Desilting Pipe will be paid for at the contract unit price per foot for each pipe desilted. Price and payment will be full compensation for furnishing all equipment, tools and labor, disposal of silt and debris, and all incidentals necessary for satisfactorily performing the work.

430-12.6 Desilting Concrete Box Culverts: Price and payment will be full compensation for all work required.

430-12.7 Flared End Sections: Price and payment will be full compensation for all work and materials required.

430-12.8 Mitered End Sections: Price and payment will be full compensation for all pipe, grates when required, fasteners, reinforcing, connectors, anchors, concrete, sealants, jackets and coupling bands, and all work required.

430-12.9 Railroad Requirements: Where pipe culvert is constructed under railroad tracks, the Contract unit price for the pipe culvert will include the costs of any jacking operations and the operation of placing the pipe by use of a tunnel liner, (except as specified for unanticipated tunnel liner, in 430-6.5, where reimbursement is to be made for such unanticipated liner), and all other work necessary to meet the requirements of the railroad company, excluding the costs of watchman or flagman services provided by the railroad company, except as provided below.

The Department will reimburse the Contractor for the actual costs of any trestle bridge work which is performed by the railroad's forces, as billed to him by the railroad, less the

value of any salvage materials derived there from, whether such salvage materials are retained by the railroad company or by the Contractor. When the work of shoring and bracing is to be performed by the railroad, such fact will be stipulated in the Contract Documents and the Contractor will be required to pay to the railroad the amount of such costs, which amount will be reimbursed to him by the Department. The Contract unit price for the pipe culvert shall include the costs of all other work of shoring and bracing.

430-12.10 Payment Items: Payment will be made under:

Item No.	430- 17-	Pipe Culvert Optional Material – Excavation or Trenching - per foot.
Item No.	430- 18-	Pipe Culvert Optional Material - Jack & Bore – per foot.
Item No.	430- 94-	Desilting Pipe – per foot.
Item No.	430- 96-	Polyvinyl Chloride Pipe - per foot.
Item No.	430- 98-	Mitered End Section - each.
Item No.	430-200-	Flared End Sections - each.
Item No.	430-610-	U-Endwall - each.
Item No.	430-830-	Filling and Plugging Pipe – cubic yard.
Item No.	430-950-	Desilting Concrete Box Culvert – per cubic yard.

431 PIPE LINER.

(REV 9-13-12) (FA 11-5-12) (7-13)

ARTICLE 431-7 (Page 445) is deleted and the following substituted:

431-7 Basis of Payment.

Price and payment for pipe liner will be full compensation for furnishing and installing the pipe liner in accordance with the requirements of this Section, including all materials, labor and incidentals required for sealing cracks and joints in the existing pipe, and sealing and grouting the annular space between the liner and interior of the host pipe.

Price and payment for pipe liner will also be full compensation for all equipment, materials and labor required for inspections, and for furnishing videos of the inspections to the Engineer.

Price and payment for flowable fill will be in accordance with Section 121.

Price and payment for desilting pipe will be in accordance with Section 430.

Payment will be made under:

Item No.	431- 1-	Pipe Liner - per foot.

450 PRECAST PRESTRESSED CONCRETE CONSTRUCTION.

(REV 9-26-12) (FA 10-26-12) (7-13)

SUBARTICLE 450-10.5.2 (Page 473) is deleted and the following substituted:

450-10.5.2 Beams: Rough float the top surface of the beam and then scrub it transversely with a coarse brush or metal tine to produce a roughened surface for bonding. For

the other external surfaces of prestressed beams, unless otherwise specified, apply a general surface finish in accordance with 400-15.1. Remove mortar leakage and stains to produce beams with a uniform appearance.

SUBARTICLE 450-10.5.4 (Page 473) is deleted and the following substituted:

450-10.5.4 Slabs and Double-T Beams: When the Plans show the top surface of prestress slab or double-T beams units to be the riding surface, apply a Class 4 floor finish in accordance with Section 400. When the Plans show the surface to be overlaid with asphalt or concrete, rough float the top surface and then scrub it transversely with a coarse brush to remove all laitance and to produce a roughened surface for bonding. For the other external surfaces of slabs and double-T beams, unless otherwise specified, apply a general surface finish in accordance with 400-15.1.

458 BRIDGE DECK JOINTS.
(REV 9-27-12) (FA 12-4-12) (7-13)

SUBARTICLE 458-5.1 (Page 596) is deleted and replaced with the following:

458-5.1 Basic Items of Joints. The Contract unit price per foot for joints will be full compensation for all work and materials necessary for the complete installation. Such price and payment will include, but not be limited to, the following specific incidental work:

(a) Any work required to clean and prepare the adjacent bridge deck, deck block out or deck joint gap.

(b) Any repairs to the galvanizing on metallic joint components.

(c) Any additional work or materials required for non-standardized or special construction or installation techniques.

(d) Any cost of erection and removal of any temporary supports which may be necessary for ensuring proper alignment and positioning of the joint relative to the bridge deck.

(e) Any sidewalk cover plates required.

461 MULTIROTATIONAL BEARINGS
(REV 10-25-12) (FA 10-31-12) (7-13)

ARTICLE 461-5 (Page 629) is deleted and the following substituted:

461-5 Construction.

Store multirotational bearings delivered to the bridge site under cover on a platform above the ground surface. Protect bearings at all times from damage and ensure they are clean, dry and free from dirt, oil, grease or other foreign substances before placement. Install the bearings in accordance with the recommendations of the manufacturer, contract drawings, and as may be directed by the Engineer. If there is any discrepancy between the recommendations of the

manufacturer, these Specifications, and Contract drawings, the Engineer will be the sole judge in reconciling any such discrepancy.

Obtain the services of a qualified technical representative, employed by the manufacturer of the bearings, to supervise the first installation of each type of bearing (expansion pot, fixed pot, expansion disc, fixed disc or other type as defined by the Engineer) but for only one size of each type. Submit to the Engineer a certified statement from the manufacturer that its representative has the necessary technical experience and knowledge to supervise bearing installations and to train Contractor personnel about proper bearing installation procedures and methods. Do not install the bearings before the Engineer receives the certification and the representative is on the job site. Assume this responsibility at no further expense to the Department.

470 TIMBER STRUCTURES.
(REV 11-13-12) (FA 2-1-13) (7-13)

SUBARTICLE 470-12.2 (Page 652) is deleted and the following substituted:

470-12.2 CCA, ACQ-D, and CA-C, Treated Timber Structures: Use the fasteners and connectors as described in the following table:

TABLE – HARDWARE REQUIREMENTS FOR TREATED TIMBER		
Environmental condition where structure will be located	Fasteners	Connectors
Permanent wood foundations and/or where salt spray if prevalent	304 or 316 Stainless Steel	04 or 316 Stainless Steel
Structures that will be exposed to standing water or rainwater	304 or 316 Stainless Steel	304 or 316 Stainless Steel
Structures that will be situated indoors and remain dry in service	304 or 316 Stainless Steel Hot-dipped galvanized fasteners meeting ASTM A-153 requirements	304 or 316 Stainless Steel Hot-dipped galvanized connectors meeting the requirements of ASTM A-653 Class G185 sheet or better
Do not use aluminum in direct contact with treated wood.		

471 POLYMERIC FENDER SYSTEMS.
(REV 11-26-12) (FA 2-1-13) (7-13)

SECTION 471 (Pages 654 – 655) is deleted and the following substituted:

SECTION 471
POLYMERIC FENDER SYSTEMS

471-1 Description.

Construct fender systems using components in accordance with this Section, the Plans, Design Standards and, if applicable, the Qualified Products List (QPL) drawings.

If piling configurations listed on the QPL are allowed by the Plans, at the Contractor's option, either use a QPL listed piling configuration or develop a custom design. Develop a custom design if required by the Plans. For all Contractor-developed custom designs, follow the design criteria and guidelines in the Structures Design Guidelines, Chapter 3 and applicable Structures Design Bulletins.

471-2 Materials.

Meet the following requirements:

Fiberglass fiber reinforced composite lumber (Dimensional Lumber) .....Section 973

Fiberglass structurally reinforced composite lumber (Wales)* .....Section 973

Concrete used to fill hollow piles .....Section 347

*or alternate wales as described below

471-3 Performance Criteria.

471-3.1 General: Provide a report from an independent lab as verification that the product meets the following minimum performance criteria.

471-3.2 Alternate Wales: For Contractor developed designs only, the wales must meet the following minimum performance criteria:

a) Be structurally continuous across a minimum of two spans.

b) Designed to accommodate recessing of any attachment hardware to avoid potential for vessel snagging and sparking during impact.

c) Provide sufficient creep resistance to prevent loosening of attachments over time.

d) Provide adequate stiffness to distribute vessel impact loading so as to achieve the maximum efficiency of the system where the critical design section remains within the piles.

e) For wale sections remaining hollow under service conditions, a minimum bolt pull-through resistance of 10 kips when equipped with manufacturer's detailed connection hardware at a maximum distance of 2 feet from the end of a wale with a minimum length of 4 feet is required.

f) Wale sections remaining hollow under service conditions must be capable of resisting crushing loads perpendicular to the axis of the member as required for the impact force applied to fender in the analysis used to determine the associated energy absorption capacity of the system. This impact force may be equally distributed between two lines of wales and over a longitudinal distance of 5 feet.

g) Wales shall be black unless otherwise shown in the Plans.

h) Wales must meet the minimum requirements in Section 973, Table 1 for Water Absorption, Brittleness, Impact Resistance, Ultraviolet, Abrasion, Chemical Resistance, and Static Coefficient of Friction (wet).

473-3.3 Polymeric Piles: All polymeric piles must meet the following minimum performance criteria:

a) Pile surfaces that may be exposed to contact with the impacting vessel must accommodate recessing of any attachment hardware to avoid potential for vessel snagging and sparking.

b) Provide sufficient creep resistance to prevent loosening of attachments over time.

c) For pile sections remaining hollow under service conditions, a minimum bolt pull-through and crushing resistance of 10 kips when equipped with manufacturer's detailed connection hardware at a maximum distance of 2 feet from the end of a pile with a minimum length of 4 feet is required.

d) Piles shall be black unless otherwise shown in the Plans.

471-4 Product Acceptance.

Manufacturers seeking evaluation of piling configurations for inclusion on the QPL must submit an application in accordance with Section 6.

Submit all Contractor developed custom designs to the Engineer for review and approval by the State Structures Design Office.

Design fender piling, wales and connections in accordance with the latest edition of the FDOT Structures Design Guidelines and applicable Structures Design Bulletins based on the desired energy capacity rating. Sign and seal all drawings in 11 inches x 17 inches PDF format and all design calculations by a Professional Engineer licensed in the State of Florida. Design calculations may be either by hand or by a computer program with hand calculations verifying the program output.

For evaluation of Contractor developed custom designed fender systems or piling configurations for listing on the QPL, provide the following additional information:

Written certification that the custom designed fender system or QPL piling configuration meets the requirements of this Section.

A report from an independent lab verifying the flexural properties of the piling as derived from ASTM D6109 with the following modification. Supports shall be located to provide a minimum span to depth ratio of 16:1 and a maximum span to depth ratio of 20:1.

For custom designed fender systems using wales not in accordance with Section 973, a report from an independent lab verifying the structural properties used in the design of the wales.

Detailed material specifications showing material type, quality, certifications, acceptance and rejection criteria and placement procedures.

Other information pertinent to the design and performance of the pile configuration or custom designed fender system as necessary.

471-5 Construction Details.

Unless otherwise shown in the manufacturer's approved field construction manual, use the following construction details.

Protect materials at all times against exposure to extreme heat or impact. Transport products in a manner that will minimize scratching or damage to the outer surfaces, stack on dunnage above ground so that it may be easily inspected and store in a manner that will avoid damage. Handle and lift products with nylon slings. Do not use sharp instruments in handling the product. Products damaged in shipping or handling will be rejected.

Products containing cracks in the reinforcing rods or cracks, partial or full depth, across the section or splits will be rejected.

Cut, bevel, drill, countersink and otherwise install products in accordance with the manufacturer's recommendations. Set all material accurately to required levels and lines, with members plumb and true and accurately cut and fitted. Securely attach all materials to substrate by anchoring and fastening as shown in the Plans. Perform all cutting and drilling in a manner that allows for the collection of all debris and dispose of properly.

Install piles in accordance with Section 455.

471-6 Method of Measurement.

When using QPL listed piling configurations, the quantity of dimensional fiberglass fiber reinforced lumber and fiberglass structurally reinforced composite lumber to be paid for will be the plan quantity, computed based upon the dimensions shown in the Plans and the quantity of polymeric piles to be paid will be lump sum.

When using custom designed fender systems the quantity for the entire fender system to be paid will be lump sum.

471-7 Basis of Payment.

471-7.1 QPL Listed Pile Configuration: Price and payment for plastic marine lumber will be full compensation for the work specified in this Section including all material, storage costs, disposal of unused material and waste, transportation costs, labor, equipment, fasteners and other necessary items required for completing the work. No separate payment will be made for plates, bolts, screws or other hardware necessary to complete the work.

Price and payment for polymeric piles will be full compensation for all labor, equipment and materials required to furnish and install the piles to the pile cut-off elevations shown in the Plans.

471-7.2 Custom Fender System Designs: Price and payment for polymeric fender system will be full compensation for the work specified in the Section including all labor, equipment and materials required to furnish and install the piles to the pile cut-off elevations shown in the Plans, wales, dimensional lumber, material, storage costs, disposal of unused material and waste, transportation costs, fasteners and other necessary items required for completing the work.

Payment will be made under:

Item No. 471-1	Fender System, Plastic Marine Lumber - MB.
Item No. 471-2	Fender System, Polymeric Piles – LS
Item No. 471-3	Polymeric Fender System – LS.

521 CONCRETE BARRIERS, TRAFFIC RAILING BARRIERS AND PARAPETS. (REV 11-5-12) (FA 11-19-12) (7-13)

SUBARTICLE 521-4.3 (Page 675) is deleted and the following substituted:

521-4.3 Slip Form Construction: When electing to use the slip form method in lieu of the stationary forming method, place the concrete with a slip form machine approved by the Engineer. The concrete cover tolerance is plus or minus 1-1/4 inches from the plan dimensions, except the minimum concrete cover, as constructed, must not be less than 1-3/4 inches.

Provide a finished texture to the slip formed barrier wall by hand troweling, brushing, or both to eliminate pockmarks, blemishes and any other discontinuities in surface texture. Ensure that the final finish has a fine texture and is free of pinholes, pockmarks, and blemishes.

Remove and recast or repair sections of slip formed barrier wall having areas of unconsolidated concrete, having surface blemishes, and/or having pockmarks greater than 1/2 inch in diameter after hand troweling and brushing. Repair areas of unsatisfactory surface finish by hand methods using mortar screened from the concrete used to construct the barrier wall. Use the mortar screened from the barrier wall concrete only to fill holes and surface blemishes below the slip formed surface of the concrete. Do not use mortar as a surface overlay coating on the barrier wall concrete.

During the finishing operation, while the concrete remains plastic, straightedge all plane surfaces of the slip formed barrier wall with a 10 foot straightedge. Straightedge by half lapping the straightedge for the full length of the plane surfaces. Correct any deviation found during straightedging, greater than 3/8 inch, measured as an ordinate between the concrete surface and the straightedge, in an approved manner at no expense to the Department. Do not use surface overlay coatings of mortar screened from the concrete, or surface overlay coatings of concrete to correct alignment deviations.

530 RIPRAP. (REV 10-29-12) (FA 12-4-12) (7-13)

ARTICLE 530-1 (Page 690) is deleted and the following substituted:

530-1 Description.

Construct riprap composed of sand-cement or rubble (consisting of broken stone or broken concrete) as shown in the Design Standards and in the Plans. Place Type D-2 geotextile filter fabric, meeting the requirements shown on Design Standards, Index No. 199, and a minimum 1 foot thick layer of bedding stone under all rubble riprap.

SUBARTICLE 530-2.2.1 (Page 690) is deleted and the following substituted:

530-2.2.1 Rubble (Bank and Shore Protection): Provide sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of

broken stone with a bulk specific gravity of at least 2.20. Ensure that stones are rough and angular.

For this application, use broken stone meeting the following gradation and thickness requirements:

Weight Maximum Pounds	Weight 50% Pounds	Weight Minimum Pounds	Minimum Blanket Thickness in Feet
670	290	60	2.5
Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds. Ensure that at least 85% of the material by weight is greater than Weight Minimum pounds.			

544 CRASH CUSHIONS.
(REV 2-12-13) (FA 2-13-13) (7-13)

SECTION 544 (Page 703) is deleted and the following substituted:

SECTION 544
CRASH CUSHIONS

544-1 Description.

Install redirective crash cushions as shown in the Plans. Redirective crash cushions are safety devices with capabilities to redirect the impacting vehicle along the full length of the device.

544-2 Qualified Products List (QPL).

Use crash cushions listed on the QPL. Manufacturers seeking approval must submit and meet all crash testing requirements of the National Cooperative Highway Research Program Report 350 (NCHRP 350) or the Manual for Assessing Safety Hardware 2009 (MASH-09). Any new or revised highway safety hardware review request submitted to and received by FHWA after January 1, 2011 shall meet all crash test requirements of MASH-09.

544-3 Construction.

Handle and install manufactured materials or articles in accordance with the manufacturer's instructions and the Design Standards.

Delineate crash cushions with a Type 1 Object Markers in accordance with Section 705. As an alternative, the Contractor may install Type III, Type IV or Type VII reflective sheeting on the nose of the crash cushion in accordance with Section 994 and the QPL drawings.

Perform repairs necessary due to defective material, work, or operations without additional cost to the Department.

Restore crash cushions damaged by the traveling public after the installation is completed, accepted and serving its intended purpose on an open section of bridge or roadway within 24 hours.

544-4 Compensation.

Price and payment will be full compensation for the complete system or module in place and accepted, including object marker or sheeting. Payment for restoring damaged crash cushions will be the manufacturer's/distributor's invoice price for the new materials/parts plus 20% markup. The 20% markup is compensation for all necessary work, including but not limited to labor, equipment, supplies and profit, as authorized by the Engineer.

Relocation of an existing crash cushion to a permanent location called for in the Plans will be paid for at the Contract unit price for relocating existing systems. Price and payment will be full compensation for relocating and reinstalling the system in accordance with the manufacturer's instructions and the Design Standards.

Payment will be made under:

Item No. 544- 74- Relocate Crash Cushion - each.
Item No. 544- 75- Crash Cushion - each.

548 RETAINING WALL SYSTEMS.
(REV 12-5-12) (2-11-13) (7-13)

SUBARTICLE 548-2.6.2 (Page 708) is deleted and the following substituted:

548-2.6.2 Compacted Select Backfill: Meet the requirements of Sections 105 and 120 except as noted within this Section. Have the backfill material tested for every soil type for pH, resistivity, sulfate and chloride content by a Department approved independent testing laboratory prior to placement. Provide certification to the Engineer that the results have met the requirements of this Section and are signed and sealed by a Professional Engineer, registered in the State of Florida.

For constructing the retaining wall volume, do not use backfill material containing more than 2.0% by weight of organic material, as determined by FM 1-T 267 and by averaging the test results for three randomly selected samples from each stratum or stockpile of a particular material. If an individual test value of the three samples exceeds 3%, the stratum or stockpile will not be suitable for constructing the retaining wall volume.

Ensure that the material is non-plastic as determined by AASHTO T90 and the liquid limit as determined by AASHTO T89 is less than 15. The pH, as determined by FM 5-550, shall not be lower than 5.0 and not higher than 9.0.Sources of select backfill material having a pH between 4.5 and 5.0, as determined by FM 5-550, may be used provided the interior face of the MSE wall panels have 3 inches of concrete cover over the reinforcement and the concrete used in the panels contains the following ingredients and proportions:

1. The quantity of cement replaced with Type F fly ash is 10% to 20% by weight.
2. The quantity of cement replaced with slag is 50% to 60% by weight.
3. Portland cement is 30% by weight of total cementitious material.
4. The total weight of the Type F fly ash and slag does not exceed 70% of total cementitious material.

Do not place metallic pipe in backfill materials having a pH less than 5.0.

Use backfill for walls using soil reinforcements that meets the following gradation limits determined in accordance with AASHTO T27 and FM 1-T 011:

Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70-100
No. 4	30-100
No. 40	15-100
No. 100	0-65
No. 200	0-12

In addition, for permanent walls utilizing metallic soil reinforcement, use backfill that meets the following electro-chemical test criteria for determining corrosiveness:

Criteria	Test Method
Resistivity: > 3000 ohm -·cm	FM 5-551
Soluble sulfate content: < 200 PPM	FM 5-553
Soluble chloride content < 100 PPM	FM 5-552

For walls not using soil reinforcement, use backfill that meets the following gradation limits determined in accordance with AASHTO T27 and FM 1-T 011:

Sieve Size	Percent Passing
3-1/2 inches	100
No. 200	0-12

ARTICLE 548-4 (Page 710) is deleted and the following substituted:

548-4 Shop Drawings.

Provide shop drawings and calculations in accordance with Section 5. Provide calculations and drawings showing details, notes, materials, dimensions, sizes and other information necessary for the complete fabrication and erection of the retaining wall system. As a minimum, provide the following:

1. Elevation view showing the final ground line and elevations of the top and bottom of wall at the begin and end of wall, all breaks in vertical alignment and all whole stations and 25 foot station increments.

2. Sections showing the length, size and designation of soil reinforcement.

3. Plan view showing the horizontal alignment and offsets from the horizontal control line to the exterior face of the wall; the location of utilities, drainage structures and other items that impact the wall; the limits of the reinforced soil volume; and, the location of piles within the reinforced earth volume.

4. Details for construction around utilities, drainage structures and other items that impact the wall; for placement of soil reinforcement at acute corners; for addressing

conflicts between soil reinforcement and obstructions in the reinforced soil volume; for addressing different wall types intersecting and impacting each other.

5. General notes and design parameters including design soil characteristics; factored bearing resistance and factored bearing pressure for each wall height increment and other notes required for construction of the walls.

6. Design calculations for each wall height increment detailed in the shop drawings.

7. When the friction angle depicted in the shop drawings exceeds 30 degrees for sand backfill or 34 degrees for limerock backfill, provide laboratory test results in accordance with 548-9.5 verifying the backfill to be used for the wall meets the design soil characteristics for the shop drawings.

SUBARTICLE 548-8.5.1 (Page 713) is deleted and the following substituted:

548-8.5.1 Compacted Select Backfill: Perform work in accordance with an approved QC Plan meeting the requirements of 105-3. A LOT is defined as a single lift of finished embankment not to exceed 500 feet in length or cumulative length of continuous, interconnected walls. Backfill within 3 feet from the panels and backfill beyond 3 feet from the panels are separate LOTs. Overlapping retaining wall volumes may be considered one LOT, excluding the 3 feet width behind the panels. Strips up to 8 feet wide between two retaining wall volumes constructed with the same material in one operation may be considered as one LOT with the retaining wall volumes. Isolated compaction operations will be considered as separate LOTs. For multiple phase construction, a LOT will not extend beyond the limits of the phase.

Place the backfill closely following the erection of each course of precast components or soil reinforcement layers and spread by moving the machinery parallel to the wall face. Do not allow equipment heavier than 8 tons closer than 3 feet behind the wall face. Place backfill in a manner to avoid any damage or disturbance to the wall materials or misalignment of the facing materials. Remove and replace any wall materials which become damaged or disturbed during backfill placement at no cost to the Department, or correct as directed by the Engineer. Remove and reconstruct any misalignment or distortion of the wall facing due to placement of backfill outside the limits of this specification at no cost to the Department.

Sheepsfoot, grid rollers or other types of equipment employing a foot are not allowed. Achieve compaction within 3 feet of the back of the wall face using a power operated roller or plate weighing less than 1,000 pounds. At a distance greater than 3 feet from the back of the wall, a vibratory roller may be used, provided that the frequency and amplitude combined with bulk weight of the roller has performed satisfactorily at a trial section of the same type of wall. A smooth wheel or rubber tire roller is considered adequate. Ensure that the maximum lift thickness after compaction does not exceed 6 inches. Decrease the lift thickness if necessary, to obtain specified density.

Perform backfill compaction in a way that the compactor moves in a direction parallel to the wall face and proceeds from a distance not less than 3 feet behind the wall face toward the end of the soil reinforcement element.

Ensure that the moisture content of the backfill material prior to and during compaction is uniformly distributed throughout each layer of material. Use backfill material having a placement moisture content at the dry side of the optimum moisture content. To achieve the required compaction moisture content, use water that meets the requirements of

Section 923. Do not use saltwater. Do not transport excessively moist backfill materials to the site for any reason. The Engineer will determine the optimum moisture content in accordance with FM 5-521.

At the end of each day's operation, shape the last level of backfill to permit runoff of rainwater away from the wall face or provide a positive means of controlling run off away from the wall such as temporary pipe, etc.

ARTICLE 548-9 (Page 714 - 716) is deleted and the following substituted:

548-9 Acceptance Program.

548-9.1 General Requirements: Meet the requirements of 120-10 except delete the requirement of 120-10.1.4.1, 120-10.1.4.3, 120-10.1.6, 120-10.2 and 120-10.3.

548-9.2 Maximum Density Determination: Determine the maximum QC density in accordance with FM 1 T-180. Determine the maximum density in accordance with AASHTO T99, Method C.

Perform gradation tests on the sample collected in accordance with AASHTO T27 and FM 1-T 011. Classify soils in accordance with AASHTO M145 in order to determine compliance with embankment utilization requirements.

548-9.3 Density Testing Requirements: Ensure compliance with the requirements of nuclear density testing in accordance with FM 1-T 238. Determine the in-place moisture content for each density test. Use FM 1-T 238, FM 5-507 (Determination of Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester), or FM 5-535 (Laboratory Determination of Moisture Content of Granular Soils by Use of a Microwave Oven) for moisture determination.

Perform these tests at a minimum frequency of one set of tests per LOT.

Determine test locations including stations and offsets, using the random number generator provided by the Engineer. Do not use note pads or work sheets to record data for later transfer to the density log book. Notify the Engineer upon successful completion of QC testing on each LOT.

548-9.4 Acceptance Criteria: Obtain a minimum density of 90% of the maximum dry density as determined by FM 1 T-180 within 3 feet behind the wall face and obtain a minimum density of 95% of the maximum dry density as determined by FM 1 T-180 from beyond 3 feet behind the wall face.

548-9.4.1 Optional Acceptance Criteria for A-3 and A-2-4 Materials: Obtain a minimum density of 95% of the maximum dry density as determined by AASHTO T99 within 3 feet behind the wall face and obtain a minimum density of 100% of the maximum dry density as determined by AASHTO T99 beyond 3 feet behind the wall face.

The combined width from both MSE wall backfill (excluding the 3 feet zone from the panels) and embankment material may be considered the same LOT if the same material is used; the material in both wall backfill and embankment is compacted with the same procedure, equipment and compacting effort; and the maximum lift thickness after compaction in both wall backfill and embankment is 6 inches.

548-9.5 Friction Angle: When the friction angle depicted in the shop drawings exceeds 30 degrees for sand backfill or 34 degrees for limerock backfill, ensure the friction angle of the backfill material tested in accordance with FM 1-T 236 equals or exceeds the backfill friction angle depicted in the shop drawings.

548-9.6 Frequency: Conduct sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.

Test Name	Quality Control (QC)	Verification
Maximum Density	One per soil type	One per soil type
Density	One set of tests per LOT	One set of tests per four LOTs for each type of QC test.
Gradation	One per Maximum Density	One per Maximum Density
LL&PI	One per Maximum Density	One per Maximum Density
Soil Classification	One per Maximum Density	One per Maximum Density
Organic Content	One per soil type	One per soil type
Direct Shear	Three per soil type when required by 548-9.5	One per soil type

In addition, for permanent walls utilizing metallic soil reinforcement, test for corrosiveness at a minimum frequency of one test per soil type at point of placement according to the electro-chemical table in 548-2.6. The Engineer will collect enough material to split and create two separate samples and retain one for resolution at point of placement until LOTs represented by the samples are accepted. The Engineer will perform verification tests for corrosiveness at a minimum frequency of one test per soil type.

548-9.7 Verification Comparison Criteria and Resolution Procedures:

548-9.7.1 Maximum Density Determination: The Engineer will collect enough material to split and create two separate samples and retain one for resolution until LOTs represented by the samples are accepted.

The Engineer will meet the requirements of 120-10.4.1 except replace AASHTO T99, Method C with FM 1-T 180, Method D. If the Contractor selects the Optional Acceptance Criteria, the Engineer will verify the QC results of AASHTO T99, Method C in accordance with 120-10.4.1.

548-9.7.2 Density Testing: Meet the requirements of 120-10.4.2.

548-9.7.3 Soil Classification: The Engineer will meet the requirements of 120-10.4.3 except test the sample retained in 548-9.7.1 instead of taking the additional one.

548-9.7.4 Gradation: The Engineer will verify the QC results if the verification result meets the gradation limits set forth in the gradation table of 548-2.6. Otherwise, the Engineer will test the sample retained in 548-9.7.1. The State Materials Office (SMO) or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with AASHTO T27 and FM 1-T 011.

If the resolution test result satisfies the required gradation limits, the LOTS will be verified. If the resolution test results do not meet the required gradation limits,

reconstruct the LOTS with acceptable material. The Engineer will perform new verification testing.

548-9.7.5 Liquid Limit and Plasticity Index (LL&PI): The Engineer will verify the QC results if the verification result satisfies the plasticity index and liquid limit criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 548-9.7.1. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with AASHTO T90 and AASHTO T89, respectively.

If the resolution test result satisfies the required criteria, LOTS of that soil type will be verified. If the resolution test results do not meet the required criteria, reconstruct the corresponding LOTS with acceptable material. The Engineer will perform new verification testing.

548-9.7.6 Corrosiveness: The Engineer will verify the QC results if the verification result satisfies the electro-chemical test criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 548-9.7.1. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with FM 5-550, FM 5-551, FM 5-552 and FM 5-553.

If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.

548-9.7.7 Organic Content: The Engineer will verify the QC results if the verification result satisfies the organic content test criteria set forth in 548-2.6. Otherwise, the Engineer will collect three additional samples. The material will be sampled and tested in accordance with FM 1-T 267 and by averaging the test results for three randomly selected samples from at least one lift per soil type. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing.

If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.

548-9.7.8 Friction Angle: When the friction angle depicted in the shop drawings exceeds 30 degrees for sand backfill or 34 degrees for limerock backfill, the Engineer will take a verification sample at the point of placement to perform a direct shear verification test in accordance with FM 1-T 236. The SMO or a consultant qualified to perform Geotechnical Specialty Lab Testing (Type of Work 9.5), per Rule 14-75 of the Florida Administrative Code will perform the verification testing. If the test verifies the material has a friction angle greater than or equal to the friction angle depicted in the shop drawings, the material in the LOTs will be verified. If the verification test does not meet the required friction angle, reconstruct the LOTs with acceptable material.

The Contractor may request to redesign the wall and resubmit the shop drawings with the lower friction angle indicated by the verification test. Employ a Professional Engineer to redesign and submit signed and sealed drawings and computations. Do not begin any reconstruction until the proposed redesign has been reviewed and approved by the Engineer. The Contractor shall bear the costs of the redesign and any work resulting from the design changes.

555 DIRECTIONAL BORE.
(REV 1-28-13) (FA 2-15-13) (7-13)

SECTION 555 (Pages 722 – 728) is deleted and the following substituted:

SECTION 555
DIRECTIONAL BORE

555-1 Description.

555-1.1 Scope of Work: The work specified in this Section documents the approved construction methods and procedures for directional boring, also commonly called horizontal directional drilling (HDD).

555-1.2 General: HDD is a trenchless method for installing a product that serves as a carrier pipe for transporting solids, liquids or gasses (under pressure or gravity flow), or serves as a conduit, casing, or duct for a carrier pipe, cable, or wire line products. It is a multi-stage process consisting of site preparation and restoration, equipment setup, and drilling a pilot bore along a predetermined path and then pulling the product back through the drilled space. When necessary, enlargement of the pilot bore hole may be necessary to accommodate a product larger than the pilot bore hole size. This process is referred to as back reaming and is done at the same time the product is being pulled back through the pilot bore hole.

Accomplish alignment of the bore by proper orientation of the drill bit head as it is being pushed into the ground by a hydraulic jack and determine orientation and tracking of the drill bit. In order to minimize friction and prevent collapse of the bore hole, introduce a soil stabilizing agent (drilling fluid) into the annular bore space from the trailing end of the drill bit.

Select or design drilling fluids for the site specific soil and ground water conditions. Confine free flowing (escaping) slurry or drilling fluids at the ground surface during pull back or drilling. Remove all residual slurry from the surface and restore the site to preconstruction conditions.

555-2 Construction Site Requirements.

555-2.1 Pedestrian Traffic: When and where installations temporarily disrupt use of a pedestrian way, provide a safe alternate route in accordance with the Design Standards, Index Nos. 600 and 660.

555-2.2 Site Conditions:

(a) Carry out excavation for entry, exit, recovery pits, slurry sump pits, or any other excavation as specified in Section 120. Sump pits are required to contain drilling fluids if vacuum devices are not operated throughout the drilling operation, unless approved by the Engineer.

(b) Within 48 hours of completing installation of the product, clean the work site of all excess slurry or spoils. Take responsibility for the removal and final disposition of excess slurry or spoils. Ensure that the work site is restored to pre-construction conditions or as identified on the Plans.

(c) Provide MOT in accordance with the Design Standards and the MUTCD when and where the former is silent.

(d) Exposure of product shall be limited to 3 feet and 14 consecutive days unless approved by the Engineer.

555-2.3 Damage Restoration: Take responsibility for restoration for any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid (frac-out), or the directional drilling operation, at no cost to the Department.

555-2.3.1 Remediation Plans: When required by the Engineer, provide detailed plans which show how damage to any roadway facility will be remedied. These details will become part of the As-Built Plans Package. Remediation plans must follow the same guidelines for development and presentation of the as-built plans. When remediation plans are required, they must be approved by the Engineer before any work proceeds.

555-3 Quality Control.

555-3.1 General: Take control of the operation at all times. Have a representative who is thoroughly knowledgeable of the equipment, boring and Department procedures, present at the job site during the entire installation and available to address immediate concerns and emergency operations. Notify the Engineer 48 hours in advance of starting work. Do not begin installation until the Engineer is present at the job site and agrees that proper preparations have been made.

555-3.1.1 Product Testing: When there is any indication that the installed product has sustained damage and may leak, stop all work, notify the Engineer and investigate the damage. The Engineer may require a pressure test and reserves the right to be present during the test. Perform pressure test within 24 hours, unless otherwise approved by the Engineer. Furnish a copy of test results to the Engineer for review and approval. The Engineer is allowed up to 72 hours to approve or determine if the product installation is not in compliance with the specifications. The Engineer may require non-compliant installations to be filled with excavatable flowable fill.

555-3.1.2 Testing Methods: Testing may consist of one of the following methods and must always meet or exceed the Department's testing requirements:

(a) Follow the product manufacturer's pressure testing recommendations.

(b) Ensure carrier pipes installed without a casing meet the pressure requirements set by the owner. If the owner does not require pressure testing, the Engineer may require at least one test.

(c) A water tight pipe and joint configuration where the product is installed beneath any pavement (including sidewalk) and front shoulders is required. The Engineer will determine when and where water tight joint requirements will be applied to the ultimate roadway section for future widening. When a product is located elsewhere, the pipe and joint configuration must meet or exceed soil tight joint requirements. Conduct tests for joint integrity for one hour. The test for a soil tight joint allows up to 0.1 gallon of water leakage at a sustained pressure of 2 psi. The water tight joint criteria allows no leakage at all for a sustained pressure of 5 psi.

555-3.1.3 Failed Bore Path: If conditions warrant removal of any materials installed in a failed bore path, as determined by the Engineer, it will be at no cost to the Department. Promptly fill all voids with excavatable flowable fill.

555-3.2 Product Locating and Tracking: The method of locating and tracking the drill head during the pilot bore will be shown in the Plans. The Department recognizes walkover, wire line, and wire line with surface grid verification, or any other system as approved by the Engineer, as the accepted methods of tracking directional bores. Use a locating and tracking system capable of ensuring the proposed installation is installed as intended. If an area of radio signal interference is expected to exceed 5 feet, the Engineer may specify the use of a suitable tracking system. The locating and tracking system must provide information on:

(a) Clock and pitch information
(b) Depth
(c) Transmitter temperature
(d) Battery status
(e) Position (x,y)
(f) Azimuth, where direct overhead readings (walkover) are not possible (i.e. subaqueous or limited access transportation facility)
(g) Ensure proper calibration of all equipment before commencing directional drilling operation.
(h) Take and record alignment readings or plot points such that elevations on top of and offset dimensions from the center of the product to a permanent fixed feature are provided. Such permanent fixed feature must have prior approval of the Engineer. Provide elevations and dimensions at all bore alignment corrections (vertical and horizontal) with a minimum distance between points of 100 feet. Provide a sufficient number of elevations and offset distances to accurately plot the vertical and horizontal alignment of the installed product. A minimum of three elevation and plot points are required.

555-3.3 Product Bore Hole Diameter: Minimize potential damage from soil displacement/settlement by limiting the ratio of the bore hole to the product size. The size of the back reamer bit or pilot bit, if no back reaming is required, will be limited relative to the product diameter to be installed as follows:

Maximum Pilot or Back-Reamer Bit Diameter When Rotated 360 Degrees	
Outside Pipe Diameter Inches*	Maximum Bit Diameter Inches
<8	Diameter + 4
8 to 24	1.5 x Diameter
>24	Diameter + 12
*Use manufacturer's recommendation for pipe with restrained joints.	

555-3.4 Drilling Fluids: Use a mixture of bentonite clay or other approved stabilizing agent mixed with potable water with a minimum pH of 6.0 to create the drilling fluid for lubrication and soil stabilization. Do not use any other chemicals or polymer surfactants in the drilling fluid without written consent from the Engineer. Certify to the Engineer in writing that any chemicals to be added are environmentally safe and not harmful or corrosive to the facility. Identify the source of water for mixing the drilling fluid. Any water source used other than a potable water source may require a pH test.

555-4 Drilling Operations:

555-4.1 Installation Process: Ensure adequate removal of soil cuttings and stability of the bore hole by monitoring the drilling fluids such as the pumping rate, pressures, viscosity and density during the pilot bore, back reaming and pipe installation. Relief holes can be used as necessary to relieve excess pressure down hole. Obtain the Engineer's approval of the location and all conditions necessary to construct relief holes to ensure the proper disposition of drilling fluids is maintained and unnecessary inconvenience is minimized to other facility users.

To minimize heaving during pull back, the pull back rate is determined in order to maximize the removal of soil cuttings without building excess down hole pressure. Contain excess drilling fluids at entry and exit points until they are recycled or removed from the site or

vacuumed during drilling operations. Ensure that entry and exit pits are of sufficient size to contain the expected return of drilling fluids and soil cuttings.

Ensure that all drilling fluids are disposed of or recycled in a manner acceptable to the appropriate local, state, or federal regulatory agencies. When drilling in suspected contaminated ground, test the drilling fluid for contamination and appropriately dispose of it. Remove any excess material upon completion of the bore. If in the drilling process it becomes evident that the soil is contaminated, contact the Engineer immediately. Do not continue drilling without the Engineer's approval.

When conditions warrant, as determined by the Engineer, back reaming for enlarging the bore diameter shall be accomplished by connecting the reamer to trailing drill stems at the exit pit of the pilot bore. The drill pipe shall remain in the bore hole until the final product is pulled into place. After the pilot bore is established, do not push anything from the entry pit to the exit pit.

The timing of all boring processes is critical. Install a product into a bore hole within the same day that the pre-bore is completed to ensure necessary support exists.

555-4.2 Boring Failure: If an obstruction is encountered during boring which prevents completion of the installation in accordance with the design location and specification, the pipe may be taken out of service and left in place at the discretion of the Engineer. Immediately fill the product left in place with excavatable flowable fill. Submit a new installation procedure and revised plans to the Engineer for approval before resuming work at another location. If, during construction, damage is observed to the FDOT facility, cease all work until resolution to minimize further damage and a plan of action for restoration is obtained and approved by the Engineer.

555-5 Documentation Requirements.

555-5.1 Boring Path Report: Furnish a Bore Path Report to the Engineer within seven days of the completion of each bore path. Include the following in the report:

(a) Location of project and financial project number including the Permit Number when assigned

(b) Name of person collecting data, including title, position and company name

(c) Investigation site location (Contract Plans station number or reference to a permanent structure within the project right of way)

(d) Identification of the detection method used

(e) Elevations and offset dimensions as required in 555-3.2

555-5.2 As-Built Plans: Provide the Engineer a complete set of as-built plans showing all bores (successful and failed) within 30 calendar days of completing the work. Ensure that the plans are dimensionally correct copies of the Contract Plans and include roadway plan and profile, cross-section, boring location and subsurface conditions as directed by the Engineer. The plans must show appropriate elevations referenced to a permanent FDOT feature (mast arm foundation, manhole inlet cover, head wall, etc). Plans must be same scale in black ink on white paper, of the same size and weight as the Contract Plans. Submittal of electronic plans data in lieu of hard copy plans is preferred and may be approved by the Engineer if compatible with the Department software. Specific plans content requirements include but may not be limited to the following:

(a) The Contract Plan view shows the center line location of each facility installed, or installed and placed out of service, to an accuracy of 1 inch at the ends and other points physically observed in accordance with the bore path report.

(b) As directed by the Engineer, provide either a profile plan for each bore path, or a cross-section of the roadway at a station specified by the Engineer, or a roadway centerline profile. Show the ground or pavement surface and crown elevation of each facility installed, or installed and placed out of service, to an accuracy of within 1 inch at the ends and other exposed locations. On profile plans for bore paths crossing the roadway, show stationing of the crossing on the Contract Plans. On the profile plans for the bore paths paralleling the roadway, show the Contract Plans stationing. If the profile plan for the bore path is not made on a copy of one of the Contract profile or cross-section sheets, use a 10 to 1 vertical exaggeration.

(c) If, during boring, an obstruction is encountered which prevents completion of the installation in accordance with the design location and specification, and the product is left in place and taken out of service, show the failed bore path along with the final bore path on the plans. Note the failed bore path as "Failed Bore Path - Taken Out of Service". Also show the name of the utility owner, location and length of the drill head and any drill stems not removed from the bore path.

(d) Show the top elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

(e) Include bore notes on each plan stating the final bore path diameter, product diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the product, or facility placed out of service. Note if the product is a casing as well as the size and type of carrier pipes placed within the casing as part of the Contract work.

555-6 Compensation.

No direct payment will be made for directional bore. Include the cost to perform this operation in the Contract price for the item being installed.

556 JACK AND BORE.

(REV 1-14-13) (FA 1-15-13) (7-13)

ARTICLE 556-7 (Page 737) is deleted and the following substituted:

556-7 Compensation.

No direct payment will be made under this Section. Include the cost to perform this operation in the Contract unit price for the item being installed.

No compensation will be made for failed bore paths, injection of excavatable flowable fill, products taken out of service or incomplete installations.

No compensation will be made for the pay item associated with the jack and bore until a Bore Path Report has been delivered to the Engineer.

ARTICLE 556-8 (Pages 737 – 738) is deleted.

557 VIBRATORY PLOWING.
(REV 12-5-12) (FA 1-15-13) (7-13)

SECTION 557 (Pages 739 – 742) is deleted:

560 COATING NEW STRUCTURAL STEEL.
(REV 1-16-13) (FA 2-1-13) (7-13)

SUBARTICLE 560-2.4 (Page 743) is deleted and the following substituted:

560-2.4 Soluble Salts Test Kit: Use a soluble salts test kit in accordance with SSPC-Guide 15 utilizing a Class A retrieval method. Ensure the test sleeve or cell creates a sealed, encapsulated environment during ion extraction and is suitable for testing all structural steel surfaces. As an alternative, electronic conductivity meters approved for use by the Engineer may be used.

SUBARTICLE 560-2.5 (Page 743) is deleted and the following substituted:

560-2.5 Abrasives: Use properly sized abrasives to achieve the required cleanliness and anchor profile. Use abrasives meeting the requirements of SSPC-AB 1, Mineral and Slag Abrasives, SSPC-AB 2, Cleanliness of Recycled Ferrous Metallic Abrasives, or SSPC-AB 3, Newly Manufactured or Re-Manufactured Steel Abrasive and do not introduce any contamination that interferes with the coating application and performance.

Provide certification to the Engineer that the abrasives used meet the requirements of this Section and do not contain any chlorides and other salts.

For non- metallic abrasives, verify compliance with the conductivity and cleanliness requirements of SSPC-AB1. For recycled abrasives, verify compliance with the conductivity and cleanliness requirements of SSPC-AB 2 after each recycling or more frequently if required by the Engineer. Select a sample from each recycling machine in use and conduct the water-soluble contaminant and oil content tests outlined in SSPC-AB 2 at least one time each week or more frequently if directed by the Engineer. Conduct the non-abrasive residue and lead content tests as directed by the Engineer. If test results do not meet requirements, notify the Engineer immediately, remove and replace the abrasive, clean the recycling equipment, and conduct tests each day to confirm the equipment is functioning properly. Return to the weekly testing interval as directed by the Engineer.

SUBARTICLE 560-6.3 (Page 744) is deleted and the following substituted:

560-6.3 Quality Control Inspectors in the Shop and Field: Provide documentation to the Engineer that all personnel performing quality control inspections are certified at a minimum as a National Association of Corrosion Engineers (NACE) Coating Inspector Level I or a SSPC Level 1 Bridge Coating Inspector and that they report directly to a Quality Control Supervisor who is certified either as a NACE Coating Inspector Level 3 or a SSPC Level 2 Bridge Coating Inspector.

SUBARTICLE 560-7.4 (Page 745) is deleted and the following substituted:

560-7.4 Washing: Clean all steel surfaces in accordance with the requirements of SSPC-SP 12 LPWC WJ4.

SUBARTICLE 560-7.5 (Page 745) is deleted and the following substituted:

560-7.5 Soluble Salts Detection and Removal: When using SSPC Guide 15, Class A retrieval methods, determine the chloride, sulfate and nitrate concentrations on all steel surfaces using soluble salts test kits meeting the requirements of 560-2.4. Measure the concentration levels using the method described in SSPC-TU 4. Perform the tests after washing and after each applied coat of the coating system. Ensure the non-visible surface contaminant concentrations on blast-cleaned surfaces do not exceed 7 g/gm^2 for chlorides, 10 g/cm^2 for soluble ferrous iron, 17 g/m^2 for sulfates and 10 $\mu g/cm^2$ for nitrates. When using electronic conductivity meters, use meters meeting the requirements of 560-2.4 and measure the surface conductivity as prescribed by the manufacturer. The instrument shall be properly calibrated and maintained according to the manufacturer's recommendations. Ensure the surface conductivity does not exceed 70 micro-Siemens per centimeter squared. For either contaminant assessment method (salt test kits or conductivity meter) test three random locations in the first 1000 square feet and one random location for each subsequent 1000 square feet. When quality control documentation at a fixed location indicates 36 months of historical sequential soluble salt/conductivity levels below those specified above, soluble salt/conductivity testing frequency may be reduced to one test in the first 1000 square feet and one test every 2000 square feet of steel surface area thereafter. When any concentration or conductivity measurement exceeds the levels given above, rewash the entire surface area and retest. If additional washing does not reduce the concentration to the acceptable level, a surface treatment or water additive may be used. Use a surface treatment or water additive that is approved by the coating system supplier and the Engineer.

SUBARTICLE 560-7.7 (Page 745) is deleted and the following substituted:

560-7.7 Hand and Power Tool Cleaning: Prepare steel by power and hand tool cleaning as defined in SSPC-SP 11, SSPC-SP 15, SSPC-SP 3, and SSPC-SP 2 for touch up and repair when approved by the Engineer. Use SSPC-VIS 3 as an aid in establishing cleanliness.

SUBARTICLE 560-9.3 (Page 746) is deleted and the following substituted:

560-9.3 Sealing Using Caulk: Apply caulk after the intermediate coat has cured to a condition suitable for recoating in accordance with the manufacturer's product data sheet, and before application of the finish coat. Completely seal the perimeter of all faying surfaces, cracks and crevices, joints open less than 1/2 inch, and skip-welded joints using caulk. Apply the caulk to the joint following the caulk manufacturer's recommendations. Ensure the caulk bead has a smooth and uniform finish and is cured according to the caulk manufacturer's curing schedule prior to the application of the finish coat. It is unnecessary to caulk cracks and crevices less than 0.003 inches in width, located on the interior surface area of box girders.

SUBARTICLE 560-9.7 (Page 747) is deleted and the following substituted:

560-9.7 Stripe Coating: Apply stripe coats for both intermediate and finish coats to achieve complete coverage and proper thickness on welds, corners, crevices, sharp edges, bolts, nuts, rivets, and rough or pitted surfaces. A stripe coat of clear coating is not required. Do not apply subsequent coats until the previous stripe coat has cured per the manufacturer's product data sheet for recoating. Stripe coating is not required for the inside surface area of all steel box girders.

SUBARTICLE 560-9.8 (Page 747) is deleted and the following substituted:

560-9.8 Thickness of Coats: Apply coatings to the thickness as identified in the manufacturer's product data sheet. After application of each coat, thoroughly inspect the surfaces and measure the dry film thickness (DFT) in accordance with SSPC-PA 2. As an exception to SSPC-PA2, the DFT of the prime coat shall not be less than the minimum specified by the manufacturer's product data sheet. When the DFT is deficient or excessive, correct in accordance with the coating manufacturer's recommendations and retest the area.

570 PERFORMANCE TURF.
(REV 1-11-13) (FA 1-15-13) (7-13)

SUBARTICLE 570-3.3 (Pages 759 - 760) is deleted and the following substituted:

570-3.3 Sod: Place the sod on the prepared surface, with edges in close contact. Do not use sod which has been cut for more than 48 hours.

Place the sod to the edge of all landscape areas as shown in the Plans and as shown in the Design Standards.

Place rolled sod parallel with the roadway and cut any exposed netting even with the sod edge.

Monitor placed sod for growth of pest plants and noxious weeds. If pest plants and/or noxious weeds manifest themselves within 30 days of placement of the sod during the months April through October, within 60 days of placement of the sod during the months of

November through March treat affected areas by means acceptable to the Department at no expense to the Department. If pest plants and/or noxious weeds manifest themselves after the time frames described above from date of placement of sod, the Engineer, at his sole option, will determine if treatment is required and whether or not the Contractor will be compensated for such treatment. If compensation is provided, payment will be made as Unforeseeable Work as described in 4-4.

Remove and replace any sod as directed by the Engineer.

ARTICLE 570-4 (Pages 761 - 762) is deleted and the following substituted:

570-4 Turf Establishment.

Perform all work necessary, including watering and fertilizing, to sustain an established turf until final acceptance, at no additional expense to the Department. Provide the filling, leveling, and repairing of any washed or eroded areas, as may be necessary.

Established turf is defined as follows:

1. An established root system (leaf blades break before seedlings or sod can be pulled from the soil by hand).
2. No bare spots larger than one square foot.
3. No continuous streaks running perpendicular to the face of the slope.
4. No bare areas comprising more than 1% of any given 1,000 square foot area.
5. No deformation of the turf areas caused by mowing or other Contractor equipment.
6. No exposed sod netting.
7. No pests or noxious weeds.

Monitor turf areas and remove all competing vegetation, pest plants, and noxious weeds (as listed by the Florida Exotic Pest Plant Council, Category I "List of Invasive Species", Current Edition, http://www.fleppc.org). Remove such vegetation regularly by manual, mechanical, or chemical control means, as necessary. When selecting herbicides, pay particular attention to ensure use of chemicals that will not harm desired turf or wildflower species. Use herbicides in accordance with 7-1.7.

If at the time that all other work on the project is completed, but all turf areas have not met the requirements for established turf set forth in 570-4, continuously maintain all turf areas until the requirements for established turf set forth in 570-4 have been met.

During the entire establishment period and until turf is established in accordance with this specification, continue inspection and maintenance of erosion and sedimentation control items in accordance with Section 104. Take responsibility for the proper removal and disposal of all erosion and sedimentation control items after turf has been established.

Notify the Engineer, with a minimum of seven calendar days advance notice, to conduct inspections of the turf at approximate 90-day intervals during the establishment period to determine establishment. Results of such inspections will be made available to the Contractor within seven calendar days of the date of inspection. Determination of an established turf will be based on the entire project and not in sections.

Upon the determination by the Engineer that the requirements of 570-4 have been met and an established turf has been achieved and all erosion and sedimentation control items have been removed, the Engineer will release the Contractor from any further responsibility provided for in this Specification.

The Contractor's establishment obligations of this specification will not apply to deficiencies due to the following factors, if found by the Engineer to be beyond the control of the Contractor, his subcontractors, vendors or suppliers:

a. Determination that the deficiency was due to the failure of other features of the Contract.

b. Determination that the deficiency was the responsibility of a third party performing work not included in the Contract or its actions.

The Department will only pay for replanting as necessary due to factors determined by the Department to be beyond the control of the Contractor.

630 CONDUIT.

(REV 1-17-12) (FA 2-6-13) (7-13)

SECTION 630 (Pages 780 – 784) is deleted and the following substituted:

SECTION 630
CONDUIT

630-1 Description.

Furnish and install conduit for traffic control signals and devices, highway lighting, and other electrically powered or operated devices as shown in the Contract Documents.

630-2 Materials.

630-2.1 Conduit: Use materials that have been tested and listed by a Nationally Recognized Testing Laboratory to the following industry standards:

Schedule 40 and 80 Polyvinyl Chloride (PVC)[1]	UL 651
Fiberglass Reinforced Epoxy[2]	UL 2420
Intermediate Metal[3]	UL 1242
Rigid Galvanized Metal[3,4]	UL 6
Rigid Aluminum[4]	UL 6A
PVC Coated Intermediate Metal[4]	ASTM A135/A135M, ASTM A513, ASTM A568/A568M, NEMA RN1-2005
Liquid Tight Flexible Metal	UL 360
High Density Polyethylene (HDPE) Standard Dimension Ratio (SDR) 9-11[5]	ASTM F2160
HDPE SDR 13.5[5]	ASTM F2160, NEMA TC-7
Schedule 40 and 80 HDPE	UL 651A

[1]Use conduit with solvent weld slip-fit plastic couplings unless approved by the Engineer.

[2]Use conduit having a minimum stiffness value of 250. Ensure that each section has a duct bell with an integral gasket on one end and a duct spigot on the other end.

[3]Use conduit that is hot-dipped galvanized with a minimum coating of 1.24 ounces per square foot on both the inside and outside of the conduit. The weight of the zinc coating shall be determined using ASTM A90.

[4]Use conduit with both ends reamed and threaded.

[5]Can be used with preassembled cable and rope-in-conduit.

630-2.2 Locate Wire: Ensure that locate wire is a single copper conductor with a minimum gauge of No. 12 AWG. Ensure locate wire is insulated using a 45 mil minimum thickness polyethylene sheath that is orange in color and marked to identify the manufacturer and the conductor size.

630-2.3 Locate Wire Grounding Unit: Ensure that locate wires are attached to a wire grounding unit (WGU) dedicated to safely dissipate high transient voltages or other foreign electrical surges induced into the designated system. Ensure the WGU conforms to the following:

1. Allows signals generated by locate system transmitters to pass through the protection system without going to ground.

2. The protection system automatically resets and passes locate system transmitter signals after the unit has been grounded to dissipate over-voltages.

3. Is intended for below or above grade applications. Ground the WGU to a driven rod within 10 feet of the system using a No. 6 AWG single conductor wire with green insulation. Ensure that the WGU is enclosed for protection from environmental hazards and is accessible for the connection of portable locate system transmitters.

4. The WGU system meets the minimum standards listed in Table 1 for surge protection:

Table 1: Minimum Standards for Surge Protection	
Surge Element	3-element maximum duty fail-safe gas tube.
Rating	40,000 A surge capacity (single-cycle, 8 by 20 microsecond waveform).
Life	Minimum 1,000 surges (1000 A to ground).
Fail-Safe	Integral fail-shorted device.
Insulation Resistance	1,000 megohm minimum at 100 volts of direct current (V_{DC}).
Clamp Voltages	a. Impulse at 100 volts per microsecond: Typically 500 volts. b. Direct Current: 300 to 500 volts.

630-2.4 Warning Tape: Ensure that the buried cable warning tape is flexible, elastic material 3 inches wide, 6 mil thick, intended for burial and use as an underground utility warning notice, and that the surface of the warning tape is coated and sealed to prevent deterioration caused by harsh soil elements. Ensure that the warning tape color follows the American Public Works Association color code for underground utilities and has the repeating message "CAUTION: FDOT CABLE," or other wording approved by the Engineer, permanently printed on its surface. Ensure that the tape material and ink colors do not change when exposed to acids, alkalis, and other destructive chemical variances commonly found in Florida soils.

630-2.5 Route Markers: Route markers may be either a standard route marker (SRM) type or an electronic route marker (ERM) type. Ensure the SRM is a rigid, tubular, driven post used for location and notification purposes only. Ensure the ERM is physically identical to the SRM, but also includes a termination board to provide aboveground access to locate wire buried alongside conduit and cable runs.

Ensure that each SRM is labeled and identified as an FDOT fiber optic cable marker unless otherwise shown in the Plans. The labels must include the Department's logo, contact information for the local FDOT District, and a telephone number to call prior to any excavation in the area. Ensure that the identification information is permanently imprinted on the

top fitting, and will not peel, fade, or deteriorate.

630-2.5.1 Standard Route Marker (SRM): Ensure that SRM posts are white with an orange top fitting cover with black or white lettering and graphics. Ensure that the SRM is a tubular configuration, and both the marker post and the top fitting are made from virgin Type 111 HDPE. Ensure that any fasteners used with the SRM are constructed of stainless steel.

Ensure that all SRMs have a minimum outside diameter of 3.5 inches with a minimum wall thickness of 0.125 inches. Ensure that the top fitting cover is a minimum of 1.5 feet long and has an outside diameter of 3.75 inches with a minimum wall thickness of 0.125 inches. Ensure that each SRM provides a tensile strength of 4,200 pounds per square inch as required in ASTM D638. Ensure that each SRM is manufactured for use in temperatures range of minus 30° to 165°F in accordance with NEMA TS 2.

Ensure the SRM can withstand an impact force of 70 pounds per foot at 32°F in accordance with ASTM D2444, before and after UV conditioning for 2,000 hours in accordance with ASTM G154. Ensure that the control sample of any material tested maintains a minimum of 70 percent of its original tensile strength.

Ensure that SRMs installed at the minimum 2 foot depth can withstand at least one impact at 45 miles per hour by a vehicle weighing at least 3,500 pounds and that after impact, post returns to an upright position within 10 degrees of vertical alignment within 30 seconds from the time of impact.

630-2.5.2 Electronic Route Marker (ERM): Ensure ERMs meet the same material and performance requirements as the SRMs with the following exceptions. Equip each ERM with a removable, top-fitting cover that is black with white lettering. Ensure that each ERM contains a terminal board equipped with locate wire and ground connectors.

Ensure that the terminal board is made from corrosion-resistant materials and includes terminal facilities labeled according to function and provides uniform spacing between connection points.

630-3 Installation Requirements.

630-3.1 General: Install the conduit in accordance with NEC or National Electrical Safety Code (NESC) requirements and the Design Standards. Consider the locations of conduit as shown in the Plans as approximate. Construct conduit runs as straight as possible, and obtain the Engineer's approval for all major deviations in conduit locations from those shown in the Plans. Include buried cable warning tape with all trenched conduit. Mark the location of the conduit system with route markers as shown in the Plans and approved by the Engineer. Ensure that all route markers used are new and consistent in appearance.

For conduit installed by directional bore, install in accordance with Section 555. For conduit installed by jack and bore, install in accordance with Section 556.

Use only intermediate metal conduit, rigid galvanized metal conduit, rigid aluminum conduit or PVC coated intermediate metal conduit for above-ground electrical power service installations and rigid galvanized metal conduit or rigid aluminum conduit for underground electrical power service installations. Meet the requirements of Section 562 for coating all field cut and threaded galvanized pipe.

Use Schedule 80 PVC or fiberglass reinforced epoxy conduit in structural elements in or on bridge decks.

Use HDPE with an SDR number less than or equal to 11, Schedule 80 PVC or Schedule 40 PVC for underground installations in earth or concrete for traffic control signal and device applications.

Use HDPE with an SDR number less than or equal to 13.5, Schedule 80 PVC, or Schedule 40 PVC for underground installations of electrical conduit in earth for lighting applications and landscape irrigation applications.

Use HDPE with an SDR number less than or equal to 13.5, Schedule 80 PVC, Schedule 40 PVC, or rigid galvanized metal for underground installations of electrical conduit in concrete for lighting applications.

Do not place more than the equivalent of three quarter bends or 270 degrees of bends, including the termination bends, between the two points of termination in the conduit, without a pull box. Obtain the Engineer's approval to use corrugated flexible conduits for short runs of 6 feet or less.

When a conduit installation changes from underground to above-ground, make the change a minimum of 6 inches below finished grade.

Install a No. 12 AWG pull wire or polypropylene cord inside the full length of all conduits. Ensure that a minimum of 24 inches of pull wire/cord is accessible at each conduit termination.

Ensure the conduit includes all required fittings and incidentals necessary to construct a complete installation.

When earth backfill and tamping is required, place backfill material as per Section 120 in layers approximately 12 inches thick, and tamp each layer to a density equal to or greater than the adjacent soil.

When backfilling trenches in existing pavement, use a flowable fill meeting the requirements of Section 121.

Provide a standard clearance between underground control cable and electrical service cable or another parallel underground electrical service cable that meets NESC requirements.

Prevent the ingress of water, dirt, sand, and other foreign materials into the conduit prior to, during, and after construction. Exclude water and debris from buried conduit and from the top riser assembly of above-ground conduit using a foam-sealing material, rubber plug, or other device designed for this application and approved by the Engineer.

630-3.1.1 Fiber Optic Cable Conduit: Install the conduit system so the fiber optic cable maintains a minimum bend radius of 20 times the cable diameter. Use approved methods for connecting inner duct or conduit within or between plowed portions, trenched portions, and bored portions. Submit the conduit manufacturer's coupling method and material to the Engineer for approval.

630-3.2 Conduit Sizes: Size the conduit to be used on all installations, unless otherwise shown in the Contract Documents. Use conduit of sufficient size to allow the conductor to be installed without any damage and meeting NEC requirements. Use conduit that is at least 2 inches in diameter, with the following exceptions:

For conduit protecting the ground wire on the side of a pole, use conduit that is at least 1/2 inch in diameter.

For traffic control signal and device electrical service conduit, use the minimum conduit size required by the local maintaining agency and the electrical service provider.

630-3.3 Conduit Joints: Make conduit joints using materials as specified by the manufacturer. When conduit crosses an expansion joint of a structure and where shown in the Plans, install an expansion or expansion/deflection fitting as specified by the manufacturer. Certify that expansion/deflection fittings are rated to accommodate a minimum rotation of

30 degrees and that both the expansion and expansion/deflection fittings are rated to accommodate the anticipated longitudinal movement (minimum of 2 inches for deflection fittings and 0.7 inches for expansion/deflection fittings). Ensure that all installed joints are waterproof. As an exception to the threaded coupling for intermediate metal conduit, at locations where it is not possible to screw the threaded coupling properly, the Contractor may use a waterproof slip-joint coupling approved by the Engineer. Secure the joint, and tighten threaded connections.

Prior to insertion into the coupling, clean, prime and coat the ends of PVC conduit with solvent-type cement as specified by the manufacturer.

630-3.4 PVC Coating: Apply PVC coating to exposed metal surfaces of the conduit, except for the threads, to attain a nominal thickness of 40 mils. Ensure that the coating is free of sags and drips.

Attach the coupling to the conduit prior to the application of the coating for conduit of 1 inch diameter or less.

Use a coupling with sleeve extensions on conduit larger than 1 inch. Ensure that the sleeve extensions on all threaded female openings have a length equal to the diameter of the conduit up to and including size number 53.

630-3.5 Conduit Terminations: Fit the terminating ends of all metal conduit and metal conduit sleeves with an appropriate bushing.

For conduit to be encased in concrete, wrap with tape or otherwise protect all terminations to prevent the entrance of concrete.

Connect new underground conduits to existing underground conduits with a pull box.

Install conduit terminating in a concrete strain pole through the cable entry hole and up the center of the pole to a location approximately 6 inches below the handhole.

Seal conduits terminating in a controller base, pole, pull box, junction box, or pedestal base with a moisture resistant sealant approved by the Engineer.

For a controller base, pole or pedestal base, and junction boxes, terminate conduit runs into the center of the base or box at least 2 inches above the surface of the base.

630-3.6 Restoration of Trench Areas: Restore the conduit trench construction area to an acceptable condition. Such work includes repair or replacement of all pavement areas, sidewalks, driveways, curbs, structures, landscaping, grass areas (including removal of excavated materials and spoils), removal and disposal of drilling fluids, and backfilling areas disturbed by the conduit installation.

630-3.7 Above-Ground Installation: Use conduit designed and manufactured for use in long-term above-ground applications with UV stabilization to prevent material deterioration. Securely attach above-ground conduit installations to the surface of the supporting structure using conduit straps. As a minimum, use conduit straps located on 5 foot centers. Use galvanized metal conduit straps when installing intermediate metal conduit, fiberglass reinforced epoxy conduit, rigid galvanized conduit, rigid aluminum conduit or PVC coated intermediate metal conduit above ground.

Use the same PVC coating for the metal straps as the conduit, when using PVC coated intermediate metal conduit.

630-3.8 Elbows: The radius of curvature of the inner edge of any bend shall not be less than shown below:

Size	Standard Radius
1/2 inch	4 inches
3/4 inch	4-1/2 inches
1 inch	5-1/2 inches
1-1/4 inches	7-1/4 inches
1-1/2 inches	8-1/4 inches
2 inches	9-1/2 inches
2-1/2 inches	10-1/2 inches
3 inches	13 inches
3-1/2 inches	15 inches
4 inches	16 inches
5 inches	24 inches
6 inches	30 inches

630-3.9 Fiber Optic Cable Locate Wire: Install locate wire in the trench or bore with all underground conduits to provide end-to-end electrical continuity for electronically locating the underground conduit system. Bury locate wire along the centerline of the top outer surface of installed conduit. Do not install locate wire in a conduit with fiber optic cable.

Do not run locate wires into field cabinets. Terminate locate wires at the first and last pull boxes in the conduit run or as shown in the Plans. Ensure that wire termination occurs in a pull box as shown in the Design Standards, Index No. 17700.

In a trenching operation, install the locate wire no more than 3 inches above the conduit. Ensure that the locate wire enters all pull and splice boxes, and that a minimum of 10 feet of slack locate wire is coiled and neatly stored in each box.

In a boring operation, install the locate wire in an encasement, install the conduit detection wire external to the conduit with no separation between conduit and wire, or use conduit with integral locate wire. Locate wire may also be placed in the void between the inner wall of conduit and innerducts contained within the conduit as long as no other cables are present within the void.

Perform continuity tests and insulation resistance tests on all locate wires and provide the Engineer with all test results. Replace, or repair defective locate wire at no additional cost.

Make locate wire splices in a flush grade-level box. Ensure that locate wire splices are waterproof and suitable for direct burial. Ensure that locate wire splices at the pull box meet NEC requirements. Ensure that locate wire splices are constructed of and in the following order: a mechanical crimp connection with a butt sleeve, an oxide-preventing aerosol lacquer, mastic electrical splicing tape, and standard electrical tape. At the completion of the installation, provide the Engineer with as-built drawings that document all splice locations.

Install WGUs in pull boxes and splice boxes as shown in the Plans or directed by the Engineer. Mount the device in a location high enough from the bottom of the box to allow access to terminal facilities without disturbing cables present within the box. Terminate the locate wires and connect the WGU to ground in accordance with the manufacturer's instructions.

Test the locate wire system after installation to ensure that it functions and can be used to accurately locate the conduit system.

630-3.10 Route Markers: Install route markers for fiber optic cable installations and ensure the following:

1. Markers are plumb and level and the notification information is clearly visible when viewed from the side facing the roadway.
2. Markers are set within the right of way.
3. Markers are placed at a 1 foot offset from the conduit system.
4. The top of the marker post is a minimum of 5 feet and maximum of 6 feet above the finish grade
5. Markers are spaced a maximum of 500 feet apart.
6. A clear line of sight is maintained from one marker to the next.
7. Markers are installed on both sides of the roadway at any crossing point where the conduit system changes to the opposite side of the roadway.
8. Markers are installed at the center point of any conduit run between two pull or splice boxes.
9. Markers are installed at gate locations when the conduit system is adjacent to a fence line.
10. Markers are installed on both sides of a stream, river, or other water crossing, and on both sides of aboveground attachments such as bridges and walls.

Remove and replace all marker posts damaged during installation at no additional cost. Ensure that route marker signs are labeled with a unique identification number, as detailed in the Plans or as approved by the Engineer. Provide as-built documentation at the completion of installation that includes identification number and location of all installed route markers and correlates the marker to the fiber optic infrastructure that it signifies.

Ensure that installation of ERMs includes connection of the route marker to the locate wire associated with the conduit run that the markers identify. Install locate wire through the base of the marker and terminate the locate wires to connectors mounted on the terminal board inside the marker. Install an underground magnesium anode a minimum of 10 feet away from the marker and perpendicular to the conduit system. Terminate the anode lead on the connector mounted on the terminal board inside the marker. Install the bond straps between the anode connector and all locate wire connectors to provide cathodic protection for the locate wire conductor.

630-4 Method of Measurement.

630-4.1 General: Measurement for payment will be in accordance with the following work tasks.

630-4.2 Furnish and Install: The Contract unit price per foot of conduit, furnished and installed, will include furnishing all hardware and materials and all testing as specified in this Section and the Contract Documents, and all labor, casings, removal of excavated materials and spoils, removal and disposal of drilling fluids, locate wire, trenching, boring, backfilling, flowable fill and restoration materials necessary for a complete and accepted installation.

Payment for conduit placed underground will be based on the horizontal length of the trench or bore measured in a straight line between the centers of pull boxes, cabinets, poles, etc., in linear feet, regardless of the length or number of conduits installed. No allowance will be made for sweeps or vertical distances below the ground.

Payment for conduit placed aboveground or bridge mounted will be based on the actual length of conduit installed.

630-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment for conduit placed under existing turf will be made as open trench.

Payment for conduit placed under existing pavement (roadway, driveways, or sidewalk) will be made as directional bore. If conduit is being placed under both existing turf and existing pavement between two pull boxes, payment for the total pull box-to-pull box length will be made as directional bore. Payment for conduit placed by jack & bore will be made as jack & bore, for the total pull box to pull box length.

No additional payment will be made for multiple conduits in the same trench.

No payment adjustment will be made if the Contractor chooses to use an alternative method approved by the Engineer.

No payment will be made for failed bore paths, injection of excavatable flowable fill, products taken out of service, or incomplete installations.

Payment will be made under:

Item No. 630- 2- Conduit - LF.

632 SIGNAL CABLE.

(REV 1-23-13) (FA 2-6-13) (7-13)

SECTION 632 (Pages 785 – 787) is deleted and the following substituted:

SECTION 632
SIGNAL CABLE

632-1 Description.

Furnish and install underground and aerial signal cable as shown in the Plans and in accordance with Design Standards, Index No. 17727.

632-2 Materials.

Use only new materials meeting the requirements of this Section.

632-2.1 Signal Cable: Use either polyethylene insulated, polyvinyl chloride jacketed signal cable conforming to the requirements of the International Municipal Signal Association, Inc. (IMSA) Specification No. 19-1 or polyethylene insulated, polyethylene jacketed signal cable conforming to the requirements of IMSA Specification No. 20-1. Use signal cable conductors of stranded copper, No. 14 AWG or larger.

632-2.2 Signal Cable Attachment Hardware: Ensure that all bolts and nuts less than 5/8 inch in diameter are passivated stainless steel, Type 316 or Type 304 and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 inch and over in diameter are galvanized and meet the requirements of ASTM A307. Use attachment hardware with sufficient tensile strength for the application. Use stainless steel lashing wire, galvanized or stainless steel lashing rod, cable rings or self-locking cable ties of UV stabilized black plastic having a minimum tensile strength of 100 pounds.

632-3 Installation Requirements.

Except for mast arm assemblies, install signal cable in continuous lengths between the traffic signal controller cabinet and the first disconnect hanger (or traffic signal head) on the span and between the traffic signal controller cabinet and each pedestrian signal head and pedestrian detector.

Do not use the neutral return conductor for pedestrian detectors as a neutral return for any other device. Conductors for the pedestrian signal head and the push button must be separated at the base of the pedestal and routed to the detection panel using separate raceways.

632-3.1 Number of Conductors: Determine the number of conductors required for each signal cable unless specified in the Contract Documents.

Provide three spare conductors for each signal cable used at all signal installations. Install the three spare conductors from the controller cabinet through each disconnect hanger (or traffic signal head) to the furthermost disconnect hanger (or traffic signal head).

Identify all spare conductors in a controller cabinet and ground them to the controller cabinet ground bus bar. Provide spare conductors within the controller cabinet of sufficient length to reach the furthermost field wiring terminals in the cabinet.

632-3.3 Protection of Cable: Ensure cable drawn through conduit, ducts, drilled holes protected by a rubber grommet, or support structures is installed in such a manner as to prevent damage to conductors or insulation.

632-3.4 Cabling for Mast Arm Assembly: Continuous lengths of cable between the traffic signal controller cabinet, signal heads (or disconnect hangers), pedestrian signal heads and pedestrian detectors will be allowed only when specified in Contract Documents.

632-3.5 Cable Terminations: Terminate signal cable in the terminal by inserting the bared conductors into a compression type terminal block.

When barrier terminal blocks are specified in the Contract Documents, crimp insulated fork or ring terminals to the bared conductors using a calibrated ratchet-crimping tool and connect the forks or ring terminals to the barrier terminal block.

Neatly form and tie wrap all cable terminations.

If disconnect hangers are specified in the Contract Documents, terminate spare wires at the terminal strip located inside the disconnect hangers. Individually cap or tape any additional spares in the disconnect hanger.

Connect signal cables for a mast arm assembly in the terminal compartment when provided.

632-6 Method of Measurement.

632-6.1 General: Measurement for payment will be in accordance with the following work tasks.

632-6.2 Furnish and Install: The Contract unit price per intersection for signal cable, furnished and installed, will include furnishing all material, hardware, support wire, cable ties, cable clamps, lashing wire, terminal connectors, cable grounding and labor necessary for a complete and accepted installation.

Payment for signal cable will be based on the number of intersections at which signal cable is furnished and installed.

632-6.3 Furnish: The Contract unit price of cable, furnished, will include the cost of the required cable as specified in the Contract Documents, plus all shipping and handling costs for delivery as specified in the Contract Documents.

632-6.4 Install: The Contract unit price per intersection for signal cable, installed, will include all labor, cable ties, cable clamps, lashing wire, and cable grounding necessary for a complete and accepted installation. The Engineer will supply all cable.

Payment for signal cable will be based on the number of intersections at which signal cable is installed.

632-7 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section. Payment will be made under:

Item No. 632- 7- Signal Cable - per intersection.

633 COMMUNICATION CABLE.

(REV 1-23-13) (FA 2-6-13) (7-13)

PAGE 787. The following new Section is added after Section 632:

SECTION 633
COMMUNICATION CABLE

633-1 Description.

Furnish and install underground and aerial communication cable as shown in the Plans and Design Standards.

633-2 Materials.

633-2.1 Fiber Optic Cable and Connections.

633-2.1.1 Single Mode Fiber Optic Cable: Provide all-dielectric, dry-filled, loose-tube, dispersion-unshifted, single-mode fiber (SMF) with low water peak, gel free, and suitable for underground (i.e., in conduit) and aerial outside plant installation. All fiber optic cable shall be splice-compatible with the Department's existing dispersion-unshifted SMF and require no electronic equipment for dispersion compensation between new and existing fiber. Ensure that all components that comprise a single length of cable are continuous and of the same material. Furnish only commercial off-the-shelf materials, equipment, and components.

633-2.1.1.1 Optical Fiber: Ensure that the optical fibers used in the cable meet or exceed the Telecommunications Industry Association (TIA) and Electronic Industries Alliance (EIA) TIA/EIA-492-CAAB specification, the U.S. Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900, and International Telecommunication Union ITU-T G.652.D requirements. Use only optical fibers meeting the additional requirements as follows:

Geometry
Cladding Diameter: 125µm, ±0.7 µm
Core-to-Cladding Concentricity: ≤0.5 µm
Cladding Noncircularity: ≤0.7%
Mode Field Diameter: 1,550 nm; 10.4 µm, ±0.5 µm
Coating Diameter: 245 µm, ±5 µm

Colored Fiber Nominal Diameter: 250 ±15 µm
Optical
Cabled Fiber Attenuation: 1,310 nm, ≤0.4 dB/km; 1,550 nm, ≤0.3 dB/km
Point Discontinuity: 1,310 nm, ≤0.05 dB/km; 1,550 nm, ≤0.05 dB/km
Cable Cutoff Wavelength (λ_{ccf}): ≤1,260 nm.
Total Dispersion: 1,625 nm ≤23.0 ps/(nm•km)
Macrobend Attenuation: Turns – 100; Outer diameter (OD) of the mandrel – 60 mm, ±2 mm; ≤0.05 dB at 1,550 nm
Cabled Polarization Mode Dispersion: $\leq 0.5 \ \text{ps}/\sqrt{\text{km}}$

Ensure that all fiber in the buffer tube is usable fiber that complies with attenuation requirements. Ensure that fibers do not adhere to each other. Ensure that the fiber is free of surface imperfections and inclusions. Ensure that all fiber optic core glass is from the same manufacturer.

633-2.1.1.2 Buffer Tubes: Ensure that the fiber optic cable includes loose buffer tubes that isolate internal optical fibers from outside forces and provide protection from physical damage as well as water ingress and migration. Ensure that buffer tubes provide freedom of movement for internal optical fibers. Ensure buffer tubes allow for expansion and contraction of the cable without damage to internal optical fiber. Ensure that fiber does not adhere to the inside of the tube. Ensure that buffer tubes permit intentional scoring and breakout without damage to the fiber. Ensure that each fiber optic cable buffer tube contains 12 fibers per tube unless otherwise shown in the Plans.

633-2.1.1.3 Color Code: Ensure that the marking and color-coding of the fibers and buffer tubes conforms to the E IA/TIA-598-B standard.

Ensure that colors are permanent and stable during temperature cycling, and not subject to fading or smearing onto each other or into the water-blocking material. Ensure that fibers are colored with UV curable inks that remain clearly distinguishable as the intended color.

633-2.1.1.4 Strength Member: Ensure that the fiber optic cable contains a dielectric central strength member and dielectric outside strength member to prevent buckling of the cable and provide tensile strength. Ensure that the fiber optic cable can withstand a pulling tension of 600 lbs. without damage to any components of the fiber optic cable.

633-2.1.1.5 Water Blocking Compound: Ensure that the fiber optic cable contains a dry water-blocking material to prevent the ingress of water within the outer cable jacket. Ensure that water-blocking materials are non-nutritive, dielectric, and homogeneous, and free from dirt and foreign matter. Use dry water-blocking material for fiber optic cables used for either aerial or underground installations. Apply dry water-blocking compound longitudinally around the outside of the central buffer tubes. Construct all cables with water-blocking material that complies with the requirements of the EIA/TIA-455-81B standard and is subjected to water penetration tests as defined in the EIA/TIA-455-82B standard.

633-2.1.1.6 Ripcord: Ensure that the cable contains at least one ripcord under the sheath. Ensure that the ripcord permits the removal of the sheath by hand or with pliers.

633-2.1.1.7 Filler: Fillers or rods may be included in the cable core to lend symmetry to the cable cross section if required.

633-2.1.1.8 Outer Jacket: Ensure that the fiber optic cable is jacketed with medium density polyethylene (MDPE) that is free of blisters, cracks, holes, and other deformities. Ensure that the nominal jacket thickness is a minimum of 0.03 inches. Ensure the outer jacket provides UV protection and does not promote the growth of fungus.

Mark the jacket with the cable manufacturer's name, fiber type, fiber count, date of manufacture, the words "FDOT FIBER OPTIC CABLE" unless otherwise shown in the Plans, and the sequential cable lengths marked in feet. Ensure that the actual length of the cable is within 1% of the length indicated by the marking. Provide legible marking with contrasting color to that of the cable jacket.

633-2.1.1.9 Performance Requirements:

633-2.1.1.9.1 Operating Temperature: Ensure that the shipping and the operating temperature range of fiber optic cable meets or exceeds minus 30º to 158º F. Ensure that the installation temperature range of fiber optic cable meets or exceeds minus 22º to 140ºF.

633-2.1.1.9.2 Bend radius: Ensure that the fiber optic cable is capable of withstanding a minimum unloaded bend radius of 10 times the cable diameter and a minimum loaded bend radius of 20 times the cable diameter when loaded to pulling tension of 600 pounds. Test the cable as required in the TIA/EIA-455-33A standard. Ensure that bending the fiber optic cable up to the minimum bend radius does not affect the optical characteristics of the fiber.

633-2.1.1.9.3 Cable Strength: Ensure that the fiber optic cable is capable of withstanding a pulling tension of 600 pounds during installation without increasing the fiber attenuation more than 0.8 decibel per mile and without changing other optical fiber characteristics after the tensile load is removed. Ensure that optical fiber is proof-tested by the fiber manufacturer at a minimum of 100 kilo pounds per square inch. Ensure that the cable will withstand 25 impact cycles and the change in attenuation does not exceed 0.2 decibel at 1,550 nanometers when tested according to the requirements as detailed in the TIA/EIA-455-25B standard. Ensure that the fiber optic cable can withstand a minimum compression load of 125 pounds per square inch when applied uniformly over the length of the sample at the rate of 0.15 inches to 0.8 inches per minute and maintained for 10 minutes as defined in the TIA/EIA-455-41A standard. Ensure that the change in attenuation will not exceed 0.15 decibel during loading at 1,550 nanometers, and that no fiber displays a measurable change in attenuation after load removal.

633-2.1.1.9.4 Water Penetration: Ensure that the fiber optic cable is capable of withstanding the tests for water penetration defined in the TIA/EIA-455-82 standard. Ensure that a one-meter length of cable is able to withstand a one-meter static head of water applied at one end for 24 hours without water leaking through the other open cable end.

633-2.1.2 Fiber Optic Connection Hardware: Ensure that all splice enclosures, organizers, cable end preparation tools, and procedures are compatible with the fiber optic cable, and are approved by the Engineer.

633-2.1.2.1 Splice Enclosures: Contain all optical fiber splices within a splice enclosure. Ensure that the enclosures provide storage for splices, fiber, and buffer tubes. Ensure that the splice enclosure restores the mechanical and environmental integrity of the fiber optic cable, encases the sheath opening in the cable, and organizes and stores optical fiber. Ensure all hinges and latching devices are stainless steel. Ensure that the enclosure is airtight and prevents water intrusion. Ensure that the splice enclosure can accommodate pressurization and

has the ability to be reentered without requiring specialized tools or equipment. Ensure that the enclosure provides fiber and splice organizers including splice trays and strain relief.

Ensure that splice enclosures are hermetically sealed to protect internal components from environmental hazards such as moisture, insects, and UV light. Fiber optic splice enclosures shall also:

Comply with the Telcordia Technologies' GR-711-CORE standard and all applicable NEC requirements.

Provide space for future expansion equal to 100% of the initial utilization.

Provide fiber optic cable penetration end caps to accommodate a minimum installation of two trunk fiber optic cables and two fiber optic drop cables. Ensure that the enclosure end caps are factory-drilled to the proper diameter to accept and seal the fiber optic cable entries. Ensure that the cable entry locations can accommodate an assortment of cables with outside diameters ranging from 0.45 inches to 0.55 inches, plus 10%, without jeopardizing the waterproof characteristics of the enclosure.

Provide fiber optic splice enclosures meeting the following requirements:

Mechanical
Resist compression deformation to a maximum of 400 pounds.
Withstand an impact energy to a maximum of 40 foot-pounds at 0°F.
Axial Tension: 100 pounds for 30 minutes.
Cable Torsion: ten 90-degree rotations.
Cable Flexing: ten 90-degree bends**.**
Environmental
Hydrostatic Pressure Head: Up to 20 foot-pounds (-9 pounds per square inch).
Withstand 40 freeze/thaw temperature cycles.
Ultraviolet resistant during a maximum 30-day exposure in compliance with the requirements detailed in the ASTM B117 standard.
Chemical
Withstand a 90-day exposure to solutions of 3% sulfuric acid, 0.2 normal of sodium hydroxide, 10% Igepal®, kerosene, and be fungus resistant as required in the ASTM G21 standard.

633-2.1.2.2 Splice Trays: Ensure that splice trays are securely attached and accessible, and provide sufficient storage for the fiber cable. Ensure splice trays provide access to individual fibers without disrupting other fibers in the tray. Ensure that splice trays hold the buffer tubes rigidly in place and provide protection for fusion splices. Ensure that the raceway accommodates the minimum bend radius of the fiber. Ensure that splice trays allow visible inspection of the fiber. Ensure that splice trays include a cover with a locking mechanism to hold it in place.

633-2.1.3 Cable Terminations: Use Type ST, SC, LC, or FC connectors only, as specified in the Plans or by the Engineer. Ensure that all ST-type fiber optic connectors, whether factory pre-terminated or field-installed, are 0.1 inch physical contact with preradiused tips. Ensure that ST and FC connectors include a ceramic ferrule and a metallic body, and provide a

strain relief mechanism when installed on a single fiber cable that contains strength elements. Ensure that the ST-type connector provides a minimum 50 pound pullout strength. Ensure that the optical fiber within the body of all connectors is mechanically isolated from cable tension, bending, and twisting.

Ensure that all connectors are compliant with the TIA/EIA-568-A and TIA/EIA-604 standards, as applicable, and are tested according to the Telcordia/Bellcore GR-326-CORE standard. When tested according to the TIA and EIA's Fiber Optic Test Procedure (FOTP)-171 (TIA/EIA-455-171), ensure that the connectors test to an average insertion loss of less than or equal to 0.4 decibel and a maximum loss of less than or equal to 0.75 decibel. Test the connectors as detailed in FOTP-107 (TIA/EIA-455-107) to reflectance values of less than or equal to minus 50 decibels.

633-2.1.3.1 Pre-terminated Connector Assemblies (Pigtails): Ensure that pre-terminated cable assemblies consist of fiber optic cables with factory-installed connectors on one end of the cable and an un-terminated optical fiber on the other. Ensure that the pre-terminated connector assemblies are installed with fusion splices. Ensure that all buffer tubes and fibers are protected once the attachment of pre-terminated connector assemblies is complete.

633-2.1.3.2 Buffer Tube Fan-out Kits: Ensure that a buffer tube fan-out kit is installed when fiber optic cables are terminated. Use a kit compatible with the fiber optic cable being terminated and that is color-coded to match the optical fiber color scheme. Ensure that the buffer tube fan-out kit supports 12 fiber strands. Ensure that output tubing and the fiber strands contained therein are of sufficient length for routing and attachment of fiber optic cable to connected electronics or as directed by the Engineer. Ensure that the kit and the connectors are supplied by the same manufacturer.

633-2.1.4 Patch Panels: Ensure that the patch panel is compatible with the fiber optic cable being terminated and color coded to match the optical fiber color scheme. Ensure that the patch panel has a minimum of 12 ST-type panel connectors unless otherwise shown in the Plans. Ensure that the patch panel dimensions do not exceed 14 inches x 6 inches x 4 inches for fiber counts of twelve or less. Ensure the patch panel is suitable for mounting within an approved cabinet at the field device location. Ensure patch panels are sized to accommodate specified coupler housings and maintain sufficient bend radius for cables. Ensure the patch panel is sized to occupy the minimum space required for capacity.

633-2.1.4.1 Pre-terminated Patch Panels: Ensure that the pre-terminated patch panel includes a factory installed all-dielectric SMF cable stub. Ensure that the panel includes factory installed and terminated ST-type panel connectors unless otherwise shown in the Plans. Ensure that the cable stub is of sufficient length to splice the stub and provide a fiber connection between the panel and the backbone fiber cable or as directed by the Engineer.

633-2.1.4.2 Field Assembled and Terminated Patch Panels: Ensure that the field-assembled patch panel is a termination panel that includes a connector panel and the hardware required to mount the patch panel within an approved cabinet at the field device location and connect the panel to the backbone fiber cable.

633-2.1.4.2.1 Connector Panel: Ensure that the connector panel provides 12 ST-type, bulkhead-mount coupling connectors unless otherwise shown in the Plans. Ensure that each coupling connector allows connection of a cable terminated on one side of the panel to a cable on the opposite side.

Ensure that each bulkhead-mount coupling connector includes a locknut for mounting the connector in predrilled or punched holes in the connector panel.

633-2.1.5 Handling:

633-2.1.5.1 Cable End Sealing: Ensure that fiber optic cable ends are capped or sealed to prevent the entry of moisture during shipping, handling, storage, and installation. Equip one end of the fiber optic cable with flexible pulling eyes.

633-2.1.5.2 Protective Wrap: Ensure that the fiber optic cable is shipped and stored with a protective wrap or other approved mechanical reel protection device over the outer turns of the fiber optic cable on each reel. Ensure that the wrap is weather resistant and protects the cable reel from environmental hazards. Ensure that the cable reel remains wrapped until cable is to be installed.

633-2.1.5.3 Packaging, Shipping and Receiving: Ensure that the packaging and delivery of fiber optic cable reels comply with the following minimum requirements:

1. Ensure cable is shipped on reels of marked continuous length.
2. Ensure each cable is shipped on a separate, strongly constructed reel designed to prevent damage to the cable during shipment and installation.
3. Ensure each reel has a minimum of 6 feet on each end of the cable available for testing.
4. Ensure that all fiber optic cable is continuous and free from damage.
5. Ensure no point discontinuities greater than 0.1 decibel per reel.
6. Provide a copy of the transmission loss test results as required by the EIA/TIA-455-61 standard, as well as results from factory tests performed prior to shipping.
7. Ensure that the manufacturer provides the date of manufacture; product and serial numbers; cable data, including the reel length; refraction index; the project name and location; type of fiber and quantity of strands used; technical product data sheets; and reel numbers.

633-2.1.6 Manufacturer Testing and Certification: Provide documentation of all factory tests performed by the manufacturer for all fiber optic cable, splicing material, cable terminations, and patch panels.

633-2.2 Twisted Pair Cable: Use shielded underground and aerial cable with separate support wire conforming to Rural Electrification Administration (REA) Specification PE-39, filled telephone cables. Use shielded aerial copper communication with integral support wire conforming to REA Specification PE-38, aerial telephone cables. Use only No. 22 AWG solid cables for copper connections in traffic signal closed loop systems.

633-2.3 Communication Cable Support Wire: Provide support wire, whether separate from or integral to aerial interconnect cable, having a minimum diameter of 6.35 mm and meeting the requirements in Section A634.

633-2.4 Aerial Cable Attachment Hardware: Use attachment hardware with sufficient tensile strength for the application. Ensure that all bolts and nuts less than 5/8 inch in diameter are passivated stainless steel, Type 316 or Type 304 and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 inch and over in diameter are galvanized and meet the requirements of ASTM A307. Use stainless steel lashing

wire, galvanized or stainless steel lashing rod, cable rings or self-locking cable ties of UV stabilized black plastic having a minimum tensile strength of 100 pounds.

633-3 Installation Requirements.

633-3.1 Fiber Optic Cable Installation: Install all materials and equipment according to the latest version of the manufacturer's installation procedures. Ensure that all materials and installation practices are in accordance with the applicable OSHA requirements as found in 29 CFR Part 1926, Safety and Health Standards for Construction. In addition, perform the following:

1. Ensure conduit and inner-duct is clean and free from damage prior to installing fiber optic cable.

2. Document the sequential cable length markings at each splice box and pull box wall that the cable passes through, and include the information with the as-built documentation.

Provide all incidental parts needed to complete the installation, but not specified in the Plans, as necessary for a complete and properly operating system.

633-3.1.1 Cable Identification: Develop a nomenclature plan for identification of fiber optic cable. Submit the nomenclature plan to the Engineer for approval. Use approved cable nomenclature to create cable tags for the identification of fiber optic cable. Provide cable tag identification on all test results or fiber related documents provided to the Engineer.

Install cable tags within 1 foot of each splice and/or termination point indicating the cable type, fiber count, and each fiber optic cable origination and termination points. Ensure that the cable tags are permanent labels suitable for outside plant applications and are affixed to all fiber optic cables. Ensure that lettering is in permanent ink and displays the phrase "FDOT FIBER OPTIC CABLE".

633-3.1.2 Pulling: Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments, such as "basket grip" or "Chinese finger" type, to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.

Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and splice boxes by hand. If pulleys and sheaves will be used to mechanically pull through pull boxes and splice boxes, provide a drawing of the proposed layout showing that the cable will never be pulled through a radius less than the manufacturer's minimum bend radius. Use large diameter wheels, pulling sheaves, and cable guides to maintain the appropriate bend radius. Provide tension monitoring at all times during the pulling operation. Ensure that cable pulling lubricant used during installation is recommended by the optical fiber cable manufacturer.

633-3.1.3 Blowing: Use either the high airspeed blowing (HASB) method or the piston method. When using the HASB method, ensure that the volume of air passing through the conduit does not exceed 600 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive. When using the piston method, ensure that the volume of air passing through the conduit does not exceed 300 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive.

633-3.1.4 Slack Cable Storage: Provide and store fiber optic cable at each pull box and splice box to allow for future splices, additions, or repairs to the fiber network. Store the fiber optic cable without twisting or bending the cable below the minimum bend radius.

Store a total of 200 feet of fiber optic cable in splice boxes, with 100 feet of cable on each side of the cable splice point or as shown in the Plans.

Store 50 feet of spare fiber optic cable in pull boxes.

633-3.1.5 Fiber Optic Connection - Splicing: Perform all optical fiber splicing using the fusion splicing technique, and according to the latest version of the manufacturer's cable installation procedures; industry accepted installation standards, codes, and practices; or as directed by the Engineer. Ensure that all splices match fiber and buffer tube colors unless shown otherwise in the Plans. Where a fiber cable is to be accessed for lateral or drop signal insertion, only open the buffer tube containing the fiber to be accessed and only cut the actual fiber to be accessed. If a fiber end is not intended for use, cut the fiber to a length equal to that of the fiber to be used and neatly lay it into the splice tray. Treat any fibers exposed during splicing with a protective coating and place in a protective sleeve or housing to protect the fiber from damage or contaminants. Neatly store all splice enclosures within a splice box. Attach the splice enclosure to the splice box interior wall to prevent the enclosure from lying on the bottom of the splice box.

633-3.1.5.1 Splice Plan: Provide a splice plan showing the location and configuration of splices in the system for approval by the Engineer. Perform all splicing according to the splice plan. Document each splice location and identify the source and destination of each fiber in each splice tray. Document all fiber colors and buffer jacket colors used during installation, and develop a sequential fiber numbering plan as required in the TIA/EIA-598-A standard for color-coding in the documentation.

633-3.1.5.2 Splice Equipment: Use a fusion splice machine to splice all optical fiber. Ensure that splice equipment is new from the factory, or serviced and certified by the factory or its authorized representative within the previous 6 months from the commencement of its use. Provide the Engineer with a letter from the manufacturer or his authorized representative certifying compliance. Clean all splicing equipment and calibrate according to the manufacturer's recommendations prior to each splicing session at each location.

633-3.1.6 Cable Termination Installation: Ensure that cables, buffer tubes, or strands are neatly routed, secured and terminated in a patch panel. Ensure all cable termination points include documentation regarding the identification, route, and function of each fiber installed at that location. Ensure that at least one copy of this information is placed alongside the installed equipment (for instance, in a document pouch or drawer within a field cabinet).

633-3.1.7 Patch Panel Installation: Ensure that patch panels are neatly installed and secured in a weather proof enclosure. Ensure all patch panel connectors are clearly and permanently labeled. Ensure all installed patch panels include documentation regarding the identification, route, and function of each patch panel connector at that location. Ensure that at least one copy of this information is placed alongside the installed equipment.

633-3.1.8 Installation Testing: Notify the Engineer of cable testing at least 14 calendar days in advance. Provide the testing procedures to the Engineer for approval prior to commencement of testing. Perform all tests at 1,310/1,550 nanometer wavelengths, and include the last calibration date of all test equipment with the test parameters set on the equipment in the test documentation. Test all installed fibers (terminated and un-terminated) using methods approved by the Engineer.

633-3.1.8.1 End to End Attenuation Testing: Perform testing on all fibers to ensure that end to end attenuation does not exceed allowable loss (0.4 db/km for 1310 nanometer wavelength, 0.3 db/km for 1550 nanometer wavelength, plus 0.5 db for any connectors and 0.1 db for splices). Repair or replace cable sections exceeding allowable attenuation at no cost to the Department.

633-3.1.8.2 OTDR Tracing: Test all fibers from both cable end points with an optical time domain reflectometer (OTDR) at wavelengths of 1310 and 1550 nanometer. Test the fibers that are not terminated at the time of installation using a bare fiber adapter. Present the results of the OTDR testing (i.e., traces for each fiber) and a loss table showing details for each splice or termination tested to the Engineer in an approved electronic format. Ensure all OTDR testing complies with the EIA/TIA-455-61 standard.

633-3.1.8.3 Splice Loss Testing: Ensure that the splice loss for a SMF fusion splice does not exceed a maximum bidirectional average of 0.1 decibel per splice. Repair or replace splices that exceed allowable attenuation at no cost to the Department.

633-3.1.8.4 Connector Loss Testing: Ensure that the attenuation in the connector at each termination panel and its associated splice does not exceed 0.5 decibel. Repair or replace connectors exceeding allowable attenuation at no cost to the Department.

633-3.2 Twisted Pair Cable Installation: Install all materials and equipment according to the latest version of the manufacturer's installation procedures.

Install copper communication cables in continuous lengths to and between cabinets and junction boxes. The Contractor may install junctions at intervals less than shown in the Plans; however, the Contractor must provide any additional materials (such as junction boxes, cabinets, risers, and mounting hardware) and labor for additional junctions and terminations at no expense to the Department. Obtain the Engineer's approval for any additional junctions or terminations.

633-3.2.1 Cable type and Number of Conductors: Determine the appropriate cable type and conductor count required for each twisted pair communication cable unless specified in the Contract Documents. Identify all spare conductors.

633-3.2.2 Number of Cables: Do not install more than four separate cables at any point on a single support wire.

633-3.2.3 Protection of Cable: Ensure cable drawn through conduit, ducts, drilled holes protected by a rubber grommet, or support structures is installed in such a manner as to prevent damage to conductors or insulation.

633-4 Warranty.

Ensure that the fiber optic cable, the splice enclosures, and terminations have a manufacturer's warranty covering defects for a minimum of two years from the date of final acceptance in accordance with 5-11 and Section 608. Ensure the warranty includes providing replacements, within 10 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or the maintaining agency.

633-5 Method of Measurement.

633-5.1 General: The quantities to be paid will be: (1) the length, in feet, of fiber optic cable; (2) the number, per each, of fiber optic connections; (3) the number, per each, of fiber optic connection hardware; and (4) the length, per foot, of twisted pair cable, accepted by the Engineer.

633-5.2 Furnish and Install: The Contract unit price for communication cable, furnished and installed, will include furnishing, placement, and testing of all material, and for all tools, labor, equipment, installation hardware (such as support wire, cable ties, cable clamps, and lashing wire), supplies, support, personnel training, documentation, and incidentals necessary for a complete installation.

Payment for conductive cable terminal connectors and conductive cable grounding is considered incidental and shall be included in the price for twisted pair communication cable.

Fiber optic splices and terminations, as shown in the Plans, shall be measured per each fiber optic connection furnished and installed.

633-5.3 Furnish: The Contract unit price for communication cable, furnished, will include the cost of the required cable as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

633-5.4 Install: The Contract unit for communication cable, installed, will include all tools, labor, equipment, installation hardware (such as support wire, cable ties, cable clamps, and lashing wire), supplies, support, personnel training, documentation, and incidentals necessary for a complete, warranted, tested, and accepted installation. The Engineer will supply all cable.

633-6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 633-1	Fiber Optic Cable - per foot.
Item No. 633-2	Fiber Optic Connection - each.
Item No. 633-3	Fiber Optic Connection Hardware – each.
Item No. 633-4	Twisted Pair Cable – per foot.

635 PULL, SPLICE, AND JUNCTION BOXES.

(REV 1-30-13) (FA 2-6-13) (7-13)

SECTION 635 (Pages 792 - 793) is deleted and the following substituted:

SECTION 635
PULL, SPLICE, AND JUNCTION BOXES

635-1 Description.

Furnish and install pull, splice, and junction boxes as shown in the Plans.

635-2 Materials.

635-2.1 General: Use pull and splice boxes listed on the Department's Approved Product List (APL).

635-2.2 Pull and Splice Boxes:

635-2.2.1 General: Manufacturers of concrete pull and splice boxes and covers seeking inclusion on the APL shall meet the requirements of 105-3 and this Section and be listed on the Department's list of Incidental Precast/Prestressed Concrete Producers with Accepted Quality Control Programs.

Ensure box bodies and covers are free of flaws such as cracks, sharp, broken, or uneven edges, and voids.

Ensure in-ground boxes have an open bottom design.

635-2.2.2 Marking: Ensure the following information is permanently cast into the top surface of all pull and splice box covers:

1. Unless otherwise shown in the Plans, mark application as follows:
   FDOT TRAFFIC SIGNAL for signalized intersections
   FDOT FIBER OPTIC CABLE for fiber optic cable
   FDOT LIGHTING for highway lighting
   FDOT TRAFFIC MONITORING for traffic monitoring
   FDOT ELECTRICAL for other electrical applications
2. Manufacturer's name or logo
3. FDOT APL approval number
4. TIER rating

Ensure the date of manufacture (month/day/year, or date code) is permanently located on the top or bottom of the cover. Ensure the interior of the box body has a permanent marking that includes the manufacturer part/model number and date of manufacture near the top of box in a location that is visible after installation when the cover is removed.

635-2.2.3 Dimensions: Unless otherwise shown in the Plans, provide pull and splice boxes with the following dimensions.

For signalized intersection and lighting applications, provide pull boxes with nominal dimensions of 13 inches wide by 24 inches long (cover) and no less than 12 inches deep. Ensure the inside opening area is a minimum of 240 square inches and no inside dimension is less than 12 inches.

For fiber optic cable applications, provide pull boxes with nominal dimensions of 24 inches wide by 36 inches long (cover) and no less than 24 inches deep.

Provide rectangular splice boxes with nominal dimensions of 30 inches wide by 60 inches long (cover) and no less than 36 inches deep. Provide round splice boxes with a nominal diameter of 36 inches (cover) and no less than 36 inches deep.

635-2.2.4 Fabrication: Provide box covers constructed of concrete, polymer concrete, cast iron or other materials meeting the requirements of this Section. Provide cast iron covers meeting the requirements of ASTM A48, Class 20.

Provide box covers with lifting slots and a flush-seating lockdown mechanism. Use penta-head lockdown lag bolts. Ensure lockdown bolts and lifting slots are Type 316, 304, or 302 passivated stainless steel or brass. Ensure lockdown bolt assembly is designed to prevent seizing and can be removed without damaging the cover or box body. Ensure the lockdown bolt threaded insert/nut assembly is field replaceable.

635-2.2.5 Testing Requirements: Ensure pull and splice boxes meet the American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE) 77 2010 Specification for Underground Enclosure Integrity for TIER 15 loading with the following additional clarifications and requirements:

1. Apply all environmental tests to the box and its cover.
2. Obtain all material coupons for environmental tests from full size production samples.
3. All flexural testing must be conducted in accordance with an appropriate ASTM standard and clearly stated in the report.

4. Perform repetitions of Cycle 1 in Table X2.1 of ASTM G154 for a minimum duration of 1000 hours for the simulated sunlight exposure test.

5. Use deflection-measuring devices positioned to measure vertical and lateral deflection (wherever maximum deflection occurs) for the vertical sidewall load test.

When testing pull and splice boxes of various sizes (width x length x depth), the cover impact test, internal equipment protection test, coefficient of friction test, and all environmental tests, can be completed using a single representative box/cover (instead of samples from all box/cover sizes) as long as the test report indicates the following:

1. Materials of construction, compositions, and manufacturing processes are identical for all box and cover sizes submitted for listing on the APL.

2. Size (width x length x depth) of the representative box/cover.

635-2.3 Junction Boxes:

635-2.3.1 Fabrication: Provide galvanized steel, aluminum or NEMA 4X non-metallic junction boxes. Ensure all attachment hardware is Type 316 or 304, passivated stainless steel.

Ensure the outside surface has a smooth, uniform finish. Ensure boxes are free of burrs, pits, sharp corners and dents. Ensure all welds are neatly formed and free of cracks, blow holes, and other irregularities.

635-2.3.1.1 Aerial Junction Boxes: Unless otherwise shown in the Plans, provide aerial junction boxes with minimum inside dimensions of 8 inches wide by 8 inches long and at least 3 inches deep.

635-2.3.1.2 Mounted Junction Boxes: Provide mounted junction boxes fabricated of 5052 sheet aluminum alloy with a minimum thickness of 1/8 inch. Ensure all mounted junction boxes have a hinged door and lock as specified in Section A676.

Unless otherwise shown in the Plans, provide mounted junction boxes for the following installations:

For pole and cabinet mounted installations, provide junction boxes with minimum inside dimensions of 13 inches long by 10 inches wide and at least 3 inches deep.

For base mounted installations, provide junction boxes with minimum inside dimensions of 21 inches long by 10 inches wide and at least 8 inches deep.

635-2.3.1.3 Embedded Junction Boxes: Provide weatherproof embedded junction boxes for use in concrete substructures or superstructures. Include gasketed weatherproof covers made of the same material as the box and Type 316 or 304, stainless steel, tamper resistant screws for securing the cover. Fabricate galvanized steel boxes and their covers from steel meeting the requirements of ASTM A36 and galvanized in accordance with ASTM A123.

For embedded junction boxes not exposed to vehicular impacts, provide the following types of junction boxes. Where the structure's environmental classification is slightly or moderately aggressive, provide a galvanized steel or NEMA 4X (non-metallic) box, as approved by the Engineer. Where the structure's environmental classification is extremely aggressive, provide a NEMA 4X (non-metallic) box, unless otherwise directed by the Engineer.

For embedded junction boxes exposed to vehicular impacts, provide a galvanized steel box regardless of the structure's environmental classification.

635-2.3.2 Barrier Terminal Blocks: Provide a barrier terminal block with a minimum of ten positions and rated at 600 VAC in all aerial and mounted junction boxes. Ensure

each terminal block position has two screws electrically connected by a shorting bar or other Department approved method. Ensure all terminal block positions are numbered sequentially.

635-3 Installation.

635-3.1 General: Do not pull signal or communication cable through a pull box used for loop termination. Use separate pull boxes for signal and communication cables.

When signal or 120V (or greater) power is present, ground all metal covers in accordance with Section 620.

635-3.2 Pull and Splice Boxes: Install pull and splice boxes in accordance with the Design Standards, Index No. 17700. Ensure pull and splice boxes are sized for the amount of cable to be placed inside. Ensure that the pull or splice box cover is flush with the finished grade or sidewalk. Do not install pull or splice boxes in roadways, driveways, parking areas, ditches or public sidewalk curb ramps. Avoid placing pull and splice boxes in low-lying locations with poor drainage. Ensure that pull and splice boxes house fiber optic cable without subjecting the cable to a bend radius less than 14 times the diameter of the cable.

635-3.2.1 Placement and Spacing: Place pull and splice boxes as shown in the Plans and at the following locations, unless directed otherwise by the Engineer:

1. At all major fiber optic cable and conduit junctions.
2. Approximately every 2,500 feet for fiber optic cable applications in rural areas with any continuous section of straight conduit if no fiber optic cable splice is required.
3. At a maximum of 1,760 feet for fiber optic cable applications in metropolitan areas.
4. At each end of a tunnel, and on each side of a river or lake crossing.
5. On each side of an aboveground conduit installation, such as an attachment to a bridge or wall.
6. At all turns in the conduit system.
7. Near the base of a service pole or communication cabinet to provide:
    a. A transition point between the fiber optic conduits extending from the fiber backbone and the conduit feeding the communication cabinet.
    b. An assist point for the installation of fiber optic drop cable.
    c. Storage of slack fiber optic drop cable.

635-3.2.2 Electronic Box Marker: Equip all pull and splice boxes buried below finish grade with an electronic box marker inside the pull or splice box to mark the location. Ensure that the electronic box marker is a device specifically manufactured to electronically mark and locate underground facilities. Ensure that the electronic box marker includes circuitry and an antenna encased in a waterproof polyethylene shell. Ensure that the outer shell is impervious to minerals, chemicals, and temperature extremes normally found in underground plant environments. Ensure that the electronic box marker does not require any batteries or active components to operate. Ensure that electronic box markers used to mark fiber optic cable and general telecom applications are orange in color and operate at 101.4 kHz. Ensure that the electronic box marker's passive circuits produce an RF field when excited by a marker locator to direct the locator to the marker's position. Ensure that the electronic box marker has a minimum operating range of 5 feet from the marker locator.

635-3.3 Aerial Junction Boxes: Install aerial junction boxes in accordance with the Design Standards, Index No. 17733.

635-3.4 Mounted Junction Boxes: Install mounted junction boxes in accordance with the Design Standards, Index No. 17841. Ensure that the bottom surface of pole mounted junction boxes is a minimum of 4 feet above the finished grade.

635-3.5 Cable Terminations: Make cable terminations in junction boxes in accordance with Section 632. Route and form the cable to allow access to the terminal screws. Do not cover the terminal identification numbers with the cable.

635-4 Relocation of Pull, Splice, and Junction Boxes.

Relocation of pull, splice, and junction boxes shall consist of removing an existing box and installing the box at the location shown in the Plans. Restore the area of the box removal and relocation to the condition of the adjacent area. The costs for restoration will be included in the Contract unit price of the relocation.

Boxes damaged due to the Contractor's operations must be replaced by the Contractor at no cost to the Department. Replacement boxes must be of the same material and size of the existing box, unless directed otherwise by the Engineer.

635-5 Warranty.

Ensure all pull, splice, and junction boxes have a manufacturer's warranty covering defects for a minimum of one year from the date of final acceptance in accordance with 5-11 and Section 608. Ensure the warranty includes providing replacements, within 30 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or the maintaining agency.

635-6 Method of Measurement.

635-6.1 General: Measurement for payment will be in accordance with the following work tasks:

635-6.2 Furnish and Install: The Contract unit price each for pull, splice, and junction box, furnished and installed, will consist of the pull, splice, and junction box including all required hardware for the type of box and location as specified in the Contract Documents, and all labor and materials necessary for a complete and accepted installation.

635-6.3 Furnish: The Contract unit price each for pull, splice, and junction box, furnished, will include the cost of the pull, splice, and junction box including covers, doors, locks and keys, and any necessary miscellaneous hardware specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

635-6.4 Install: The Contract unit price each for pull, splice, and junction box, installed, will include the cost of all labor, equipment, miscellaneous hardware and materials necessary to make a complete and accepted installation of the type box and at locations as shown in the Plans. The Engineer will supply a complete box as specified in the Contract Documents.

635-6.5 Relocate: The Contract unit price each for pull, splice, and junction box, relocate, will include the removal of the box and relocation to the location shown in the Plans. This includes the cost of all labor, equipment, miscellaneous hardware and materials necessary for a complete and accepted installation.

635-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, except grounding. Payment for embedded junction boxes will not be made separately.

The Contractor shall include the cost of embedded junction boxes in the Contract unit price for the concrete substructure or superstructure items.

Payment will be made under:

Item No. 635- 2- Pull, and Splice Boxes - each.

Item No. 635- 3- Junction Boxes - each.

649 GALVANIZED STEEL STRAIN POLES, MAST ARMS AND MONOTUBE ASSEMBLIES.

(REV 10-15-12) (FA 11-15-12) (7-13)

ARTICLE 649-2 (Page 799) is deleted and the following substituted:

649-2 Materials.

Use pole assemblies as shown in the Design Standards when standard mast arm assemblies or standard strain pole assemblies are required by the Contract Documents. Obtain strain poles, mast arm, and monotube assemblies from a fabrication facility that is listed on the Department's list of Metal Producers with an Accepted Quality Control Program, meeting the requirements of 105-3.

Use coating products meeting the requirements of Section 975.

Use grouts meeting the requirements of Section 934 and listed on the Department's Qualified Project List (QPL).

Use water meeting the requirements of Section 923.

Use membrane curing compounds meeting the requirements of Section 925.

ARTICLE 649-5 (Pages 801 – 802) is deleted and the following substituted:

649-5 Installation.

Install foundations for strain poles, mast arm and monotube assemblies in accordance with Section 455. Do not install the strain poles, mast arm pole, or monotube pole until the foundation has achieved 70% of the specified 28-day concrete strength and verifying test results have been provided to the Engineer. Determine concrete strength from tests on a minimum of two test cylinders prepared and tested in accordance with ASTM C31 and ASTM C39. Before erecting the pole, clean the top of the foundation of any laitance, oils, grease or any other deleterious materials. Erect strain poles in an orientation which considering the rake and the application, cable forces will produce a plumb pole. Erect monotubes plumb at the time of installation. Plumb the pole supporting mast arms after the mast arms, traffic signals or sign panels have been placed.

If the traffic signals and/or sign panels are not in place within two working days after the mast arm is erected, furnish and install a 3 foot by 2 foot blank sign panel on the bottom of each mast arm within 6 feet of the mast arm tip and plumb the pole. Re-plumb the pole supporting mast arms after installation of traffic signals and sign panels.

Install ASTM A325 bolt, nut and washer assemblies in accordance with the following. Use bolt, nut and washer assemblies that are free of rust and corrosion and that are lubricated properly as demonstrated by being able to easily hand turn the nut on the bolt thread for its entire

length. Tighten nuts to a snug tight condition to bring the faying surfaces of the assembly into full contact which is referred to as snug-tight. Snug-tight is defined as the maximum nut rotation resulting from the full effort of one person on a 12 inch long wrench or equivalent. After bringing the faying surfaces to a snug-tight condition, tighten nuts in accordance with the turn-of-nut method in 460-5, Table 460-7. Maintain uniform contact pressure on the faying surfaces during snugging and turn-of-nut process, by using a bolt tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt.

Installation steps are as follows:

1) Verify that the nuts can be turned onto the bolts past the elevation corresponding to the bottom of each in-place leveling nut and be backed off by the effort of one person on a 12 inch long wrench, without employing a pipe extension on the wrench handle.

2) Clean and lubricate the exposed threads of all anchor bolts. Clean and lubricate the threads and bearing surfaces of all leveling nuts. Re-lubricate the exposed threads of the anchor bolts and the threads of the leveling nuts if more than 24 hours has elapsed since earlier lubrication, or if the anchor bolts and leveling nuts have become wet since they were first lubricated.

3) Turn the leveling nuts onto the anchor bolts and align the nuts to the same elevation.

4) Place structural plate washers on top of the leveling nuts; one washer corresponding to each anchor bolt.

5) Install the base plate onto the leveling nut washers, place structural plate washers on top of the base plate; one washer corresponding to each anchor bolt, and turn the top nuts onto the anchor bolts.

6) Tighten top nuts to a snug-tight condition in a star pattern. A star tightening pattern is one in which the nuts on opposite or near opposite sides of the bolt circle are successively tightened in a pattern resembling a star. For an 8 bolt circle with bolts sequentially numbered 1 to 8, tighten nuts in the following bolt order: (1, 5, 7, 3, 8, 4, 6, 2).

7) Tighten leveling nuts to a snug-tight condition in a star pattern. The distance from the bottom of the leveling nuts to the top of the concrete must not exceed one anchor bolt diameter.

8) Before final tightening of the top nuts, mark the reference position of each tip nut in a snug-tight condition with a suitable marking on one flat with a corresponding reference mark on the base plate at each bolt. Then incrementally turn the top nuts using a star pattern until achieving the required nut rotation specified in Table A. Turn the nuts in at least 2 full tightening cycles (passes). After tightening, verify the nut rotation. Do not exceed the Table A value by more than 20 degrees.

9) Tighten each retainer or jam nut until it is in firm contact with the top surface of the anchor bolt nut then while preventing the anchor bolt nut from rotating, tighten the jam nut unit it is snug tight.

Table A	
Anchor Bolt Diameter (in.)	Nut Rotation from Snug-Tight Condition
≤ 1 1/2	1/3 turn
> 1 1/2	1/6 turn

660 VEHICLE DETECTION SYSTEM.
(REV 1-28-13) (FA 2-13-13) (7-13)

SECTION 660 (Pages 809 - 811) is deleted and the following substituted:

SECTION 660 VEHICLE DETECTION SYSTEM

660-1 Description

Furnish and install a vehicle detection system in accordance with the Contract Documents. Use only vehicle detection systems that meet the requirements of this Specification and are listed on the Department's Approved Product List (APL).

660-2 Materials

660-2.1 Classification of Types: Vehicle detection and data collection systems are classified by the type of function they perform and the type of technology that they employ.

660-2.1.1 Functional Types: Provide the functional type detailed in the Plans.

660-2.1.1.1 Vehicle Presence Detection System: Vehicle presence detectors produce a corresponding output any time that a vehicle occupies the physical or virtual area of the detector.

660-2.1.1.2 Traffic Data Detection System: Traffic data detectors provide presence, volume, occupancy, and speed data for the lanes they are configured to monitor.

660-2.1.1.3 Probe Data Detection Systems: Probe data detection systems provide speed data and travel times for a road segment. Probe data detectors use automatic vehicle identification (AVI) technologies to establish a unique identifier for each vehicle they detect. This identifier is then transmitted to a central site where it can be matched to past or future detections of the same vehicle at different detector locations.

660-2.1.2 Technology Types: Provide the detection technology type detailed in the Plans. Detection technology types include inductive loop, video, microwave, wireless magnetometer, and AVI systems.

660-2.1.2.1 Inductive Loop: An inductive loop detection system uses a minimum of one inductive loop and loop detector. The system operates by energizing and monitoring wire embedded in the road surface to detect vehicle presence and provide an output to traffic controllers or other devices that can generate volume, occupancy, and speed data (detection output).

660-2.1.2.1.1 Inductive Loop Detector Units: Ensure rack mount inductive loop detector units meet the requirements of NEMA TS-2-2003. Ensure shelf mount detector units meet the requirements of NEMA TS-1-1989.

660-2.1.2.1.2 Loop Wire: Use No. 12 AWG stranded copper wire with Type XHHW cross-linked polyethylene insulation, or No. 14 AWG stranded copper wire with Type XHHW cross-linked polyethylene insulation and an additional outer sleeve composed of polyvinylchloride or polyethylene insulation that meets the requirements of International Municipal Signal Association (IMSA) 51-7.

660-2.1.2.1.3 Shielded Lead-in Cable: Use No. 14 AWG two conductor, stranded copper wire with shield and polyethylene insulation, meeting the requirements for IMSA 50-2.

660-2.1.2.1.4 Splicing Material: Butt-end connectors may be used for splicing the loop wire to the lead-in cable. Butt-end connectors must be non-insulated. Use resin-core solder for soldered splices. Splicing tape must be self-fusing silicone rubber. Ensure insulated tubing used to cover splice is heat-shrinkable, cross-linked polyethylene with a silicon sealant inside the tubing and an insulation rating of at least 600 V.

660-2.1.2.1.5 Loop Sealant: Ensure loop sealant is intended for traffic loop embedding in both asphalt and concrete pavement. Ensure that multi-component systems have simple mix rations of 1:1 or 2:1 or are supplied in pre-measured containers in which all contents of both packages are to be mixed.

Ensure that loop sealant is self-leveling when applied. Ensure that loop sealant does not run out of unlevel slots as tested for viscosity using ASTM D562 at 77°F. Ensure loop sealant is tack free within a maximum of 2 hours from time of application and when cured as tested for tack free time using ASTM C679 at 77°F.

Ensure loop sealant securely adheres to concrete and asphalt when installed in a 3/8 inch by 3 inch saw cut, cured for 2 weeks at 77°F as tested for adhesion using visual inspection. Ensure loop sealant shows no visible signs of shrinkage after curing when installed in a 3/8 inch by 3 inch saw cut, cured for 2 weeks at 77°F as tested for shrinkage using a dimensional measurement.

Ensure loop sealant resists weather, oils, gasoline, antifreeze, and brake fluid as tested for absorption using ASTM D570 for water, No. 3 oil, gasoline, antifreeze, and brake fluid for 24 hours. Ensure loop sealant resists penetration of foreign materials as tested for durometer hardness using ASTM D2240 Shore A for 24 hours.

Ensure loop sealant resists cracking caused by expansion and contraction due to temperature changes as tested for tensile strength and elongation using ASTM D412.

Ensure loop sealant does not become brittle with age or temperature extremes as tested for weight loss, cracking, and chalking using ASTM C1246.

Ensure loop sealant has a minimum shelf life of 1 year in undamaged containers when stored per manufacturer recommendations.

660-2.1.2.2 Video: A video vehicle detection system (VVDS) uses one or more cameras and video analytics hardware and software to detect vehicle presence, provides a detection output, and generates volume, occupancy, and speed data.

660-2.1.2.2.1 Configuration and Management: Ensure that the VVDS is provided with software that allows local and remote configuration and monitoring. Ensure that the system can display detection zones and detection activations overlaid on live video inputs.

Ensure that the VVDS allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

Ensure that the VVDS retains its programming in nonvolatile memory. Ensure that the detection system configuration data can be saved to a computer and restored from a saved file. Ensure that all communication addresses are user programmable.

Ensure that the detection system software offers an open Application Programming Interface (API) and software development kit available to the Department at no cost for integration with third party software and systems.

660-2.1.2.2.2 Detection Camera: Provide a camera that is furnished or approved by the video detection system manufacturer.

660-2.1.2.2.3 Machine Vision Processor: Ensure the VVDS includes a machine vision processor that allows video analysis, presence detection, data collection, and interfaces for inputs and outputs as well as storage and reporting of collected vehicle detection data.

660-2.1.2.2.4 Communications: Ensure that the VVDS includes a minimum of one serial or Ethernet communications interface.

Ensure the serial interface and connector conforms to Telecommunications Industry Association (TIA)-232 standards. Ensure that the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

Ensure wireless communications are secure and that wireless devices are Federal Communications Commission (FCC) certified. Ensure that the FCC identification number is displayed on an external label and that all detection system devices operate within their FCC frequency allocation.

Ensure cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.

Ensure the system can be configured and monitored via one or more communications interface.

660-2.1.2.2.5 Video Inputs and Outputs: Ensure that analog video inputs and outputs utilize BNC connectors.

660-2.1.2.2.6 Solid State Detection Outputs: Ensure outputs meet the requirements of NEMA TS2-2003, 6.5.2.26.

660-2.1.2.2.7 Electrical Requirements: Ensure the system operates using a nominal input voltage of 120 volts of alternating current (V_{AC}). Ensure that the system will operate with an input voltage ranging from 89 to 135 V_{AC}. If a system device requires operating voltages other than 120 V_{AC}, supply a voltage converter.

660-2.1.2.3 Microwave: A microwave vehicle detection system (MVDS) transmits, receives, and analyzes a FCC-certified, low-power microwave radar signal to detect vehicle presence, provide a detection output, and generate volume, occupancy, and speed data.

Ensure that sidefire MVDS sensors used for data collection have a minimum 200-foot range and the capability to detect 8 lanes of traffic.

660-2.1.2.3.1 Configuration and Management: Ensure that the MVDS is provided with software that allows local and remote configuration and monitoring. Ensure that the system software can display detection zones and detection activations in a graphical format.

Ensure that the MVDS allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

Ensure that the MVDS retains its programming in nonvolatile memory. Ensure that the detection system configuration data can be saved to a computer and restored from a saved file. Ensure that all communication addresses are user programmable.

Ensure that the detection system software offers an open API and software development kit available to the Department at no cost for integration with third party software and systems.

660-2.1.2.3.2 Communications: Ensure that major components of the detection system (such as the sensor and any separate hardware used for contact closures), include a minimum of one serial or Ethernet communications interface.

Ensure the serial interface and connector conforms to TIA-232 standards. Ensure that the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

Ensure wireless communications are secure and that wireless devices are FCC-certified. Ensure that the FCC identification number is displayed on an external label and that all detection system devices operate within their FCC frequency allocation.

Ensure cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.

Ensure the system can be configured and monitored via one or more communications interface.

660-2.1.2.3.3 Solid State Detection Outputs: Ensure outputs meet the requirements of NEMA TS2-2003, 6.5.2.26.

660-2.1.2.3.4 Electrical Requirements: Ensure the microwave detector will operate with a nominal input voltage of 12 V_{DC}. Ensure the microwave detector will operate with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, supply a voltage converter.

Ensure that the detector is FCC-certified and that the FCC identification number is displayed on an external label. Ensure that the detector transmits within a frequency band of 10.525 gigahertz, plus or minus 25 megahertz, or another FCC-approved spectral band.

660-2.1.2.4 Wireless Magnetometer: A wireless magnetometer detection system (WMDS) uses one or more battery-powered wireless sensors embedded in the road surface, which communicates data by radio to a roadside receiver. Wireless magnetometer systems detect vehicle presence and provide a detection output to traffic controllers or other devices that can generate volume, occupancy, and speed data.

660-2.1.2.4.1Configuration and Management: Ensure that the detection system is provided with software that allows local and remote configuration and monitoring.

Ensure that the WMDS allows a user to edit previously defined configuration parameters.

Ensure that the WMDS retains its programming in nonvolatile memory. Ensure that the detection system configuration data can be saved to a

computer and restored from a saved file. Ensure that all communication addresses are user programmable.

Ensure that the detection system software offers an open API and software development kit available to the Department at no cost for integration with third party software and systems.

660-2.1.2.4.2 Communications: Ensure that components of the detection system (such as sensors, access points, and contact closure cards) include a minimum of one serial or Ethernet communications interface.

Ensure the serial interface and connector conforms to TIA-232 standards. Ensure that the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

Ensure wireless communications are secure and that wireless devices are FCC-certified. Ensure that the FCC identification number is displayed on an external label and that all detection system devices operate within their FCC frequency allocation.

Ensure cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.

Ensure the system can be configured and monitored via one or more communications interface.

660-2.1.2.4.3 Solid State Detection Outputs: Ensure outputs meet the requirements of NEMA TS2-2003, 6.5.2.26.

660-2.1.2.4.4 Electrical Requirements: Ensure the detection system will operate with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, supply a voltage converter.

660-2.1.2.5 Automatic Vehicle Identification (AVI): AVI detection systems use one or more different methods to collect information that can be used to establish a unique identifier for each vehicle detected and the time and location that the vehicle was detected. AVI detection systems collect data using probe detectors that utilize radio-frequency identification (RFID), optical character recognition, magnetic signature analysis, laser profiling, Bluetooth®, or other technologies to establish vehicle identifier, time, and location.

660-2.1.2.5.1 Configuration and Management: Ensure that the detection system is provided with software that allows local and remote configuration and monitoring.

660-2.1.2.5.2 Communications: Ensure that components of the detection system (such as sensors, controllers, and processing hardware) include a minimum of one serial or Ethernet communications interface.

Ensure the serial interface and connector conforms to TIA-232 standards. Ensure that the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

Ensure wireless communications are secure and that wireless devices are FCC-certified. Ensure that the FCC identification number is displayed on an external label and that all detection system devices operate within their FCC frequency allocation.

Ensure cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.

Ensure the system can be configured and monitored via one or more communications interface.

660-2.1.2.5.3 Probe Detector Requirements

1. Transponder Readers: Ensure transponder readers are compatible with multiple tag protocols, including Allegro and the protocol defined in ISO18000-6B.

2. Bluetooth Readers: Ensure that Bluetooth readers will operate using solar power and cellular communications. Ensure that Bluetooth readers will operate with a nominal input voltage of 12 V_{DC}.

3. License Plate Readers: License plate readers must not require the use of visible strobes or other visible supplemental lighting.

660-2.1.2.5.4 Electrical Requirements: Ensure the detection system will operate with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, supply a voltage converter.

660-2.1.3 Mechanical Requirements for all Detectors: Ensure that all parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. Ensure that all fasteners exposed to the elements are Type 304 or 316 passivated stainless steel.

660-2.1.4 Environmental Requirements for all Detectors: Meet the environmental requirements of NEMA TS-2-2003.

660-2.2 Vehicle Presence Detector Performance Requirements: Ensure presence detectors provide a minimum detection accuracy of 98%. Ensure presence detectors meet the requirements for modes of operation in NEMA TS2-2003, 6.5.2.17.

660-2.2.1 Vehicle Presence Detection Accuracy: To verify conformance with the accuracy requirements in this Section and as a precondition for listing on the APL, sample data collected from the vehicle detection system will be compared against ground truth data collected during the same time by human observation or by another method approved by the FDOT Traffic Engineering Research Laboratory (TERL). Ensure sample data is collected over several time periods under a variety of traffic conditions. Weight each data sample to represent the predominant conditions over the course of a 24-hour period. Samples will consist of 15- and 30-minute data sets collected at various times of the day. Representative data periods and their assigned weights are provided in Table 660-1.

Table 660-1
Data Collection Periods

Period	Intended To Represent	Duration	Weight
Early morning (predawn) [EM]	12:30 a.m. – 6:30 a.m.	15 minutes	24
Dawn [DA]	6:30 a.m. – 7:00 a.m.	30 minutes	2
AM Peak [AMP]	7:00 a.m. – 8:00 a.m.	15 minutes	4

Late AM Off-Peak [LAOP]	8:00 a.m. – 12:00 p.m.	15 minutes	16
Noon [NO]	12:00 p.m. – 1:00 p.m.	15 minutes	4
Afternoon Off-Peak [AOP]	1:00 p.m. – 5:00 p.m.	15 minutes	16
PM Peak [PMP]	5:00 p.m. – 6:00 p.m.	15 minutes	4
Dusk [DU]	6:00 p.m. - 6:30 p.m.	30 minutes	2
Night [NI]	6:30 p.m. - 12:30 a.m	15 minutes	24
Total Sum of Weights			96

For instance, the sample gathered for the Late AM Off-Peak period is intended to represent typical traffic conditions between 8:00 a.m. and 12:00 p.m. Since the sample period's duration is 15 minutes and the actual period of time represented is 4 hours, the multiplication factor or weight assigned is 16, the number of 15-minute intervals in a 4 hour period.

660-2.2.1.1 Calculation of Vehicle Presence Detection Accuracy: Compute presence detection accuracy as described in this subsection.

Determine individual lane presence detection accuracy per period by calculating the percentage of absolute difference of the total volume measured by the detection system and the true volume computed using a method approved by the Engineer, divided by the true volume for the period under consideration.

In the equation in 660-2.2.1.1.1, "EM" represents the early morning period. The variable "i" represents a detector or detection zone and could vary from 1,…, N, where "N" is the maximum number of detectors observed. Substitute other detector numbers and periods as necessary to determine accuracy for all detectors during each period (i.e., dawn, AM peak, late AM off peak, etc.).

Variables used in the following calculations are identified as follows:

PA = Presence detection accuracy
TT = Total time
CET = Cumulative Error Time (duration of all false and missed calls)

660-2.2.1.1.1 Vehicle Presence Detection Accuracy for Single Detector During Early Morning Expressed in Percentage:

$$PA_{EM,\det_i} = 100 - \frac{\left|TT_{EM,\det_i} - CET_{EM,\det_i}\right|}{TT_{EM,\det_i}} x100$$

where:

$PA_{EM,\det_i}$ = Presence detection accuracy of detector *i* during the early morning period.

$TT_{EM,\det_i}$ = Total time that detector *i* was monitored (for instance, the 15-minute minimum duration specified in Table 660-1 for the early morning period).

$CET_{EM,\det_i}$ = Total time that detector *i* was in an error state (indicating a detection with no vehicle present or not indicating a detection when vehicle present) during the monitoring period using human observation or another method approved by the Engineer.

The period accuracy will be the arithmetic mean of all individual detector accuracies.

In the equation in 660-2.2.1.1.2, "EM" represents the early morning period and "*N*" is the maximum number of detectors tested. Substitute other periods as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

660-2.2.1.1.2 Early Morning Vehicle Presence Detection Accuracy for All Detectors Expressed in Percentage:

$$PA_{EM} = \left(\frac{\sum_{i=1}^{N} PA_{EM,\det_i}}{N} \right)$$

Where:

PA_{EM} = Average accuracy of all detectors during the early morning.

$PA_{EM,\det_i}$ = Accuracy of detector *i* during early morning.

Calculate the roadway segment accuracy over all periods using the equation in 660-2.2.1.1.3.

660-2.2.1.1.3 Total Vehicle Presence Detection Accuracy of All Detectors Expressed in Percentage:

$$PA_{Total} = \frac{\left[PA_{EM}x24 + PA_{DA}x2 + PA_{AMP}x4 + PA_{LAOP}x16 + PA_{NO}x4 + PA_{AOP}x16 + PA_{PMP}x4 + PA_{DU}x2 + PA_{NI}x24\right]}{96}$$

Where:

PA_{Total} =Accuracy for all detectors for all periods

PA_{EM} = Accuracy of all detectors during early morning traffic conditions

PA_{DA} = Accuracy of all detectors during dawn traffic conditions

PA_{AMP} = Accuracy of all detectors during AM peak traffic conditions

PA_{LAOP} = Accuracy of all detectors during late AM off-peak traffic conditions

PA_{NO} = Accuracy of all detectors during noon traffic conditions

PA_{AOP} = Accuracy of all detectors during afternoon off-peak traffic conditions

PA_{PMP} = Accuracy of all detectors during PM peak traffic conditions

PA_{DU} = Accuracy of all detectors during dusk traffic conditions

PA_{NI} = Accuracy of all detectors during night traffic conditions

660-2.2.1.2 Vehicle Presence Detection System Field Acceptance Testing: Verify detection accuracy at installed field sites using a reduced method similar to those described in 660-2.2.1.1. Compare sample data collected from the detection system with ground truth data collected by human observation. For site acceptance tests, collect samples and ground truth data for each site for a minimum of five minutes during a peak period and five minutes during an off-peak period. For presence detection at intersections, ensure there are a minimum of three detections for each signal phase. Perform site acceptance tests in the presence of the Engineer.

660-2.3 Traffic Data Detector Performance Requirements: Provide a vehicle detection system capable of meeting the minimum total roadway segment accuracy levels of 95% for volume, 90% for occupancy, and 90% for speed for all lanes, up to the maximum number of lanes that the device can monitor as specified by the manufacturer.

660-2.3.1 Data Accuracy: To verify conformance with the accuracy requirements in this Section and as a precondition for listing on the APL, sample data collected from the vehicle detection system will be compared against ground truth data collected during the same time by human observation or by another method approved by the TERL. Ensure sample data is collected over several time periods under a variety of traffic conditions. Weight each data sample to represent the predominant conditions over the course of a 24-hour period. Samples will consist of 15- and 30-minute data sets collected at various times of the day. Representative data periods and their assigned weights are provided in Table 660-1.

660-2.3.1.1 Calculation of Volume Accuracy: Compute volume accuracy as described in this subsection.

Determine individual lane volume accuracy per period by calculating the percentage of absolute difference of the total volume measured by the detection system and the true volume computed using a method approved by the Engineer, divided by the true volume for the period under consideration.

In the equation in 660-2.3.1.1.1, "EM" represents the early morning period. The variable "*i*" represents a lane in a roadway and could vary from 1,…, N, where "N" is the maximum number of lanes on the roadway segment. Substitute other lane numbers and periods as necessary to determine the accuracy for each lane during each period (i.e., dawn, AM peak, late AM off-peak, etc.).

Variables used in the following calculations are identified as follows:

VT = Total volume

VD = Vehicle detection data (in this case, count data)

GT = Ground truth measurement utilizing a reliable method approved by the Engineer.

VA = Volume accuracy

660-2.3.1.1.1 Early Morning Lane Volume Accuracy Expressed in Percentage:

$$VA_{EM,\ln_i} = 100 - \frac{\left|VT_{EM,VD,\ln_i} - VT_{EM,GT,\ln_i}\right|}{VT_{EM,GT,\ln_i}} x100$$

Where:

VA_{EM,ln_i} = Volume accuracy for early morning traffic conditions in the i^{th} lane.

VT_{EM,VD,ln_i} = Total volume for the 15-minute early morning period using the vehicle detector in the i^{th} lane.

VT_{EM,GT,ln_i} = Total volume for the 15-minute early morning period in the i^{th} lane using human observation or another method approved by the Engineer.

The period volume accuracy will be the arithmetic mean of the lane volume accuracy over all lanes.

In the equation in 660-2.3.1.1.2, "EM" represents the early morning period and "*N*" is the maximum number of lanes in the roadway segment under test.

Substitute other periods as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

660-2.3.1.1.2 Early Morning Period Volume Accuracy Expressed in Percentage:

$$VA_{EM} = \left(\frac{\sum_{i=1}^{N} VA_{EM,\ln_i}}{N} \right)$$

Where:

VA_{EM} = Average volume accuracy for early morning traffic conditions for all lanes on the roadway segment.

VA_{EM,ln_i} = Volume accuracy for early morning traffic conditions in the i^{th} lane.

Calculate the roadway segment accuracy over all periods using the equation in 660-2.3.1.1.3.

660-2.3.1.1.3 Total Roadway Segment Accuracy Expressed in Percentage:

$$VA_{Total} = \frac{[VA_{EM}x24 + VA_{DA}x2 + VA_{AMP}x4 + VA_{LAOP}x16 + VA_{NO}x4 + VA_{AOP}x16 + VA_{PMP}x4 + VA_{DU}x2 + VA_{NI}x24]}{96}$$

Where:

VA_{Total} = Volume accuracy for all lanes for all periods
VA_{EM} = Volume accuracy for early morning traffic conditions
VA_{DA} = Volume accuracy for dawn traffic conditions
VA_{AMP} = Volume accuracy for AM peak traffic conditions
VA_{LAOP} = Volume accuracy for late AM off-peak traffic conditions
VA_{NO} = Volume accuracy for noon traffic conditions
VA_{AOP} = Volume accuracy for afternoon off-peak traffic conditions
VA_{PMP} = Volume accuracy for PM peak traffic conditions
VA_{DU} = Volume accuracy for dusk traffic conditions
VA_{NI} = Volume accuracy for night traffic conditions

Position the detector and configure the detection zones so that a vehicle is detected when 70% or more of the vehicle width is inside a lane, and not detected when 15% or less of the vehicle width is in the lane. Use the detection zone configuration to minimize the occurrence of a double count for the same vehicle, while ensuring that it will be counted at least once.

660-2.3.1.2 Calculation of Speed and Occupancy Accuracy: Calculate speed accuracy as discussed in this subsection. Calculate occupancy in a manner similar to the speed computation methodology described below.

The difference between the volume accuracy and speed accuracy computation is that the volume of a particular lane can be aggregated over a period of time, while speed cannot. For computing the accuracy of the detector speed measurement, the average speed readings obtained from the detection system are compared to ground truth values on a particular roadway segment.

The equation in 660-2.3.1.2.1 represents the ground truth average speed computation procedure for a particular lane during a specific time period. The equation in 660-2.3.1.2.2 represents the average speed computation procedure for a particular lane during a specific time period using data gathered from the detection system.

In the equations in 660-2.3.1.2.2 and 660-2.3.1.2.2, the time period described is the early morning period, represented by "EM", and the variable "k" represents a vehicle traveling on the roadway and could vary from 1,…, K, where "K" is the maximum number of vehicles in lane i during the time period under consideration. The variable "i" represents a lane in a roadway and could vary from 1,…, N, where "N" is the maximum number of lanes on the roadway segment. Substitute other lanes and periods as necessary and compute the accuracy for each lane for all time periods.

Variables used in the following calculations are identified as follows:

SA = Speed accuracy
S = Speed of an individual vehicle
veh = Vehicle

660-2.3.1.2.1 Early Morning Average Ground Truth Vehicle Speed:

$$S_{Avg,EM,GT,\ln_i} = \frac{1}{K}\sum_{k=1}^{K} S_{EM,GT,\ln_i,veh_k}$$

Where:

SA_{Avg,EM,GT,ln_i} represents the average ground truth vehicle speed for the i^{th} lane during the early morning period.

S_{EM,GT,ln_i,veh_k} represents the true speed for the k^{th} vehicle in the i^{th} lane during the early morning period using human observation or another method approved by the Engineer.

660-2.3.1.2.2 Early Morning Average Vehicle Detector Speed Measurement:

$$S_{Avg,EM,VD,\ln_i} = \frac{1}{K}\sum_{k=1}^{K} S_{EM,VD,\ln_i,veh_k}$$

Where:

S_{Avg,EM,VD,ln_i} represents the average speed recorded by the vehicle detector for the i^{th} lane during the early morning period.

S_{EM,VD,ln_i,veh_k} represents the speed for the k th vehicle in the I th lane during the early morning period using the vehicle detector.

The lane speed period accuracy is computed as a percentage of the absolute difference of the average lane speed calculated using detection system data and the average lane true speed calculated in the equation in 660-2.3.1.2.1 (or using another method approved by the Engineer), divided by average ground truth lane speed for the period.

In the equation in 660-2.3.1.2.3, "EM" represents the early morning period. The variable "*i*" represents a lane on a roadway and could vary from 1,…,N, where "N" is the maximum number of lanes on the roadway segment. Substitute other lanes as

necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

660-2.3.1.2.3 Early Morning Lane Speed Accuracy Expressed in Percentage:

$$SA_{Avg,EM,\ln_i} = 100 - \frac{\left|S_{Avg,EM,VD,\ln_i} - S_{Avg,EM,GT,\ln_i}\right|}{S_{Avg,EM,GT,\ln_i}} \times 100$$

Where:

SA_{Avg,EM,ln_i} represents the average speed accuracy during early morning traffic conditions for all vehicles that traveled in lane i of the roadway segment.

The period speed accuracy will be the arithmetic mean of the lane speed accuracy, computed using the equation in 660-2.3.1.2.3, over all lanes.

In the equation in 660-2.3.1.2.4, "EM" represents the early morning period. The variable "i" represents a lane on a roadway and could vary from 1,…, N, where "N" is the maximum number of lanes on the roadway segment. Substitute data as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

660-2.3.1.2.4 Early Morning Speed Accuracy Expressed in Percentage:

$$SA_{EM} = \left(\frac{\sum_{i=1}^{N} SA_{Avg,EM,\ln_i}}{N} \right)$$

Where:

SA_{EM} represents the average speed accuracy during early morning traffic conditions for all lanes on the roadway segment.

Calculate the roadway segment accuracy over all periods using the equation in 660-2.3.1.2.5.

660-2.3.1.2.5 Total Roadway Segment Accuracy Expressed in Percentage:

$$SA_{Total} = \frac{[SA_{EM}x24 + SA_{DA}x2 + SA_{AMP}x4 + SA_{LAOP}x16 + SA_{NO}x4 + SA_{AOP}x16 + SA_{PMP}x4 + SA_{DU}x2 + SA_{NI}x24]}{96}$$

Where:

SA_{Total} = Speed accuracy for all lanes for all periods
SA_{EM} = Speed accuracy for early morning traffic conditions
SA_{DA} = Speed accuracy for dawn traffic conditions
SA_{AMP} = Speed accuracy for AM peak traffic conditions
SA_{LAOP} = Speed accuracy for late AM off-peak traffic conditions
SA_{NO} = Speed accuracy for noon traffic conditions
SA_{AOP} = Speed accuracy for afternoon off-peak traffic conditions
SA_{PMP} = Speed accuracy for PM peak traffic conditions
SA_{DU} = Speed accuracy for dusk traffic conditions

SA_{NI} = Speed accuracy for night traffic conditions

660-2.3.1.3 Traffic Data Detection System Field Acceptance Testing: Verify detection accuracy at installed field sites using a reduced method similar to those described in 660-2.3.1. Compare sample data collected from the detection system with ground truth data collected by human observation. For site acceptance tests, collect samples and ground truth data for each site for a minimum of five minutes during a peak period and five minutes during an off-peak period. Perform site acceptance tests in the presence of the Engineer.

660-2.4 AVI Detection System Performance Requirements: Ensure that AVI detectors establish a unique and consistent identifier for each vehicle detected and the time and location that the vehicle was detected. Ensure that probe detectors provide a minimum penetration rate of 75%. Ensure AVI detection systems that match upstream and downstream detection of the same vehicle provide a minimum match rate of 5%. Ensure AVI detection systems meet a minimum total roadway segment speed and travel time accuracy level of 90%. Verify system performance over several time periods under a variety of traffic conditions as described in 660-2.3.1.

660-2.4.1 Calculation of Penetration Rate: Penetration rate is defined as the volume of vehicles detected, identified, and time stamped divided by the number of qualified vehicles that passed within the detection area of the probe detector.

660-2.4.1.1 Early Morning Penetration Rate Expressed as a Percentage:

$$PR_{EM} = 100 - \frac{\left|R_{EM,VD} - V_{EM,GT}\right|}{V_{EM,GT}} \times 100$$

Where:

PR_{EM} = Penetration Rate for early morning.

$R_{EM,VD}$ = Number of unique vehicle records captured by the vehicle detector.

$V_{EM,GT}$ = Total volume of vehicles that pass the detection area for the 15-minute early morning period using human observation or another method approved by the Engineer.

660-2.4.1.2 Calculation of Match Rate: Match rate is the percentage of the total vehicle population of a road segment that is detected and matched at consecutive probe data detection sites.

660-2.4.1.2.1 Early Morning Match Rate Expressed as a Percentage:

$$MR_{EM} = 100 - \frac{\left|M_{EM,VD} - V_{EM,GT}\right|}{V_{EM,GT}} \times 100$$

Where:

MR_{EM} = Match Rate for early morning.

$M_{EM,VD}$ = Number of matched detections between two probe vehicle detection sites (typically a pair of sites at each end of a roadway segment) during early morning.

$V_{EM,GT}$ = Total volume of vehicles that pass the detection area for the 15-minute early morning period using human observation or another method approved by the Engineer.

660-2.4.1.3 Calculation of AVI Detection System Speed and Travel Time Accuracy: Calculate speed and travel time accuracy by comparing the speeds and travel times reported by the system against ground truth collected through human observation or another method approved by the Engineer.

660-2.5 Environmental Requirements for all Detectors: Meet the environmental requirements of NEMA TS-2-2003.

660-3 Installation Requirements.

660-3.1 Installation Requirements for all detectors: Install, configure, and demonstrate a fully functional vehicle detection system, as shown in the Plans. Connect all field equipment to the existing communication network, and provide all materials specified in the Contract Documents. Install all equipment according to the manufacturer's recommendations.

Ensure that above-ground detectors can be mounted on existing poles or sign structures, or on new poles, as shown in the Plans. Furnish all equipment with the appropriate power and communication cables. Install the power cable and the communication cables according to the manufacturer's recommendation. Ensure that the cables comply with NEC sizing requirements and meet all other applicable standards, specifications, and local code requirements.

Do not install communication cables in the same conduit or pull boxes as power cables carrying voltage greater than 24 V_{DC}/V_{AC} or current in excess of 1.5 amps.

Cut all wires to their proper length before assembly. Do not double back any wire to take up slack. Neatly lace wires into cables with nylon lacing or plastic straps. Secure cables with clamps and provide service loops at all connections.

In the event that power to the vehicle detection system or a subcomponent thereof is interrupted, ensure that the equipment automatically recovers after power is restored. Ensure that all programmable system settings return to their previous configurations and the system resumes proper operation.

660-3.2 Inductive Loop Detector Installation: Install vehicle loops in accordance with the manufacturer's instructions and the Design Standards, Index No. 17781.

660-3.2.1 Inductive Loop-Detector Units: Adjust the operating frequency of each detector unit, if required, to prevent crosstalk of the units.

660-3.2.2 Saw Cuts: Use a chalk line or equivalent method to outline the perimeter of the loop on the pavement and routes for lead-in cables. Do not allow the saw cut in the pavement to deviate by more than 1 inch from the chalked line. Ensure that all saw cuts are free of any dust, dirt, or other debris and completely dry prior to installation of the loop wire, loop wire twisted pair lead, or lead-in cable.

Ensure that the top conductor of the loop wire or lead-in cable is a minimum of 1 inch below the final surface of the roadway.

660-3.2.3 Loop Wire: Ensure that all loops are wound in a clockwise manner and the first turn of the loop wire is placed in the bottom of the saw cut, with each subsequent turn placed on top of the preceding turn. Push the loop wire to the bottom of the saw cut with a non-metallic tool which will not damage the insulation.

Tag and identify the clockwise "lead" of each loop.

Use alternate polarity on adjacent loops.

Ensure that the hold down material is non-metallic, is placed in the saw slot using segments 1 to 2 inches long, spaced 12 inches apart, and that the distance from the top of the hold down material to the final surface of the roadway is not less than 1-1/2 inches.

660-3.2.4 Loop Wire Twisted Pair Lead: Create a loop wire twisted pair lead by twisting the loop wire pair a minimum of 10 turns per foot to form a loop wire twisted pair lead from the edge of the loop to the pull box located adjacent to the roadway. Place only one loop wire twisted pair lead in a saw cut. Ensure that the distance between a twisted loop wire pair lead

within the roadway is a minimum of 6 inches from any other twisted loop wire pair lead or loop, until they are within 1 foot of the edge of pavement or curb, at which point they may be placed closer together.

Provide a minimum of 3 feet of twisted loop wire pair lead in the pull box located adjacent to the roadway. Do not route twisted loop wire pair lead directly through conduits to the cabinet, unless otherwise shown in the Plans.

660-3.2.5 Loop Sealant: Prepare and apply loop sealant in accordance with the manufacturer's instructions. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

660-3.2.6 Shielded Lead-in Cable: Place the lead-in cable in the bottom of the saw cut. Do not damage the insulation.

Install no more than four lead-in cables in a saw cut. Ensure that the hold down material is not longer than 1 inch and that the distance from the top of the hold down material to the final surface of the roadway is not less than 1-1/2 inches.

660-3.2.7 Splicing: Perform the splicing in a pull box located off the roadway, not in the roadway itself.

Splice the black conductor of the lead-in cable to the clockwise "lead" of the loop.

Ensure that the ends of the cable jackets, twisted pair, and lead-in are encased in the loop splice material.

Ensure that each loop has an individual return to the cabinet and series splicing is performed on a separate terminal block in the cabinet.

660-3.2.8 Terminations: Using insulated terminal lugs, terminate lead-in cables or twisted pair loop wire on a terminal strip, which is located in the controller or detector cabinet. Use a calibrated ratchet type crimping tool to attach the lugs to the conductors of the lead-in cable or twisted loop wire.

660-3.2.9 Loop Assembly Identification: Identify and tag each loop assembly in the controller or detector cabinet by lane and movement number.

660-3.2.10 Inductive Loop Detector Testing and Turn-on:

660-3.2.10.1 Series Resistance: Obtain Department of Transportation Traffic Signal Resistance Measurement Data Sheets from the Engineer. Measure and record the series resistance of each loop assembly on these data sheets. Leave a copy in the controller cabinet.

If the series resistance of a loop assembly is greater than 10 Ω, inspect the loop assembly to find the cause of the excessive resistance. Correct the cause of the excessive resistance at no additional cost to the Department.

660-3.2.10.2 Insulation Resistance: Measure and record the insulation resistance of each loop assembly and verify that the resistance is greater than 100 MΩ. Use a 500 V_{DC} insulation tester to measure the resistance. Reference all measurements to a good earth ground (ground rod, metallic water pipe, etc.). Disconnect the transient suppression devices from the loop assemblies before taking any measurements. If the insulation resistance is less than 100 MΩ, determine if the lead-in cable or the loop wire is causing the problem, and replace the defective cable or loop wire at no additional cost to the Department.

660-3.2.10.3 Loop Detector Turn-on: Connect the loop assemblies to the appropriate inductive loop vehicle detectors and tune the detectors in accordance with the

manufacturer's instructions. Separate the operating frequencies of vehicle detectors, in adjacent lanes, by at least 2 kHz. Verify operation proper operation in accordance with 660-2.2.1.2.

660-3.3 Video Detector Installation: Install cameras and configure detection zones and settings in accordance with the Contract Documents, manufacturer's recommendations, and as directed by the Engineer. Submit configuration settings (including, but not limited to detector names, communication settings, and output assignments) and configuration file backups to the Engineer. Submit a graphical depiction of each camera site, its pole location, mounting height, the ratio of distance away from the camera versus the mounting height, the camera's mounting type (i.e., pole or structure), camera aiming procedures, and the placement of the proposed detection zone for each lane.

Do not use coaxial cable runs in excess of 500 feet. Mount and aim cameras in a manner that eliminates as much environmentally generated glare as possible.

660-3.4 Microwave Detector Installation: Install detector and configure detection zones and settings in accordance with the Contract Documents, manufacturer's recommendations, and as directed by the Engineer. Submit configuration settings (including, but not limited to detector names, communication settings, and output assignments) and configuration file backups to the Engineer.

660-3.5 Wireless Magnetometer Installation: Install in accordance with the Contract Documents, manufacturer's recommendations, and as directed by the Engineer. Ensure that materials used for the installation of magnetometers in the road surface have cured completely before allowing vehicular traffic to travel over them.

660-3.6 AVI Detection System Installation: Install in accordance with the Contract Documents, manufacturer's recommendations, and as directed by the Engineer.

660-4 Warranty.

Ensure that vehicle detection and data collection systems have a manufacturer's warranty covering defects for a minimum of 5 years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608. Ensure the warranty includes providing replacements, within 10 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or the maintaining agency.

660-5 Method of Measurement.

660-5.1 Furnish and Install: The Contract unit price for each inductive loop detector and per assembly for loop assembly, furnished and installed, will include all equipment, materials as specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

The Contract unit price for each component of an MVDS, VVDS, WMDS, or AVI detection system , furnished and installed, will include furnishing, placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, warranty documentation, and incidentals necessary to complete the work.

660-5.2 Furnish: The Contract unit price for each inductive loop detector, per assembly for loop assembly, per gallon for loop sealant, and per foot for cable, furnished, will include all equipment and materials as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

The Contract unit price for each component of an MVDS, VVDS, WMDS, or AVI detection system, furnished, will include providing all equipment specified in the Contract

Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

660-5.3 Install: The Contract unit price for each inductive loop detector and per assembly for loop assembly, installed, will include all loop sealant, miscellaneous materials, labor, and equipment necessary for a complete and accepted installation. The Engineer will supply the inductive loop detector, harness, lead-in cable, and loop wire.

The Contract unit price for each component of an MVDS, VVDS, WMDS, or AVI detection system, installed, will include placement and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, warranty documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

660-5.4 Modify: The Contract unit price per assembly for loop assembly, modified, will include all lead-in cable, saw cuts, miscellaneous materials as specified in the Contract Documents, connecting new lead-in cable to an existing loop and installing and terminating the lead-in cable to the location designated in the Contract Documents, and all labor and equipment necessary for a complete and accepted installation.

The Contract unit price for each component of an MVDS, VVDS, WMDS, or AVI detection system, modified, will include adjustment, relocation, placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, warranty documentation, and incidentals necessary to complete the work.

660-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Payment will be made under:

Item No. 660-1	Inductive Loop Detector – each.
Item No. 660-2	Loop Assembly – per assembly.
Item No. 660-3	Vehicle Detection System - Microwave – each.
Item No. 660-4	Vehicle Detection System – Video – each.
Item No. 660-5	Vehicle Detection System – Wireless Magnetometer – each.
Item No. 660-6	Vehicle Detection System - AVI – each.

700 HIGHWAY SIGNING.

(REV 11-27-12) (FA 12-4-12) (7-13)

SUBARTICLE 700-2.4.2 (Page 827) is deleted and the following substituted:

700-2.4.2 Installation: Install nuts on anchor bolts in accordance with 649-5 and 649-6, with one exception. For cantilever overhead sign structures, after placement of the upright and prior to installation of the truss, adjust the leveling nuts beneath the base plate to achieve the back rake shown on the camber diagram. If the top surface of the base plate has a slope that exceeds 1:40, use beveled washers under the top nuts.

Use ASTM A325 bolt, nut and washer assemblies for all installations other than anchor bolts as follows. Use bolt, nut and washer assemblies that are free of rust and corrosion and that are lubricated properly as demonstrated by being able to easily hand turn the nut on the bolt thread for its entire length. Tighten nuts to a snug tight condition to bring the faying surfaces of the assembly into full contact which is referred to as snug-tight condition. Snug-tight is defined as the maximum nut rotation resulting from the full effort of one person on a 12 inch long wrench or equivalent. After bringing the faying surfaces of the assembly into full contact and to a snug tight condition, tighten nuts to achieve the minimum torque as specified in Table 700-1 unless the connection is an alternate splice connection of a span sign structure, in which case, tighten nuts in accordance with the turn-of-nut method of Table 460-7 of Section 460. Maintain uniform contact pressure on the faying surfaces during snugging and the subsequent final tightening process, by using a bolt tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt. Within 24 hours after final tightening, the Engineer will witness a check of the minimum torque using a calibrated torque wrench for 3 bolts or a minimum of 10% of the bolts, whichever is greater, for each connection; however, do not perform this check on alternate splice connections of span sign structures.

Table 700-1	
Bolt Diameter (in.)	Minimum Torque (ft.-lbs.)
3/8	15
1/2	37
5/8	74
3/4	120
7/8	190
1	275
1 1/8	375
1 1/4	525

715 HIGHWAY LIGHTING SYSTEM.
(REV 1-8-13) (FA 2-5-13) (7-13)

SUBARTICLE 715-3.1 (Page860) is deleted and the following substituted:

715-3.1 General: Meet the materials and equipment requirements of Section 992.

ARTICLE 715-9 (Pages 861 – 862) is deleted and the following substituted:

715-9 Conduit.

Install conduit at the locations shown in the Plans and in accordance with Section 630.

ARTICLE 715-16 (Pages 863 – 864) is deleted and the following substituted:

715-16 Method of Measurement.

The quantities to be paid for will be as follows, completed and accepted:

(a) Conduit: Payment will be made in accordance with Section 630.

(b) Luminaire and Truss Arm: The Contract unit price will include the truss arm, luminaire with lamp, and all necessary mounting hardware as indicated in the Plans and the Design Standards.

(c) Service Point: The Contract unit price will include the service pole, insulators, weatherheads, transformers, enclosures, panel boards, breakers, safety switches, H.O.A. switches, lightning protectors, fuses, photo electric assembly, meter base, and all external and internal conduit and conductors for the service as indicated in the Plans and the Design Standards.

(d) Light Pole Foundation: The Contract unit price will include the foundation and anchor bolts with lock nuts and washers as indicated in the Plans and the Design Standards.

(e) Luminaire: The Contract unit price will include the luminaire with lamp and necessary mounting hardware as indicated in the Plans and the Design Standards.

(f) Pull Box: Payment will be made in accordance with Section 635.

(g) High Mast Parts: The Contract unit price will include the part specified with all mounting hardware as indicated in the Contract Documents and the Design Standards.

(h) Frangible Base for Light Pole: The Contract unit price will include the frangible base, attachments, bolts, and washers as indicated in the Plans and the Design Standards.

(i) Photo Electric Control Assembly: The Contract unit price will include the photo electric control, transformers, conduit, and conductors as indicated in the Plans and the Design Standards.

(j) Pre-Fab Pilaster: The Contract unit price will include the pilaster and all mounting hardware as indicated in the Plans.

(k) High Mast Lighting Pole Complete: The Contract unit price will include the pole, luminaires with lamps, lowering system, breakers and anchor bolts with lock nuts and washers, and foundation as indicated in the Plans and the Design Standards.

(l) Conductor: The length, in feet, as indicated in the Plans and the Design Standards.

(m) Lighting Pole Complete: The Contract unit price will include the pole, internal vibration damping device, truss arm, luminaire with lamp, anchor bolts with lock nuts and washers, frangible base and foundation.

(n) Pole Cable Distribution System: The Contract Unit price will include the surge protector, fuse holders with fuses, waterproof connectors and the waterproof wiring connection to the luminaries.

782 VIDEO EQUIPMENT.
(REV 2-8-13) (FA 2-15-13) (7-13)

SECTION 782 (Pages 885 – 896) is deleted and the following substituted:

SECTION 782
VIDEO EQUIPMENT

782-1 CCTV Camera.

782-1.1 Description. Furnish and install a closed-circuit television (CCTV) camera at the location(s) shown in the Plans. Ensure that the installed equipment provides unobstructed video images of the roadway, traffic, and other current conditions around a roadside CCTV field site; that it responds to camera control signals from the operator; and that the video images can be transmitted to remote locations for observation.

782-1.2 Materials:

782-1.2.1 Camera: Furnish a CCTV camera that is compatible with the current version of the Department's SunGuide® software system, and any other camera operating software indicated in the Plans or in the contract documents. Use either a dome-type or external positioned-type CCTV camera assembly. Ensure that the appropriate type is used at the locations shown in the Plans. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

For analog cameras, ensure that the camera produces National Television System Committee (NTSC) composite video output of 1 volt peak-to-peak (Vp-p) at 75 ohms (Ω). In addition, ensure analog and internet protocol (IP) cameras provide the following features and capabilities:

1. Day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.
2. Minimum resolution of 470 horizontal and 350 vertical TV lines.
3. Ability to produce clear, detailed, and usable video images of the areas, objects, and other subjects visible from a roadside CCTV field site. Ensure that video produced by the camera is true, accurate, distortion free, and free from transfer smear, oversaturation, and any other image defect that negatively impacts image quality under all lighting and weather conditions in both color and monochrome modes.
4. User-selectable automatic gain control (AGC) that is peak-average adjustable to 28 decibels (dB).
5. A minimum signal-to-noise ratio of 50 dB.
6. Automatic color balance that references the white areas of the scene through the lens.
7. An automatic electronic shutter that is user selectable from 1/60 to 1/10,000 of a second.
8. A digital signal processor that provides a minimum 10x digital zoom.
9. Programmable azimuth and compass display with ability to display pan and tilt position with a 1 degree resolution.

Furnish a CCTV camera that provides titling and masking features, including, but not limited to, programmable camera title, programmable preset titles for each

preset position, and programmable privacy zones. Ensure that programmable titles are a minimum of 18 characters per line.

782-1.2.2 Lens: Ensure that the standard definition CCTV camera has a minimum 22x motorized optical zoom lens with automatic iris. Ensure that the high definition CCTV camera has a minimum 18x motorized optical zoom lens with automatic iris. Ensure that the lens is capable of automatic and manual focus and iris control. Ensure that the lens depth of field provides a clear image of roadside areas under all lighting conditions and that the lens has a maximum aperture of at least f/1.6.

782-1.2.3 Pan/Tilt Mechanism for Dome-Type Cameras: Ensure that dome-type CCTV cameras include an integrated pan/tilt mechanism capable of providing 360 degree continuous pan with a minimum 90 degree tilt range (i.e., 0 degrees to minus 90 degrees); provide variable speed control; have a preset position return accuracy of plus or minus 0.36 degree, or less than 0.10% or better; support a minimum of 64 presets; support a minimum of one tour with a minimum of 32 presets; and support a minimum of eight programmable blackout zones.

Ensure that the positioner within the dome-type CCTV camera has a minimum automatic pan speed of 240 degrees per second to a preset camera position; that the maximum manual pan speed is a minimum of 80 degrees per second; and that maximum manual tilt speed is a minimum of 40 degrees per second.

782-1.2.4 Pan/Tilt Mechanism for External Positioner-Type Cameras: Ensure that external positioner-type CCTV cameras include a pan/tilt mechanism capable of providing 360 degree continuous pan with a minimum 115 degree tilt range (i.e., minus 90 to plus 25 degrees); provide variable speed control; have a preset position return accuracy of plus or minus 0.36 degree, or less than 0.10% or better; and support a minimum of 32 presets.

782-1.2.5 Communication: Ensure that the CCTV camera supports the National Transportation Communications for ITS Protocol (NTCIP) 1205 v1.08. Ensure that the camera is capable of communication with other devices using Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)-232 or TIA-422 at a rate of 9600 bps, transmission control protocol (TCP)/IP, or user datagram protocol (UDP)/IP. Ensure that the CCTV camera supports the communication links shown in the Plans. The camera must be capable of remote firmware upgrade via the communication interface.

Ensure that IP cameras also support the Open Network Video Interface Forum (ONVIF) Core, Streaming, and Media Service specifications.

782-1.2.6 Electrical Specifications: Ensure that the CCTV camera system operates using a nominal input voltage at the cabinet of 120 volts alternating current (VAC). Ensure that the camera power supply will operate with an input voltage ranging from 89 VAC to 135 VAC.

Ensure that the CCTV camera and positioner operate at 24 VAC or 10 volts to 28 volts of direct current (VDC). If the camera or any camera-related ancillary device requires operating voltages other than these, provide an appropriate voltage converter. Ensure power consumption does not exceed 125 watts.

782-1.2.7 Mechanical Specifications: Provide camera housings and hardware that are light in color or as noted in the Plans.

Ensure that the camera housing has a sunshield to reduce the solar heating of the camera. Ensure that the total weight of dome type CCTV cameras (including the housing,

sunshield, and all internal components) is less than 17.0 pounds. Ensure that the lower dome of the camera housing is distortion free clear plastic.

Ensure that pressurized dome-type housings are capable of pressurization at 5 pounds per square inch (psi) using dry nitrogen, that they have a low-pressure alarm feature, and carry a NEMA 4X/IP-67 rating.

If a non-pressurized dome-type housing enclosure is used, ensure that the unit is vented with a thermostat-controlled heater and blower. Ensure that the non-pressurized enclosure has a NEMA 4/IP-66 rating.

Ensure that the total weight of external positioner-type CCTV cameras (including housing, sunshield, all internal components, and external pan and tilt mechanism) is less than 35 pounds.

782-1.2.8 Environmental Specifications: Ensure that the CCTV camera performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.

Ensure that the housing protects the camera and other internal components from rain, dust, corrosive elements, and typical conditions found at a roadside environment. Ensure that the CCTV camera, mounting hardware, and any other camera-related material that is exposed to the environment can withstand 150 mph wind speeds and meet the requirements of the Department's Structures Manual, Volume 9.

782-1.2.9 Additional Requirements for IP Cameras: The following sub-articles provide additional requirements for IP-enabled cameras.

782-1.2.9.1 Video Encoding: The camera must utilize the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the ISO and IEC requirements detailed in the ISO/IEC 14496-10:2009 Standard.

Ensure that the camera is capable of unicast and multicast operation. Ensure that the camera provides 99.999% error-free operation. Ensure the encoded video can be transmitted utilizing programmable bit rates. Ensure the camera supports, at a minimum, fixed bit rate mode.

782-1.2.9.2 Encoded Video Interoperability: Ensure the camera's encoded video can be displayed using video display control systems on the APL.

782-1.2.9.3 Encoded Video Specifications: Ensure that the camera's encoded video supports resolutions that include, but are not limited to, those defined in Table 1.1. Ensure that the camera is capable of delivering color and monochrome video at 30 frames per second (fps) regardless of resolution.

Table 1.1 – Minimum Resolution Requirements

Format	Vertical Resolutions
H.264	240, 480
Note: The resolutions attained depend on the data transmission rate.	

782-1.2.9.4 Network Interface: Ensure that the camera's local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet connections. The camera shall have a minimum of one Ethernet port, which shall be a 10/100 Base-TX connection.

Ensure that all unshielded twisted pair/shielded twisted pair network cables are compliant with the TIA-568 Standard. Ensure that the network communication conforms to TCP, UDP, Version 4 of the IP, real-time streaming protocol (RTSP), and Version 2 of the internet group multicast protocol (IGMP), at a minimum. Ensure the camera can be controlled via NTCIP using either TCP/IP or UDP/IP.

782-1.2.9.5 Configuration Management: The camera shall support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including but not limited to, network configuration, video settings, device monitoring, and security functions. Ensure that the camera supports configuration and management via serial login, telnet login, or a web-based interface.

782-1.3 Installation Requirements: Install the CCTV camera on a pole in accordance with Design Standards, Index Nos. 18100 through 18111 and as shown in the Plans.

Furnish and install the power supplies, local control equipment, and any other camera-related field electronic equipment and transient voltage surge suppressors within a pole- or base-mounted lockable cabinet. Ensure that the cabinet protects these electrical and electronic devices from rain, dust, dirt, and other harmful elements of nature.

Furnish and install all power, video, and data cables necessary to provide connection points for camera video and pan/tilt/zoom (PTZ) control signals within the cabinet. Furnish and install any and all ancillary equipment required to provide a complete and fully operational CCTV camera. Verify that all wiring meets National Electric Code (NEC) requirements where applicable.

Ensure that data and video cables from the pole or support structure to the camera are routed inside the mounting hardware and protected from exposure to the outside environment.

Coat the exterior of the dome-type enclosure's lower half with a clear, rain repellant product prior to final acceptance.

782-1.4 Testing:

782-1.4.1 General: Subject the equipment covered by these specifications to a field acceptance test (FAT). Develop and submit a test plan to the Engineer for review and approval. Ensure that the test plan demonstrates each and every functional requirement specified for the device or system under test. The Engineer reserves the right to witness all tests.

782-1.4.2 Field Test Requirements: Perform local field operational tests at CCTV field sites according to the following:

1. Verify that physical construction has been completed as specified in the Plans.
2. Verify the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Verify all connections, including correct installation of communication and power cables.
5. Verify that the video signal from the camera is present and of consistent quality at all connection points between the camera, the cabinet, and any video devices therein.
6. Exercise PTZ and focus in all directions and execute a minimum of three other unique programming commands to ensure that the communication link between the cabinet and the camera is functioning properly.

782-2 Video Display Equipment.

782-2.1 Description. Furnish and install video display equipment as shown in the Plans.

782-2.2 Materials:

782-2.2.1 General: Use video display equipment that can display analog, digital, and other images associated with the operation of the transportation management center (TMC). These types of images include, but are not limited to:

1. CCTV video images, including feeds from other TMCs.
2. Video vehicle detection (VVD) system images.
3. System infrastructure mapping images.
4. Graphical user interfaces from computers running typical TMC applications.
5. Weather mapping images.
6. Television broadcasts.
7. Digital video discs (DVDs), videocassette recordings, or other video storage media.

Provide equipment, mounting hardware, cabling, and other video display components that are compatible with each other. Ensure that all equipment and materials furnished and installed are reviewed and approved by the Engineer.

Use display devices of the types shown in the Plans.

782-2.2.2 Video Display Control System: Furnish a video display control system listed on the APL. Ensure that the video display control system enables the operator to control and manage the display of video and computer-generated graphics on the display equipment connected to the system as well as provide selection and switching of multiple sources for display, including video streams available on the TMC Ethernet network. Ensure that the display control system allows an operator to control all displays from the same workstation that is used for the SunGuide® operator interface. Ensure that the video display control system is capable of decoding and displaying all video streams produced by encoders listed on the APL.

Use a video display control system capable of simultaneously displaying a minimum of 32 video windows, each containing streaming video at a minimum resolution of 720 pixels x 480 pixels and frame rate of 30 (fps). Ensure that the system allows any display window to be sized from 1/32 of the total display area up to the total display area, and any size in between.

Ensure that the video display control system hardware is designed to be rack mounted and secured in an EIA 19 inch equipment rack. Ensure that any system incorporating personal computer (PC) hardware utilizes current microprocessor technology and commercial, off-the-shelf components, including random access memory (RAM), hard disk drives, and network interface cards sufficient to provide the functional requirements of the system.

782-2.2.2.1 Display Control Software: Provide display control software that enables multiple operators to control all features and functions of the video display control system. These features and functions include, but are not limited to, selection of video sources for display; adjusting the size, location, and layout of video and other graphic information the system displays; and system configuration and setup. Ensure that the control software is able to operate a video wall composed of multiple display components as though it were a single, high-resolution display.

Use display control software that is compatible with the Department's SunGuide® software system.

Ensure that the display control software includes a non-proprietary software development kit (SDK) including, but not limited to, an application programming interface (API) that describes interfaces and protocols which can be used to integrate system features and functions with third-party applications.

782-2.2.2.2 Inputs and Outputs: Use a video display control system that supports and displays a variety of video and data inputs simultaneously, including composite and component National Television System Committee (NTSC) video, digital visual interface (DVI), video graphics array (VGA), super video graphics array (SVGA), and super extended graphics array (SXGA) computer graphics. Ensure that all inputs and outputs can be controlled by an operator in order to display any or all of this information on any number of display devices within the system. Ensure all inputs and outputs can be sized with and without constrained proportions across multiple screens and moved at will around any display area and combination of displays.

Ensure that the video display control system is expandable and scalable to support any combination of inputs and outputs. Provide the video display control system with a minimum configuration of 4 composite video inputs, 4 component (red, green, and blue [RGB]) video inputs, and 4 DVI inputs as well as network connections, decoders, and associated hardware and software required to display 32 inputs simultaneously at a minimum resolution of 720 pixels x 480 pixels and a frame rate of 30 fps, or as shown in the Plans. Provide the video display control system with a minimum configuration of 4 composite video outputs, 2 component (RGB video outputs), and 4 DVI outputs, or as shown in the Plans. Ensure the video display control system can be expanded to accommodate at least 128 discreet inputs and outputs.

Ensure that a single input can be routed to multiple displays simultaneously and that multiple inputs can be routed to a single display simultaneously for viewing in separate windows. Ensure that all inputs and outputs are synchronized by the video display control system and that switching between inputs or outputs does not cause displayed images to unlock, roll, or otherwise exhibit visible distortion.

782-2.2.2.2.1 Analog Video: Ensure that the video display control system is able to accept S-video, composite, and component video sources, and can digitize these signals for manipulation and display on any display device attached to the system. Ensure that all analog video inputs utilize BNC connectors.

Ensure that analog video sources can be displayed within their own windows, and can be resized up to or beyond their native resolution to conform to the wall display size.

782-2.2.2.2.2 Digital Video: Ensure that the video display control system is able to accept digital video sources, and can manipulate and display these signals on any display attached to the system. Ensure that all digital video outputs utilize DVI connectors.

Ensure that each MPEG video stream can be displayed within its own window, which shall be freely movable and sizable up to or beyond its native resolution to conform to the wall display size.

782-2.2.2.2.3 RGB Video: Include an analog input that enables the TMC operator to project an exact copy of his or her workstation desktop display on the video

wall display. Ensure that analog RGB inputs allow native images up to 1,280 pixels by 1,024 pixels at 60 Hz to be displayed on the video wall.

Ensure that RGB inputs are sizable up to or beyond their native resolution to conform to the wall display size.

782-2.2.2.2.4 Streaming Media: Ensure that the video display control system can display a minimum of 32 compressed video streams simultaneously in MPEG-2 over TCP/UDP/RTP over IP and supports multicasting as defined in Version 2 of the Internet Gateway Message Protocol (IGMP). Ensure that the video display control system can display MPEG-4 and H.264. Ensure that the MPEG video input interface is, at minimum, a 10/100 megabit per second network port per every 15 streams.

782-2.2.2.2.5 Primary Display Output: Use a video display control system that can process the various signal input types to be viewed, such as the RGB feeds from monitor outputs and streaming video feeds. Ensure that the unit provides direct digital streaming video through cable feeds using a digital video decoder. Ensure that the video display control system provides the layout definitions for each signal to be displayed and saves the predefined layouts. Ensure that the video display control system also permits switching of the predefined layouts and accepts external alarm triggers to change the layouts.

Include output capacity with sufficient memory and processing speed to provide fast rendering of video and image displays. Ensure that the output has, at a minimum, a dual DVI connector that allows a digital connection of 1,280 horizontal pixels by 1,024 vertical pixels or greater resolution. Ensure that the color depth is a minimum of 24 bits per pixel. If the projection device requires an analog signal, then breakout cables may be used to convert the DVI output connector to a HD15 analog RGB connector.

782-2.2.3 Video Wall Display: Furnish and install a video wall display consisting of tiled, rear projection video display cubes arranged in a wall, as shown in the Plans, together with a video display control system.

Ensure that the video wall display is capable of producing, at a minimum, a large-scale, high-resolution video image having accurate color rendition, sufficient image brightness, and a high contrast ratio, as described in 782-2.3. Ensure that the display system provides access to serviceable components for repair and replacement of electronics, lamps, and optical components without removing the device from service for a period longer than 30 minutes.

Integrate the individual projection units in a single, seamless display capable of projecting a continuous image across the entire active display area provided, under the complete control of the TMC operators from their individual shared workstations.

Source all major wall display components from a single provider or manufacturer to ensure that the various devices are compatible with each other and able to function together as an integrated display.

Ensure that the individual video images exhibit a uniformity of color quality across the multiple displays. Ensure that colors are displayed evenly across the video wall, and that the video wall maintains uniform brightness characteristics from one video display unit to the next in the tiled display, with no degradation in color or brightness uniformity over time. Ensure that the video wall display provides features that allow physical and electronic alignment of the separate high-resolution display units that comprise the wall.

782-2.2.4 Video Wall Support Structure: Furnish and install an aluminum or steel-frame structure capable of supporting the rear projection video display units as mounted

and stacked to form the matrix for the video wall display. Ensure that the support structure consists of stackable projection modules delivering a one-to-one relationship between the number of projectors and the number of screens. Ensure that this structure maintains a consistent maximum horizontal and vertical spacing of 0.04 inches between adjacent display units in the video wall matrix.

Fabricate the support structure specifically to ensure that a continuous, accurate image is projected on the screens without any distortion or unused screen space. Ensure that no observable distortions are present in the installed video wall display due to normal building vibration. Ensure that each completed structure is enclosed such that there is no ambient light effect on the screen from behind the display.

Ensure that the components of the individual video modules can be serviced without disturbing the integrity of the entire video wall display.

782-2.2.5 Rear Projection Video Display: Use rear projection video displays that are suitable for digital video wall applications in mission-critical TMCs where video wall image quality, operational reliability, and serviceability objectives as stated in this specification can be achieved.

Use rear projection video displays capable of displaying a minimum of a single or quad-split, four-paned CCTV camera video image. Ensure that each video display can be independently controlled from any of the central operator or shift supervisor workstations, and that each video display can be integrated with additional video units to form a single video display, or a virtual desktop where video windows can be positioned and resized by the operator.

Ensure that the rear projection video display facilitates lamp replacement without the need to readjust the image being projected on the screen.

Ensure that the rear projection video display's intensity is sufficient to ensure effective and comfortable viewing by TMC operations personnel under normal lighting conditions, subject to approval by the Department. Ensure that the unit's display engine produces a minimum light output of 550 ANSI lumens.

Ensure that the rear projection video units have the following minimum features and characteristics:

1. Screen brightness achieved by a combination of projection techniques and screen materials, so that the video display has a minimum brightness measurement of 130 candelas per square meter (cd/m2) across the outside viewing surface of the projection screen.

2. Brightness uniformity that meets or exceeds 80 percent across the display unit, as measured using a photometer.

3. A multi-lamp optical engine must be provided for rear projection video units that do not use light-emitting diodes (LEDs) for illumination. Multi-lamp optical engines must provide a failover feature whereby a second lamp can be automatically activated when the first lamp fails. Ensure displays with multi-lamp optical engines provide indication of lamp status.

4. Multi-lamp optical engines must include (1) a "hot standby" mode in which failover to the second lamp takes no more than two seconds and (2) a "cold standby" mode in which failover and the time for the display to return to full light output does not exceed 30 seconds.

5. A display module that utilizes modular component architecture to permit service or replacement of serviceable parts without removing the projection engine.

6. Each unit shall be completely enclosed and light tight, with fixed panels for access to the lamp, power supply, and projection engine.

782-2.2.6 Flat Panel Display: Furnish and install a flat panel display unit to reproduce video and computer graphics information. Ensure that the device displays, at a minimum, a high-resolution, distortion-free image and maintains a consistent level of illumination across the entire screen area. Ensure that it has the following minimum features and characteristics:

1. Dimensions of 24 inches high by 41 inches wide by 4 inches deep, or as shown in Plans.

2. Ability to be installed on the face of a standard wall or flush mounted within the wall system.

782-2.2.7 Cabling: Furnish each video display component with all required appurtenances, including all the necessary cables, with proper length and connectors for power and communication, as defined by the manufacturer. Ensure that cabling conforms to applicable EIA/TIA standards. Size the power cables to meet NEC requirements. Provide communication cables from each video display component to the network communication devices that are appropriate for and compatible with the technology employed (e.g., fiber optic, twisted pair, or coaxial), and meet the minimum size and bandwidth specifications the manufacturer requires.

Provide all cabling of adequate length, along with the compatible connectors and any ancillary equipment necessary to fully interconnect the video components and display control systems needed to achieve the functions required. Label all cables at both ends, as approved by the Engineer.

782-2.2.8 Electrical Specifications: Provide equipment that operates on 120 VAC at a frequency of 60 Hz. Furnish a transformer or other necessary means of power conversion for any device that requires another voltage or frequency.

Conduct TMC field reviews to examine the electrical distribution panels allocated for various equipment items and the electrical schedules for each. Make any changes, additions, or corrections to the electrical panels, wiring, outlets, and connectors that may be deemed necessary to adequately power all of the equipment proposed for a video display project at the intended location, subject to the approval of the Engineer. Make any changes to the building's electrical wiring in accordance with applicable codes and permits, and with the NEC. Have any modifications to an existing building's wiring or the video wall electrical wiring plans signed and sealed by a Specialty Engineer, as defined in 1-3.

782-2.3 Performance Specifications: Use only display devices meeting the following minimum requirements.

	Flat Panel Display			Rear Projection Video Display
Type	Direct View LCD			DLP or LCD
Size	(dependent on TMC design, as shown in Plans)			
Aspect Ratio	(dependent on TMC design, as shown in Plans)			
Resolution	1600 x 1200 / 1280 x 768 pixels; 16.7 million colors			1024 x 768 pixels
Viewing Angle	170 degrees horizontally and	160 degrees horizontally		160 degrees horizontally

	vertically	and vertically		and vertically
Half Gain Angle	—	—		±40 degrees horizontally and vertically
Contrast Ratio	500:1	600:1		600:1
Screen Brightness *	250 cd/m2	450 cd/m2		130 cd/m2
Lamp Life	—	—		8,000 hrs. (avg.)
Video Inputs	Analog/digital via 15-pin D-sub (HD-15) connector; DVI-D connector.	Composite video (NTSC) on RCA connector; analog/digital via 15-pin D-sub (HD-15) connector; DVI-I connector; HDMI.		Composite video (NTSC) on BNC; RGB via 15-pin D-sub (HD-15) connector; DVI-D connector.
Operating Temperature and Humidity	32° to 95°F. 20 to 80%.	32° to 95°F. 20 to 80%.		32° to 95°F. 20 to 80%.
Power Requirements	120 VAC at 60 Hz	120 VAC at 60 Hz		120 VAC at 60 Hz
* Measured using a photometer.				

782-2.4 Installation Requirements: Do not proceed with any part of the procurement, construction, or installation of the video display equipment until the Construction Plans and materials are approved by the Engineer. Provide the Engineer with submittal documentation, including the manufacturers' product specification sheets and a detailed description of each item's function as well as a compliance matrix that confirms all equipment meets or exceeds the requirements of these specifications.

Configure each video display unit to provide individual, independent control from each operator workstation.

Create the video wall display by arranging individual video display units in a framework or apparatus that creates the video wall configuration as shown in the Plans. Ensure that the finished video wall provides a single, apparently seamless display area. Ensure that adjacent individual display units are aligned physically and electronically so that image content stretched across multiple monitors align within plus or minus 2 lines of horizontal and vertical resolution.

Ensure that all rear projection video unit controls are accessible at all times when the devices are permanently installed. Ensure that installation and positioning does not conceal or limit access to any display unit controls at any time during active use.

Follow proper ventilation and cooling procedures for the equipment installed, as determined by the equipment manufacturers. Provide electrical requirements and power distribution units and power supplies for the video display components on an as-needed basis.

782-2.5 Testing:

782-2.5.1 General: Submit a detailed system acceptance test plan to the Engineer for review and approval. Prepare a test plan that covers all areas of system function described in this section, and that is developed according to the various equipment manufacturers' recommendations.

Check and test the satisfactory operation of all video display components upon completion of the equipment's installation. At minimum, include in the video display system test the testing of each color video monitor type, each secondary display output at workstations, each rear projection video display unit, and the video wall display's image alignment and control functions.

782-2.5.2 Observation Period: Subject the video wall display to a 90 day operational observation period, during which time the Contractor shall perform any and all maintenance, recalibration, system checking, and display modifications required by the Engineer. The Engineer has the option to require a restart of the observation period if a major system flaw or failure occurs.

782-3 Warranty.

782-3.1 General: Ensure that CCTV cameras and video display equipment have a manufacturer's warranty covering defects for a minimum of three years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608. Ensure that the warranty requires the manufacturer to furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department or the maintaining agency within 10 calendar days of notification.

Warranty repairs of the video display control system and related TMC display equipment must commence within 24 hours after notification by the Department.

782-4 Method of Measurement.

782-4.1 General: Measurement for payment will be in accordance with the following tasks.

782-4.2 Furnish and Install: The Contract unit price for each CCTV camera or video display device or system, furnished and installed, will include furnishing, placement, and testing of all equipment and materials, and for all tools, labor, operational software packages and firmwares, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

The video display equipment shall be measured as each major system component is furnished, installed, made fully operational, and tested in accordance with this Specification or as directed by the Engineer.

782-4.3 Furnish: The Contract unit price per CCTV camera or video display device or system, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

782-4.4 Install: The Contract unit price per CCTV camera or video display device or system installed will include placement and testing of all materials and equipment, and for all labor, equipment, hardware, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

782-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 782-1- CCTV Camera–each.
Item No. 782-2- Video Display–each.

783 INTELLIGENT TRANSPORTATION SYSTEMS – FIBER OPTIC CABLE AND INTERCONNECT.

(REV 11-20-12) (FA 2-6-13) (7-13)

SECTION 783 (Pages 897 – 913) is deleted.

786 INTELLIGENT TRANSPORTATION SYSTEMS – VEHICLE DETECTION AND DATA COLLECTION.

(REV 11-20-12) (FA 2-6-13) (7-13)

SECTION 786 (Pages 946 – 968) is deleted.

916 BITUMINOUS MATERIALS.

(REV 1-15-13) (FA 1-28-13) (7-13)

SECTION 916 (Pages 985 – 995) is deleted and the following substituted:

SECTION 916
BITUMINOUS MATERIALS

916-1 Superpave PG Asphalt Binder:

916-1.1 Requirements: Superpave Performance Graded (PG) asphalt binders, identified as PG 52-28, PG 58-22, and PG 67-22 shall meet the requirements of 916-1.2, AASHTO M 320-10 Table 1. Polymer Modified Asphalt (PMA) or Asphalt Rubber Binders (ARB), identified as PG 76-22 (PMA), PG 76-22 (ARB), and PG 82-22 (PMA), shall meet the requirements of 916-1.2 and AASHTO MP 19-10. All PG asphalt binders shall meet the following additional requirements:

1. The intermediate test temperature at 10 rad/s. for the Dynamic Shear Rheometer (DSR) test AASHTO T 315-10 shall be 26.5ºC for PG grades PG 67 and higher.

2. An additional high temperature grade of PG 67 is added for which the high test temperature at 10 rad/sec for the DSR test AASHTO T 315-10 shall be 67ºC.

3. All PG asphalt binders having a high temperature designation of PG 67 or lower shall be prepared without modification.

4. All PMA binders having a high temperature designation higher than PG 67 shall be produced with a styrene-butadiene-styrene (SBS) or styrene-butadiene (SB) elastomeric

polymer modifier and resultant binder shall meet all requirements of this Section. In addition, polyphosphoric acid may be used as a modifier not exceeding 1.25% by weight of asphalt binder.

5. The phase angle (tested in accordance with AASHTO T 315-10) shall be a maximum of 75 degrees at 76ºC for PG 76-22 (PMA) and PG 76-22 (ARB) and a maximum of 65 degrees at 82°C for PG 82-22 (PMA).

6. PG 76-22 (ARB) shall meet the additional requirements of 916-1.1.1.

7. Do not substitute a PG binder with a high temperature grade more than 5.9°C higher than the specified PG grade, (for example, if a PG 58-22 is specified, do not supply a PG 64-22 or higher).

For all PG binder used in all hot mix asphalt, silicone may be added to the PG binder at the rate of 25 cubic centimeters of silicone mixed to each 5,000 gallons of PG binder. If a disbursing fluid is used in conjunction with the silicone, the resultant mixture containing the full 25 cubic centimeters of silicone shall be added in accordance with the manufacturer's recommendation. The blending of the silicone with the PG binder shall be done by the supplier prior to the shipment.

All PG binder for friction course mixes and for other hot mix asphalt products containing reclaimed asphalt pavement (RAP) shall contain 0.5% heat stable anti-strip additive by weight of PG binder unless specifications for the hot mix asphalt product requires testing by FM 1-T 283 and the test results indicate it is not required, or the mixture contains hydrated lime. Where FM 1-T 283 indicates an anti-strip additive is required, it shall be from 0.25% to 0.75%. The anti-strip additive shall meet the requirements of 916-5. The anti-strip additive shall be introduced into the PG binder by the supplier during loading.

916-1.1.1 Additional Requirements for PG 76-22 (ARB): The following additional requirements apply only to PG 76-22 (ARB):

1. The asphalt binder shall contain a minimum of 7.0% ground tire rubber (GTR) by weight of asphalt binder.

2. The GTR shall meet the requirements of Section 919.

3. Polymer modification is optional for PG 76-22 (ARB).

4. All testing performed with the DSR (AASHTO T 315-10 and AASHTO TP 70-11) shall be performed with a 2 mm gap.

916-1.2 Qualified Products List (QPL): The Superpave PG asphalt binders supplied under this specification shall be one of the products included on the QPL as specified in 6-1. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include a report of test results from an independent laboratory confirming the material meets the requirements of this section. In lieu of submitting test results from an independent laboratory, the Department will evaluate the material. Any marked variation from the original test values for a material below the established limits or evidence of inadequate quality control or field performance of a material will be considered to be sufficient evidence that the properties of the material have changed, and the material will be removed from the QPL.

For each binder grade, the supplier may be required to submit to the State Materials Office (SMO), a split sample of material representative of test results submitted with the product evaluation application. In addition, for modified binders, the original PG binder grade, the modifier product designation, and modifier type shall be indicated on the product evaluation application and in the Quality Control Program below. Additionally, for PG 76-22 (ARB), provide a certification statement on the product evaluation application and in the Quality Control Program that a minimum of 7.0% GTR is used in the formulation of the PG 76-22

(ARB). Suppliers shall not ship any PG asphalt binder until notified that the product is on the QPL and the Quality Control Program meets the requirements of 916-1.3 and has been approved by the Department.

916-1.3 Quality Control Program: The supplier of Superpave PG asphalt binder shall at a minimum have a Quality Control Program meeting the requirements of this Section based on AASHTO R 26-01 (2009). The Quality Control Program shall be submitted in electronic format to the SMO for approval.

The requirements for the Quality Control Program apply to the supply location of PG asphalt binders for the use on Department projects. The supply location of PG binder may represent refinery production, terminal distribution, blending, processing, and/or modification location. Rack blending (blending from two tank sources) will be permitted to meet the requirements for a PG asphalt binder product. Any special handling requirements such as rack blending and manufacture of polymer and or rubber modified asphalt shall be described in the Quality Control Program.

916-1.3.1 Identification of Personnel and Supply Locations: The supplier's primary and secondary representatives responsible for quality control shall be identified by name, title, address, telephone, fax and e-mail address. At least one of the representatives shall be located at the supply location. The supply locations shall be identified by name, address and telephone.

916-1.3.2 Specification Compliance and Quality Control (QC) Testing: Specification compliance testing shall consist of complete testing of each PG asphalt binder shipped in accordance with 916-1.1 of these specifications. Specification compliance testing shall be conducted by a testing laboratory that participates at least annually in the AASHTO Materials Reference Laboratory (AMRL) Proficiency Sample Program for PG asphalt binder. Results of specification compliance testing shall be available to the supplier within five working days of sampling. The primary testing lab and any other labs to be used for specification compliance testing shall be identified in the suppliers Quality Control Program. The results from each AMRL Proficiency Sample for each testing laboratory shall be forwarded by the supplier for each supply location in electronic format to the SMO within one week of receiving the results. Acceptable performance in the AMRL Proficiency Sample Program shall be a minimum score of 3 for each test. A rating of less than 3 shall require identification of appropriate action on the part of the supplier and be acceptable to the State Materials Engineer.

QC testing as a minimum shall consist of testing a representative sample of each PG asphalt binder shipped by the supplier in accordance with AASHTO T 315-10 Test Method for Determining Rheological Properties of Asphalt Binder using a DSR.

Results of QC testing shall be available to the supplier within 5 hours of sampling. A QC test result outside the specification limits will require immediate sampling and testing for specification compliance and appropriate action taken. The QC testing and location where the test will be done shall be identified in the suppliers Quality Control Program. In the event that testing equipment goes out of service, the supplier may elect to test at a qualified lab identified in the supplier's Quality Control Program. The QC testing results shall be supplied within 48 hours of the sampling.

916-1.3.3 Frequency of Sampling and Testing: Sampling of PG asphalt binders shall be done in accordance with AASHTO T 40-02 (2006). Initial specification compliance test results shall be required for each PG asphalt binder grade for each new LOT of material which will be further subjected to QC testing in accordance with 916-1.3.2. A new LOT will occur

when the material in a tank changes and the specification compliance test may no longer be representative of the material in the tank. This may be due to an incoming bulk shipment of material, change in refinery run, the manufacture of a product, or a blend of material in a tank. Additional testing is as follows:

(1) Any PG asphalt binder shipped to a Department project during any one calendar month shall be tested at least once during that month for specification compliance in accordance with 916-1.3.2.

(2) When being shipped to Department projects, samples shall be obtained by the supplier and tested for QC testing in accordance with 916-1.3.2. A single, 1-quart representative sample of each PG asphalt binder shall be obtained and tested by the supplier each calendar week; for each rack blended PG asphalt binder, additional representative samples shall be obtained daily. Each QC sample and additional daily rack blended samples shall be adequately identified and retained for not less than 8 weeks at the supply location. Any PG asphalt binder not shipped to Department projects is not required to be sampled or tested.

(3) Split samples of any PG asphalt binder will be provided when requested by a representative of the Department. In this situation, three representative 1-quart samples will be obtained by the supplier under the direction of the Department. One sample will be submitted to the SMO, one will be tested by the supplier for specification compliance and one will be tested by the supplier for quality control. The method of obtaining the three representative 1-quart samples is to obtain a single gallon sample, which is then stirred and poured into three 1-quart cans. When split samples are requested by the Department, the results from both parties will be made available within 10 working days.

(4) For each rack blended PG asphalt binder, identify minimum daily Process Control (PC) Testing in the QC Plan.

916-1.3.4 Reporting: A monthly report by the supplier containing specification compliance and QC test results for each PG asphalt binder LOT shall be submitted by the supplier in electronic format using the form provided by the Department to the SMO within 7 days following the end of the calendar month. Test results for split samples shall also be included. PC test results shall not be included. Copies of these monthly reports and supporting test reports shall be available at the supply location for a minimum of 3 years.

The report shall consist of the specification compliance testing and QC testing of the following as applicable by these specifications.

SUPERPAVE PG ASPHALT BINDER		
Test and Method	Conditions	Specification Minimum/Maximum Value
Original Binder		
Superpave PG Asphalt Binder Grade		Report
Qualified Products List Number		Report
Modifier	Modified binders only	Report
Solubility, AASHTO T 44-03 (2007)	in Trichloroethylene	Minimum 99.0% (Not applicable for PG 76-22 (ARB))

Flash Point, AASHTO T 48-06 (2010)	Cleveland Open Cup	Minimum 450ºF
Rotational Viscosity, AASHTO T 316-11	275ºF	Maximum 3 Pa·s[(a)]
Dynamic Shear Rheometer, AASHTO T 315-10	$G^*/\sin\delta$, Test Temperature @ 10 rad/sec, °C Phase Angle, δ PG 76-22 (PMA) and PG 76-22 (ARB)[(b)] PG 82-22 (PMA)	Minimum 1.00 kPa Maximum 75 degrees Maximum 65 degrees
Separation Test, ASTM D 7173-11 and Softening Point, AASHTO T 53-11	163±5°C 48 hours	Maximum 15°F (PG 76-22 (ARB) only)
Rolling Thin Film Oven Test Residue (AASHTO T 240-09)		
Rolling Thin Film Oven, AASHTO T 240-09	Mass Change%	Maximum 1.00
Dynamic Shear Rheometer, AASHTO T 315-10	$G^*/\sin\delta$, Test Temperature @ 10 rad/sec, °C (Unmodified binders only)	Minimum 2.20 kPa
Multiple Stress Creep Recovery, $J_{nr,\,3.2}$[(b,c)] AASHTO TP 70-11	67°C (Modified binders only)	"V" = 1.0 Pa·s max "E" = 0.5 Pa·s max Maximum $J_{nr,diff}$ = 75%
Multiple Stress Creep Recovery, %Recovery[(b,c)] AASHTO TP 70-11	67°C (Modified binders only)	$\%R_{3.2} > 29.37(J_{nr,\,3.2})^{-0.2633}$ (Figure X2.1 in TP 70-11) For $J_{nr,3.2} \leq 2.0$
Pressure Aging Vessel Residue (AASHTO R 28-09)		
Dynamic Shear Rheometer, AASHTO T 315-10	$G^*\sin\delta$, 10 rad/sec.	Maximum 5000 kPa
Creep Stiffness, AASHTO T 313-10	S (Stiffness), @ 60 sec. M-value, @ 60 sec.	Maximum 300 MPa Minimum 0.300

(a) Binders with values higher than 3 Pa·s should be used with caution and only after consulting with the supplier as to any special handling procedures, including pumping capabilities.
(b) AASHTO T 315-10 and AASHTO TP 70-11 will be performed at a 2 mm gap for PG 76-22 (ARB)
(c) All binders with a high temperature designation >67 will be tested at 67°C. PG 76-22 (PMA) and PG 76-22 (ARB) shall pass a "V" graded and PG 82-22 (PMA) shall pass an "E" grade per AASHTO MP 19-10.

916-1.3.5 Notification and Evaluation: In the event that a specification compliance test is outside specification requirements or a QC test is outside limits established by the supplier as part of his Quality Control Program, shipments of that product to Department projects will cease immediately and the Contractor and the SMO will be notified and the product retested for specification compliance (re-sampling as appropriate). Where the retest for specification compliance meets all requirements, shipments of that product may resume. Where off-specification material has been shipped and the retest confirms the original test, the Contractor and the SMO will be informed of the steps taken to achieve specification compliance on the product shipped.

Where off-specification materials have been shipped, further shipment of that product to Department projects shall remain suspended until the cause of the problem is evaluated and corrected by the supplier to the satisfaction of the State Materials Engineer.

916-1.3.6 Certification and Verification: The supplier shall furnish certification on the bill of lading for each shipment of PG binder delivered to a Department project that includes: the quantity (including initial weights of the neat binder and GTR and ending GTR percentage by weight of asphalt binder for PG 76-22 (ARB)), the Superpave PG asphalt binder grade (including QPL number), PG binder LOT designation, the customer name, the delivery location, a statement that the binder is in conformance with 916-1 and the suppliers Quality Control Program, and the quantity of silicone and anti-strip agent addition, as applicable, including product designation (QPL number as applicable). Any special handling or temperature requirements shall be indicated on the certification and are solely the responsibility of the Contractor to follow.

The Department may sample and test PG asphalt binder from the suppliers storage tank, the delivery vehicle, and/or Contractors storage tank to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that PG asphalt binder product. Further shipment of that PG asphalt binder product to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-2 Cut-Back Asphalts.

916-2.1 Requirements: Rapid-curing, cut-back asphalt shall conform to the requirements of AASHTO M 81-92 (2008), except that the penetration range shall be from 60-120 instead of 80-120.

For Grade RC-3000, in addition to the requirements shown in Table 1 of AASHTO M 81-92 (2008) the following values shall be added to the requirements for distillation test:

Distillate, Percentage by Volume of Total Distillate to 680ºF	Grade RC-3000 Maximum
to 320ºF	0
to 374ºF	10
to 437ºF	40

All other requirements for the distillation test (and for other properties included in the table) shall be as shown in Table 1 of AASHTO M 81-92 (2008).

Medium-curing, cut-back asphalt shall conform to the requirements of AASTHO M 82-75 (2008).

916-2.2 Sampling, Certification, and Verification: Sampling of cut-back asphalts shall be done in accordance with AASHTO T 40-02 (2006). For each tank of cut-back asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the SMO for testing before use. A pretest number will then be assigned by the SMO which shall be furnished with all cut-back asphalt delivered to the project. The pretest number shall be valid for three months from the date of issue.

The Department may sample and test pre-tested cut-back asphalt from the supplier's storage tank, the Contractor's transport tank and/or distributor to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that pretested cut-back asphalt product. Further shipment of that pretested cut-back asphalt product to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-3 Emulsified Asphalts.

916-3.1 Requirements: Anionic emulsified asphalt shall meet the requirements of AASHTO M 140-08 with the exception that the cement mix test will be waived when the asphalt is used in non-mix application, such as tack coats and primes. Cationic emulsified asphalt shall meet the requirements of AASHTO M 208-01 (2009). Additional emulsions permitted by specifications shall meet the following requirements:

HIGH FLOAT EMULSIONS		
Test	Conditions	Asphalt Emulsion Grade AE-60
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 1% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 40
Absolute Viscosity	140ºF	minimum 3,200 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichloroethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-90
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%

Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 2% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 70
Absolute Viscosity	140ºF	minimum 1,600 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichloroethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-150
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour(b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 3% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 125
Absolute Viscosity	140ºF	minimum 800 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichloroethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-200
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	122ºF	minimum 45 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 62%
Oil Portion	500ºF. Dist.	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 150
Absolute Viscosity	140ºF	minimum 400 poise
Ductility	77ºF, 50 mm/minute	
Float Test	140ºF	minimum 1,200 seconds

Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days.
(b) The 24-hour (one day) storage stability test may be used instead of the 5 day settlement test.

SPECIAL MS-EMULSION		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77ºF	minimum 45 seconds
Storage Stability	24 hour	maximum 1%
Sieve Test	50 mL $CaCl_2$ 0.10 N	maximum 0.10%
Demulsibility		minimum 65%
Residue by Distillation		minimum 62%
Naphtha Content	500ºF. Dist.	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 50
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Absolute Viscosity	140ºF	minimum 800 poise
Solubility	in Trichloroethylene	minimum 97.5%
Maximum application temperature shall be 170ºF.		

EMULSIFIED ASPHALT GRADE CRS-2H		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	122ºF	100/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Demulsibility	35 mL 0.8% Sodium Dioctyl Sulfosuccinate (c)	minimum 40%
Particle Charge		positive
Sieve Test		maximum 0.1%
Residue		minimum 65%
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	80/140
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days.
(b) The 24-hour (one day) storage stability test may be used instead of the 5 day settlement test.
(c) The demulsibility test shall be made within 30 days from date of shipment.

ASPHALT EMULSION PRIME (AEP)		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77ºF	20/150 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%

Sieve Test		maximum 0.1%
Residue		minimum 55%
Naphtha Content	500ºF. Dist	maximum 12% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	40/200
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%
(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days. (b) The 24-hour (one day) storage stability test may be used instead of the 5 day settlement test.		

ASPHALT EMULSION GRADE RS-1h		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77ºF	20/100 seconds
Storage Stability	24 hour	maximum 1%
Demulsibility	35 mL 0.02N $CaCl_2$ (a)	minimum 60%
Sieve Test		maximum 0.10%
Residue by Distillation		minimum 55%
Naphtha Portion	500ºF. Dist (b)	maximum 3% by volume
Tests on Residue From Distillation Test:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 45
Viscosity	140ºF	minimum 1,600 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%
(a) The demulsibility test shall be made within 30 days from the date of shipment. (b) When RS-1H has been modified to include naphtha, the 24-hour storage stability test will be waived.		

EMULSION PRIME (RS TYPE)		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77ºF	minimum 75 seconds
Storage Stability	24 hour	maximum 1.0%
Sieve Test		maximum 0.1%
Naphtha Content		5/15% by volume
Residue		minimum 55%
Tests on Residue:*		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 50
Viscosity	140ºF	minimum 800 poise
Solubility	in Trichloroethylene	minimum 97.5%
* Residue by distillation shall be in accordance with AASHTO T 59-09 except that the maximum temperature shall be 329°F, plus or minus 10ºF [165°C, plus or minus 5ºC] and the sample shall be maintained at this temperature for 20 minutes.		

EPR-1 PRIME (e)

Tests	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77ºF	6/24 seconds
Sieve Test (a)		maximum 0.1%
Residue by Distillation (b)		minimum 20%
Particle Charge Test (c)		positive
Test on Residue: (d)		
Flash Point	COC	minimum 410ºF
Viscosity	140ºF	600/1000cSt

(a) Distilled water shall be used in place of 2% sodium oleate solution.
(b) Residue by distillation shall be in accordance with AASHTO T 59-09 with the exception that a 50 g sample is heated to 300ºF [149ºC] until foaming ceases, then cooling immediately and calculating results.
(c) Caution: this material has a positive particle charge, and therefore should not be mixed with materials having a negative particle charge.
(d) Residue by distillation shall be in accordance with AASHTO T 59-09 except that the maximum temperature shall be 329°F, plus or minus 10ºF [165°C, plus or minus 5ºC] and the sample shall be maintained at this temperature for 20 minutes.
(e) EPR-1 Prime shall not be diluted. In the event that EPR-1 Prime is not used in a 12 hour period, the material shall be thoroughly mixed by circulation or other suitable means prior to use.

EMULSIFIED ASPHALT GRADE CRS-1h		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77°F	20 – 100 seconds
Storage Stability	24 hour	maximum 1%
Demulsibility	35 ml 0.8% Sodium Dioctyl Sulfosuccinate (a)	minimum 60%
Sieve Test		maximum 0.10%
Residue by Distillation	500°F. Distillation	minimum 55%
Naphtha Portion	500°F. Distillation. (b)	maximum 3% by volume
Particle charge		positive
Tests on Residue From Distillation Test:		
Penetration (0.1 mm)	77°F, 100 g, 5 seconds	minimum 45
Viscosity	140°F	minimum 1600 poise
Ductility	77°F	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The demulsibility test shall be made within 30 days from the date of shipment.
(b) When CRS-1 has been modified to include naphtha, the 24 hour storage stability will be waived.

EMULSIFIED ASPHALT GRADE NTSS-1hm		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Viscosity	77°F	20 – 500 seconds
Storage Stability	24 hour	maximum 1%
Settlement	5 days	maximum 5%
Residue by Distillation		minimum 50%
Naphtha Content	500°F. Distillation	maximum 1% by volume
Sieve Test		maximum 0.30% (a)

Tests on Residue From Distillation Test:		
Penetration (0.1 mm)	77°F, 100 g, 5 seconds	maximum 20
Softening Point ASTM D 36		minimum 149°F
Dynamic Shear Rheometer AASHTO T 315-10	G*sin δ, 179.6°F @ 10 rad/sec	minimum 1.00 kPa
(a) Sieve test may be waived if no application problems are present in the field.		

916-3.2 Sampling, Certification, and Verification: For each tank of emulsified asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the SMO for testing before use. A pretest number will then be assigned by the SMO which shall be furnished with all emulsified asphalt delivered to the project. The pretest number shall be valid for 3 months from the date of issue.

The Department may sample and test pretested emulsified asphalt from the suppliers storage tank, the Contractors transport tank and/or distributor to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that pretested emulsified asphalt product. Further shipment of that pretested emulsified asphalt product to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-4 Liquid Anti-strip Agents.

916-4.1 Requirements: Liquid anti-strip agents shall be tested in accordance with FM 5-508. Tensile strength ratios will be calculated for the following two conditions and expressed as percentages: 1) conditioned mixture without anti-strip to unconditioned mixture without anti-strip and 2) conditioned mixture with anti-strip to unconditioned mixture without anti-strip. A 20% gain in tensile strength ratio for condition 2 as compared to condition 1 shall be required.

916-4.2 Qualified Products List (QPL): Liquid anti-strip agents supplied under this specification shall be one of the products included on the QPL. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include a report of test results from an independent laboratory confirming the material meets the requirements of this section. In lieu of submitting test results from an independent laboratory, the Department will evaluate the material. For each liquid anti-strip agent, the supplier will submit to the SMO one pint of a representative sample of liquid anti-strip agent when submitting the QPL application to the Department's Product Evaluation Section.

Any marked variation from the original test values for a material below the established limits or evidence of inadequate quality control or field performance of a material will be considered sufficient evidence that the properties of the material have changed, and the material will be removed from the QPL.

916-4.3 Mix Design Verification: Inclusion of a liquid anti-strip agent on the QPL does not guarantee that the anti-strip will be approved for use in an asphalt mixture. Specifications may require subsequent moisture susceptibility testing per FM 1-T 283 for the particular mix design. Results from this testing may indicate the need for a larger dosage rate of anti-strip agent (up to 0.75% maximum) or a different anti-strip agent to meet the specification requirements.

919 GROUND TIRE RUBBER FOR USE IN ASPHALT RUBBER BINDER. (REV 11-20-12) (FA 1-28-13) (7-13)

SECTION 919 (Pages 997 – 998) is deleted and the following substituted:

SECTION 919
GROUND TIRE RUBBER
FOR USE IN ASPHALT RUBBER BINDER

919-1 Description.

This Section governs ground tire rubber for use in asphalt rubber binders for use in a variety of paving applications.

919-2 General Requirements.

The ground tire rubber shall be produced from tires and shall be sufficiently dry so as to be free flowing and to prevent foaming when mixed with asphalt cement. The rubber shall be substantially free from contaminants including fabric, metal, mineral, and other non-rubber substances. Up to 4% (by weight of rubber) of talc or other inert dusting agent, may be added to prevent sticking and caking of the particles.

The ground tire rubber used shall be one of the products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

919-3 Physical Requirements.

The physical properties of the ground tire rubber shall be determined in accordance with FM 5-559, and shall meet the following requirements:

Specific Gravity	1.06 to 1.20
Moisture Content	Maximum 0.75%
Metal Contaminants	Maximum 0.01%
Gradation	98% Passing the No. 30 Sieve

919-4 Chemical Requirements.

The chemical composition of the ground tire rubber shall be determined in accordance with ASTM D297-93 and shall meet the following requirements:

Acetone Extract	Maximum 25%
Rubber Hydrocarbon Content	40 to 60%
Ash Content	Maximum 8%
Carbon Black Content	20 to 40%
Natural Rubber	16 to 45%

919-5 Packaging and Identification Requirements.

The ground tire rubber shall be supplied in moisture resistant packaging such as either disposable bags or other appropriate bulk containers. Each container or bag of ground tire rubber shall be labeled with the manufacturer's designation for the rubber and the specific type, maximum nominal size, weight and manufacturer's batch or LOT designation.

919-6 Certification Requirements.

The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the ground tire rubber meets the requirements of this Section.

949 BRICK AND CONCRETE MASONRY UNITS FOR MANHOLES, INLETS AND OTHER STRUCTURES.

(REV 10-16-12) (FA 1-7-13) (7-13)

SECTION 949 (Page 1064) is deleted and the following substituted:

SECTION 949
BRICK AND CONCRETE MASONRY UNITS FOR MANHOLES, INLETS AND OTHER STRUCTURES

949-1 Clay Brick and Shale Brick.

This brick shall meet the requirements of ASTM C62, Grade MW or ASTM C32, Grade MM.

949-2 Concrete Brick.

Concrete brick shall meet the requirements of ASTM C55.

949-3 Concrete Masonry Units.

Concrete masonry units for use in manholes, inlets and similar structures shall meet the requirements of ASTM C139.

949-4 Acceptance.

Provide the Engineer a certification from the manufacturer stating that the bricks or concrete masonry units meet the requirements of this Section. Acceptance of materials will be in accordance with Section 6.

955 TIMBER TREATMENT (INCLUDING TREATING MATERIALS).

(REV 1-8-13) (FA 2-1-13) (7-13)

SECTION 955 (Pages 1071 – 1072) is deleted and the following substituted:

SECTION 955
TIMBER TREATMENT
(INCLUDING TREATING MATERIALS)

955-1 General.

The work specified in this Section is the treating of structural timber, timber piling and timber posts. The method of treatment for all such timber materials shall be in accordance with

AASHTO M 133, or American Wood Protection Association (AWPA) Use Category Standard (USC) - U1, with the exceptions and additions as specified herein.

955-2 Preservative.

955-2.1 Salt or Brackish Water Use: The treating of Southern Yellow Pine (SYP) lumber or timber for use in salt or brackish water environments shall be done with Chromated Copper Arsenate (CCA).

955-2.2 Above Ground or Ground Contact and Fresh Water Immersion Use: The treating of SYP lumber and timber for above ground or ground contact and fresh water immersion applications, shall be done with, Copper Azole-Type C (CA-C), Alkaline Copper Quat-Type D (ACQ-D), or CCA, with the following exceptions:

Treatment of the wood products of the pedestrian bridges, wood rails at buildings or rest areas, and fence posts shall be done either with, Copper Azole-Type C (CA-C), or Alkaline Copper Quat-Type D (ACQ-D).

955-3 Process.

All timber and lumber items shall be treated in accordance with Standard T1 of the AWPA manual.

955-4 Requirements for Preservative Materials.

Alkaline Copper Quat-Type D (ACQ-D), Chromated Copper Arsenate (CCA), Copper Azole-Type C (CA-C), Ammoniacal Copper Zinc Arsenate (ACZA) shall be in accordance with AWPA P5.

955-5 Requirements for Retainment.

955-5.1 Piling: A minimum of 2.50 lb/ft^3 of CCA oxides shall be retained in zone 1, outer 0.50 inch, and 1.5 lb/ft^3 in zone 2, outer 0.50 inches to 2 inches.

If ACZA is used, a minimum of 2.50 lb/ft^3 shall be retained in zone 1, outer 0.50 inch, and 1.5 lb/ft^3 in zone 2, outer 0.50 inches to 2 inches.

955-5.2 Structural Timber and Sheet Piles: When installation is not in a salt (or brackish) water environment, the minimum retention shall be 0.60 lb/ft^3 of CCA or ACQ-D or 0.31 lb/ft^3 of CA-C, as determined by cores from the outer 0.60 inch. When installation is in a salt (or brackish) water environment, a minimum of 2.50 lb/ft^3 of CCA oxides shall be retained in the outer 0.60 inch.

All guardrail material (timber posts, blocks, wedges, etc.) shall retain a minimum of 0.40 lb/ft^3 of CCA or ACQ-D; or 0.15 lb/ft^3 of CA-C in the outer 1 inch zone.

955-5.3 Posts: Round/sawn timber fence posts shall retain a minimum of 0.40 lb/ft^3 of ACQ-D or 0.15 lb/ft^3 of CA-C in the outer 1 inch zone.

955-5.4 Determination of Retention: Retention shall be determined by assay performed and certified by the treating company in accordance with the applicable AWPA standards.

955-6 Penetration Requirements.

955-6.1 For Structural Timber: The penetration of the treatment shall be in accordance with the applicable AWPA standards, with the exceptions as specified herein.

955-6.2 For Round Piles and Fence Posts: Any round pile or post, which does not show complete sapwood penetration will be rejected or shall be retreated to meet such penetration requirement.

955-6.3 Retreatment: The necessity for retreatment of structural timber, piling and posts shall be avoided as far as practicable and if it becomes apparent that due measures are not being taken to prevent such necessity, the acceptance of retreated materials may be withdrawn.

When retreatment is necessary the maximum limits for temperature of steam or preservative, and for preservative pressure, which apply to the original treatment shall not be exceeded during the retreatment.

955-6.4 Determination of Penetration: Sapwood penetration shall be determined by taking at least one increment boring core from each pile and cap, and other pieces of similar dimensions and, for other sizes of material, at least one boring from the charge for each 1,000 FBM in the charge. All bored holes shall be immediately plugged, with tight fitting treated plugs.

955-7 Handling Salt Treated Piling.

In handling of piles that have been treated with chromated copper arsenate or ammoniacal copper arsenate, cable slings shall be used. Mechanical grabbers or pointed tools shall not be permitted. Rough or careless handing shall be avoided at all times.

955-8 Identification of Treating Plants for Round Piling.

The treating plant shall brand, or place a distinctive permanent mark, on each round pile, approximately 6 feet from the butt end, such that the plant responsible for the treatment can be readily determined at any time during the service life of the piling.

960 POST-TENSIONING COMPONENTS.
(REV 12-17-12) (FA 1-3-13) (7-13)

SUBARTICLE 960-2.1 (Pages 1073 – 1074) is deleted and the following substituted:

960-2.1 Anchorage Assembly:

(a) Construct anchorages from ferrous metal.

(b) Anchorage shall develop at least 95% of PT steel guaranteed ultimate tensile strength (GUTS) when tested in an unbonded state, without exceeding anticipated anchor set.

(c) Average concrete bearing stress shall be in compliance with AASHTO LRFD Bridge Design Specifications and "AASHTO LRFD Bridge Construction Specifications."

(d) Test anchorage with typical local zone reinforcement shown in system drawings.

(e) Anchorages with grout outlets shall be suitable for inspection from either top or front of anchorage. Anchorage may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type, each providing singular inspection entry locations.

(f) Geometry of grout outlets must facilitate access for endoscope inspection directly behind wedge plate using a straight 3/8 inch diameter drill bit. For all PT systems other than 4 strand flat configurations, place vent holes of 3/8 inch minimum diameter through wedge plate to allow for passage of grout and inspection.

(g) Ferrous metal components of an anchorage that are to be embedded in concrete shall be galvanized in accordance with Section 962. Other anchorage assembly

components, including wedges, wedge plates, and local zone reinforcement need not be galvanized.

(h) All anchorages shall have a permanent vented anchorage cap bolted to anchorage.

SUBARTICLE 960-2.2.2.1 (Page 1078) is deleted and the following substituted:

960-2.2.2.1 Anchorage Caps:

(a) Provide permanent anchorage caps made of stainless steel, nylon, polyester, or Acrylonitrile Butadiene Styrene (ABS).

(b) Seal anchorage cap with "O"-ring seals or precision fitted flat gaskets placed against the bearing plate.

(c) Place a vent hole of 3/8 inch minimum diameter suitable for grout venting and inspection of the content inside the anchorage cap from the top or front of the anchorage cap as appropriate (e.g. anchorage caps not accessible after grouting must have a vent at the top of the cap). Anchorage caps may be fabricated to facilitate both inspection locations.

(d) Anchorage caps shall have a minimum pressure rating of 150 psi.

(e) Stainless steel bolts shall be used to attach cap to anchorage.

(f) Certified test reports documenting steel chemical analysis shall be provided when stainless steel anchorage caps are used.

SUBARTICLE 960-2.4.3 (Page 1079) is deleted and the following substituted:

960-2.4.3 Stainless Steel:

Conforms to the following:

(a) ASTM A240 Type 316 - for metallic components other than bolts.

(b) ASTM F593 Type 316 - for bolts.

971 TRAFFIC MARKING MATERIALS.
(REV 12-5-12) (FA 12-7-12) (7-13)

SUBARTICLE 971-1.7 (Page 1094) is deleted and the following substituted:

971-1.7 Additional Requirements: Traffic marking materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Provide supporting independent analytical data or product material safety data sheets (MSDS) identifying any components listed in Table 1 of 40 CFR 261.24.

Additionally, retroreflective elements shall contain no more that 200 ppm by weight of lead or arsenic when tested in accordance with the Environmental Protection Agency (EPA) Testing Methods 3052, 6010B, and 6010C.

973 STRUCTURAL PLASTICS.
(REV 11-1-12) (FA 2-1-13) (7-13)

SECTION 973 (Pages 1107 – 1109) is deleted and the following substituted:

SECTION 973
STRUCTURAL PLASTICS

973-1 Description.

This work covers structural plastic components including fiberglass structurally reinforced composite lumber (SCL) and dimensional fiberglass fiber reinforced composite lumber (FFRCL).

973-2 Product Acceptance.

Use structural plastics listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of products for listing on the QPL must submit an application in accordance with Section 6 and include independently certified test reports, and manufacturer's certification that the material meets the requirements of this Section.

Structural plastic components used in Contractor-developed custom designs may be used in place of QPL listed products. For Contractor-developed custom designs, meet the product acceptance criteria in Section 471.

973-3 Materials.

Use polyethylene made from recycled post consumer or post industrial thermoplastics. Mix the plastic with appropriate colorants, UV inhibitors, hindered amine light stabilizers and antioxidants so that the resulting product meets the material property requirements specified in Tables 1 and 2. Structural plastic must not corrode, rot, warp, splinter or crack. The skin must be smooth and black in color unless otherwise specified in the Contract Documents. Skin is the surface material exposed to the atmosphere. Core is the material that surrounds and bonds to the fiberglass reinforcing rods. The use of separate materials for skin and core is at the discretion of each manufacturer; however, if a single material is used, that material must meet the requirements for both skin and core.

Manufacture structural plastic as one continuous piece with no joints or splices to the dimensions and tolerances in accordance with Table 3. Interior voids shall not exceed 3/4 inches in diameter. Structural plastic members shall be free of twist and curvature.

Reinforce square fiberglass structurally reinforced composite lumber with a minimum of four fiberglass reinforcing rods placed in the corners of the section.

Reinforcing rods must be continuous and offer a minimum flexural strength of 70.0 ksi when tested in accordance with ASTM D4476 and a minimum compressive strength of 40.0 ksi when tested in accordance with ASTM D695. Steel reinforcing rods are not permitted.

Reject any sections of structural plastic containing cracks or splits. Also, inspect the ends of the reinforcing rods and reject any sections containing reinforcing rods with voids or cracks.

Add a minimum of 15% (by weight) chopped fiberglass reinforcement to the polyethylene used for fiberglass structurally reinforced composite lumber and a minimum of 15% (by weight) chopped fiberglass reinforcement for smaller dimensional fiberglass fiber

reinforced composite lumber. The fiberglass reinforcement may be reduced when other means of controlling cracking are specified with test results which show long term cracking is nonexistent.

Fiberglass structurally reinforced composite lumber must meet the minimum structural properties listed in Table 4.

Dimensional fiberglass fiber reinforced composite lumber must meet the minimum physical properties listed in Table 5.

Table 1 Plastic Material Properties - SCL			
Density	ASTM D792	Skin	55-63 pcf
Density	ASTM D792	Core	48–63 pcf
Water Absorption	ASTM D570	Skin	2 hrs:<1.0% weight increase 24 hrs:<3.0% weight increase
Brittleness	ASTM D746	Skin	Brittleness temperature to be less than - 40°C
Impact Resistance	ASTM D256 Method A (Izod)	Skin	Greater than 0.55 ft-lbs/in
Hardness	ASTM D2240	Skin	44-75 (Shore D)
Ultraviolet	ASTM D4329 UVA	Skin	500 hours<10% change in Shore D Durometer Hardness
Abrasion	ASTM D 4060	Skin	Weight Loss: <0.02 oz Cycles=10,000 Wheel=CS17 Load=2.2 lb
Chemical Resistance	ASTM D543	Skin/Core Sea Water Gasoline No. 2 Diesel	<1.5% weight increase < 9.5% weight increase <6.0% weight increase
Tensile Properties	ASTM D638	Core	2200 psi at break min.
Compressive Modulus	ASTM D695	Core	40 ksi min.
Static Coefficient of Friction	ASTM D1894	Skin	0.25, wet max.
Nail Withdrawal or Screw Withdrawal	ASTM D6117	Skin/Core	60 lb (nail) min. 400 lb (screw) min.

Table 2 Plastic Material Properties - FFRCL		
Density	ASTM D792	50-65 pcf
Impact Resistance	ASTM D256 Method A (Izod)	Greater than 2.0 ft-lbs/in
Hardness	ASTM D2240	44-75 (Shore D)
Ultraviolet	ASTM D4329 (UVA)	500 hours <10% change in Shore D Durometer Hardness
Chemical Resistance	ASTM D756 or ASTM D543 Sea Water Gasoline No. 2 Diesel	<1.5% weight increase <7.5% weight increase <6.0% weight increase

Table 2 Plastic Material Properties - FFRCL		
Tensile Properties	ASTM D638	3000 psi at break min.
Static Coeffecient of Friction	ASTM D2394	0.25, wet or dry min.
Nail Withdrawal or Screw Withdrawal	ASTM D6117	250 lb (nail) min. 400 lb (screw) min.

Table 3 Dimensions and Tolerances		
Structural Plastic	Dimension	Tolerance
Length	Per order (80 ft Maximum)	0/+6 inch
Width – SCL Width – FFRCL	See Contract Plans	±1/2 inch ±1/4 inch
Height – SCL Width – FFRCL	See Contract Plans	±1/2 inch ±1/4 inch
Skin Thickness	3/16 inch minimum	n/a
Distance from outer surface to center rebar elements (SCL)	2 inches	±1/2 inch
Straightness (gap, bend or inside while lying on a flat surface)		<1-1/2 inches per 10 feet

Table 4 Structural Properties for SCL		
Member Size		10 inches x 10 inches min.
Modulus of Elasticity	ASTM D6109	521 ksi min.
Stiffness, E.I.	ASTM D6109	4.05E+08 lb-inch^2 min.
Yield Stress in Bending	ASTM D6109	5.3 ksi min.
Weight		30-37 lb/ft

Table 5 Minimum Properties for FFRCL		
Modulus of Elasticity	ASTM D6109	300,000 psi
Flexural Strength	ASTM D6109	2,500 psi
Compressive Strength	ASTM D6108	2,200 psi
Compressive Strength Perpendicular to grain	ASTM D6108	700 psi

975 STRUCTURAL COATING MATERIALS.
(REV 1-14-13) (FA 2-1-13) (7-13)

SUBARTICLE 975-2.4.1 (Page 1112) is deleted and the following substituted:

975-2.4.1 Prime Coat: Zinc dust pigment shall be a minimum of Type II in accordance with ASTM D520. Organic zinc rich primers shall meet the requirements SSPC Paint 20, Type II, Level 2.

Zinc primers shall be used as galvanizing repair compounds for areas greater than 100 square inches.

ARTICLE 975-7 (Pages 1114 – 1115) is deleted and the following substituted:

975-7 Anti-Graffiti Coating Materials.

975-7.1 General Requirements: Anti-graffiti coatings intended for use under this specification shall be of a composition capable of preventing the adhesion of and facilitating the removal of acrylic, polyurethane, and alkyd spray paint. All anti-graffiti coatings shall possess the physical and handling characteristics that are compatible with the requirements of Section 563. The manufacturer shall designate the non-sacrificial product as water cleanable or solvent cleanable in accordance with this section.

Anti-graffiti coatings shall contain less than 5.0 lb per gallon volatile organic compounds (VOC) as defined by 40 CFR Part 59, Subpart D, evaluated as per ASTM D3960.

The manufacturer shall supply the following additional information:

a. Technical data sheet that includes installation instructions and graffiti removal instructions, including any solvents or other materials, as necessary. Graffiti removal must be accomplished with nonproprietary cleaners as defined in ASTM D6578.

b. Sacrificial Coating Removal instructions, as applicable.

c. Certification that non-sacrificial anti-graffiti coating shall not blister, crack, check, chalk, delaminate, or exhibit a color change of more than 8 dE94 (or dE76) CIE LAB units for a period of one year after installation.

975-7.2 Performance Requirements: For laboratory testing, use flat test panels prepared in accordance with AASHTO R31. Outdoor exposure testing will be performed by the Department. Submit four, 4 inch by 8 inch fiber cement test panels to the State Materials Office. Panels will be exposed at the Department's outdoor test site in accordance with ASTM G .

Laboratory Testing - Non-Sacrificial		
Property	Test Method	Requirement
Graffiti Resistance (solvent cleanable)	ASTM D6578. Complete removal of solvent-based acrylic, polyurethane, and alkyd spray paint; after exposure; and recleanability	Cleanability Level 8, 9, or 10, Accelerated or outdoor exposure is not required. Cure per the spray paint manufacturer's requirements and assess cleanability per Section 10 of ASTM D 6578.
Fluid Resistance (solvent cleanable)	ASTM D1308 – Spot Test; Paint Thinner, Gasoline	No blistering, discoloration, softening or adhesion loss.

Laboratory Testing - Non-Sacrificial		
Property	Test Method	Requirement
Outdoor Exposure Testing – Non-Sacrificial		
Property	Test Method	Requirement
Graffiti Resistance (water cleanable)	ASTM G7: 6 months exposure at FDOT test site 2500 psi using pressure washer	Complete removal of solvent based acrylic, polyurethane, and alkyd based spray paint. No delamination or visual defects.

Laboratory Testing - Sacrificial		
Property	Test Method	Requirement
Cyclic Weather Testing	AASHTO R31, no salt fog, 95°F, 0%- 90% Relative Humidity, 500 hours, alternating RH every 100 hours	No melting or disbondment
Outdoor Exposure Testing - Sacrificial		
Property	Test Method	Requirement
Sacrificial Coating removability	ASTM G7: 6 months exposure at FDOT test site	Complete removal of solvent based acrylic, polyurethane, and alkyd based spray paint from substrate

981 TURF MATERIALS.
(REV 12-3-12) (FA 1-8-13) (7-13)

SUBARTICLE 981-3.2 (Pages 1116 - 1117) is deleted and the following substituted:

981-3.2 Dimensions: The sod shall be taken up in commercial-size rectangles, or rolls, preferably 12 inches by 24 inches or larger, except where 6 inch strip sodding is called for, or as rolled sod at least 12 inches in width and length consistent with the equipment and methods used to handle the rolls and place the sod. Sod shall be a minimum of 1-1/4 inches thick including a 3/4 inch thick layer of roots and topsoil. Reducing the width of rolled sod is not permitted after the sod has been taken up from the initial growing location. Any netting contained within the sod shall be certified by the manufacturer to be degradable within three years.

992 HIGHWAY LIGHTING MATERIALS.
(REV 1-22-13) (FA 2-5-13) (7-13)

SUBARTICLE 992-1.4 (Page 1133) is deleted and the following substituted:

992-1.4 Conduit: Conduit shall be used in accordance with the National Electrical Code and as specified in the Plans. Conduit shall meet the requirements of Section 630.

SUBARTICLE 992-1.8 (Pages 1133 – 1134) is deleted and the following substituted:

992-1.8 Pull Boxes: Pull boxes shall meet the requirements of Section 635.

SUBARTICLE 992-2.5 (Page 1135) is deleted and the following substituted:

992-2.5 Luminaire Cable: Pole and bracket cable shall be multi-conductor Type XHHW-2 XLP TC with three No. 10 AWG.

SUBARTICLE 992-2.7 (Page 1135) is deleted and the following substituted:

992-2.7 Surge Protection Devices: The metal oxide varistor (MOV) based SPD shall be potted in a manner to be waterproof. UL listing is not required. SPD's per mode surge current rating shall be 20KA for 480V to ground and 40KA for neutral to ground. Maximum continuous operation voltage (MCOV) shall be not less than 550Vrms and not greater than 600Vrms. All wires and internal spacings shall be insulated for 600Vrms.

ARTICLE 992-4 (Page 1140) is deleted and the following substituted:

992-4 Sign Lighting.

992-4.1 Luminaires and Ballasts: The luminaire shall consist of a precision cast aluminum housing with a corrosive resistant polyester powder coat finish. The standard color shall be gray. The cover shall be attached to the housing utilizing stainless steel hardware, and the housing shall be sealed to provide an IP 55 rating or greater. The mounting assembly for a sign light shall be a slipfitter type to accommodate a 1-1/2 inch, Schedule 40 steel pipe connection. The luminaire manufacturer shall place a permanent tag on the luminaire housing on which the following is imprinted: the luminaire voltage, lamp wattage and a blank area for the Contractor to inscribe the installation date. The refractor shall be tempered clear or microprismatic glass.

Induction or LED fixtures shall meet the following requirements: Correlated Color Temperature of CCT 4500 K (plus or minus 500K), maintain 94.1% intensity at 6,000 hours (IES LM-80) and have IESNA light distribution curves (IES LM-79) by an EPA recognized laboratory. The driver/ballast may be internal or external to the fixture. The driver/ballast shall have a power factor greater than or equal to 90% at full load and a total harmonic distortion less than or equal to 20% at full load. The fixture shall accommodate a circuit voltage of 480 volts. If the fixture is not compatible with the circuit voltage, step-down transformers or other equivalent circuitry shall be provided by the fixture manufacturer to provide for a complete installation.

The fixture shall be rated for a minimum lamp efficiency of 60% lumen output at 75,000 hours at 25°C. The manufacturer shall provide a five year non-prorated warranty to the Department. The warranty shall begin on the installation date.

SUBARTICLE 992-5.1 (Pages 1140 – 1141) is deleted and the following substituted:

992-5.1 Luminaires and Ballasts: Luminaires shall consist of a die-cast aluminum housing and reflector holder and a heat-resistant, high-transmission glass prismatic refractor. Housing shall have gasketing between the reflector and the refractor and the socket entry. Luminaires shall be high pressure sodium vapor unless otherwise indicated in the Plans.

High pressure sodium lamps shall meet the following requirements: NEMA C78.42, Color Rendering Index of CRI 21 (Min), CCT 2100 K and average rated life of 24,000 hours (min).

Underdeck fixtures may be wall mounted or pendant mounted fixtures. Pendant mounted fixtures shall be vibration tested in accordance with NEMA C136.31.

THIS COMPLETES THIS SPECIFICATIONS PACKAGE