DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

FIRST USE: March 1, 2008

2008 Edition

SUPPLEMENTAL SPECIFICATIONS
FOR
CONSTRUCTION OF ROADS AND BRIDGES

Georgia Department of Transportation

Modifying the Standard Specifications, 2001 Edition

approved by the State Transportation Board

on June 21, 2001

J. Tom Coleman, Jr.

Commissioner

No. 2 Capitol Square, Atlanta, Georgia 30334

The Standard Specifications for the Construction of Roads and Bridges dated June 21, 2001 shall be modified and expanded in accordance with the revisions, deletions, and additions contained herein.

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

Table of Contents

DEPARTMENT OF TRANSPORTATION
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May 2, 2006

2001 Standard Specifications Editorial and Errata Corrections

Page	Section	Correction
37	107.14.C.7	In Figure 1, Tandem Axle Trucks, change the maximum acceptable gross weight from "24,947 kg to 27,679 kg."
313	432.1.02.B	Change GDT 93 to GDT 126.
599	551.5	
938	800.2.01.C	
971	815.2.02.A.1.d	In the table under “Carbonate content (magnesium or calcium)” – Delete “At least 90%” and add “At least 80%.”
972	815.2.03.A.3	In the first sentence under Gradation – Delete “, except that the aggregate will be recycled concrete.” And add “, except that the minimum required to pass the No. 200 (75 micron) sieve shall be 2%.”
990	828.1.02.B 828.2.A	Change the word "pipe" to "pile".
1119	883.1.01.B	In the table under the test for “Reactivity” – Delete “ASTM C 227, C 289 and C 586” and add “AASHTO T 303”
1162	919.2.A.2	In the Table, change the description of Type 1 rpm from “One-way, one-color, 4x2 in (100 mm x 50 mm), reflective” to “Two-way, one-color, 4x2 in (100 mm x 50 mm), reflective”
1162	919.2.A.2	In the Table, change the description of Type 2 rpm from “Two-way, one-color, 4x2 in (100 mm x 50 mm), reflective” to “One-way, one-color, 4x2 in (100 mm x 50 mm), reflective”
950	805.2.02.A.1	Change “Type 1” to “Type A”.
950	805.2.02.A.2	Change “Type 2” to “Type B”.
951	805.2.02.A.2.h	Change "Type 2" to "Type B".
707	627.5.G	In the payment for Item No. 627 Traffic barrier, V, wall No._, change the measurement from "Per cubic yard (meter)" to Per linear foot (meter)".
1116	881.2.07.A.2	In the Table, change the minimum fabric width (metric value) for Type A from 900 mm to 914 mm.
1116	881.2.07.A.2	In the Table, change the minimum fabric width (metric value) for Type B from 550 mm to 559 mm.
1116	881.2.07.A.2	In the Table, change the minimum fabric width (metric value) for Type C from 900 mm to 914 mm.

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August 18, 2006

Section 107.12—Legal Regulations and Responsibility to the Public: Explosives

Delete Subsection 107.12 and substitute the following:

107.12 Use of Explosives

When the use of explosives is necessary for the prosecution of The Work, the Contractor shall exercise the utmost care not to endanger life or property, and shall obey all State, Federal and other Governmental regulations applying to transportation, storage, use, and control of such explosives. The Contractor shall be completely responsible for any and all damage resulting from the transportation, storage, use, and control of explosives in the prosecution of The Work by the Contractor, the Contractor's agents, or employees; and shall hold the Department harmless from all claims of damages resulting in any manner therefrom.

The Contractor shall notify each public utility owner having structures or other installations, above or below ground, near the site of The Work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the utility owners to take such steps as they may deem necessary to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for all damages resulting from his blasting operations.

All explosives shall be stored securely in compliance with all laws and ordinances, and all such storage places shall be clearly marked DANGEROUS EXPLOSIVES. Explosives and detonators shall be stored in separate storage facilities in separate areas. Where no laws or ordinances apply, locked storage shall be provided satisfactory to the Engineer, never closer than 1,000 ft (300 m) from any travel-road, building, or camping area.

In all cases where the transport, storage, or use of explosives is undertaken, such activities shall be controlled and directed by fully qualified representatives of the Contractor.

Whenever electric detonators are used, all radio transmitters shall be turned off within a radius of 500 ft (150 m). No blasting supplies shall be transported in vehicles with two-way radio unless the transmitter is turned off, or extra shielding precautions are taken. Appropriate signs shall be placed so as to give ample warning to anyone driving a vehicle equipped with two-way radio. Electrical detonators will not be used within 500 ft (150 m) of a railroad.

Submit a blasting plan to the Engineer a minimum of five working days prior to the use of explosives, that provides details of the proposed blasting plan, including, but not limited to, the type and amount of explosives, the shot sequence, the description of and distance to the closest inhabitable structure, and other information as requested by the Engineer. Do not begin blasting until the blasting plan has been reviewed and approved in writing by the Engineer. Such approval does not relieve the contractor of the responsibility for the adequate and safe performance of the blasting.

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July 20, 2007

Section 149—Construction Layout

Delete Section 149 and substitute the following:

149.1 General Description

Perform construction layout to guide and control performance of items of the work according to this Specification.

This work includes:

- Placing, replacing (if necessary), and maintaining construction layout points.
- Preparing construction layout drawings, sketches, and computations.

- Recording data in field books such as alignment, slope stake, blue top, drainage layout, bridge, and other books used for layout for this Project.

149.1.01 Definitions

General Provisions 101 through 150

149.1.02 Related References

A. Standard Specifications

General Provisions 101 through 150

B. Referenced Documents

General Provisions 101 through 150

149.1.03 Submittals

Submit the following documentation to the Department:

A. Project Construction Records

These records detail information that the Department uses to determine the template line for the as-built cross sections, which defines the computation line for unclassified excavation. These records include:

- Survey records
- Bound field notebooks
- Computer printouts that record the Project’s construction

Prepare the records as directed by the Engineer.

B. Survey Documents

Furnish the Engineer with a copy of survey documents that relate to construction layout. Provide these documents when the Engineer requests or as they are completed. The Engineer may check the documents for accuracy and may require revisions where necessary. The documents become Department property and will be included in the permanent Project records.

C. Drainage Structure Sketches

Profile both inlet and outlet ends of proposed drainage structures for at least 100 ft (30 m) in the existing ditch line or stream bed. Adjust flowline elevations, if necessary, to enhance the hydraulics and to reduce silting, scouring, or backwater.

Calculate the length of each structure and provide sketches of the structure to the Engineer for review and approval at least 24 hours before beginning the work.

D. Bridge Layout Sketch

Furnish a layout sketch before staking on bridges. After staking, submit a revised sketch for the Engineer’s review and approval before beginning construction. Include in the layout sketch relevant stations, angles, dimensions, and redundant checks including exterior beam dimensions in each span. Also include all horizontal and vertical clearances with calculations that verify the clearances shown.

Submit for the Engineer’s review and approval survey data and calculations with the layout sketch and information required for bent construction.

Verify the Plan elevations for all bridge bearing seats on the substructure.

E. Wall Layout Sketches

Submit sketches and other data verifying either that the wall will fit the final field conditions, or indicate where revisions are necessary. Submit these sketches well before the wall construction begins so the Engineer can make any necessary structural design changes.

149.2 Materials

General Provisions 101 through 150

149.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150

149.3 Construction Requirements

General Provisions 101 through 150

149.3.01 Personnel

Furnish personnel capable of establishing line and grade points necessary to complete the work. Establish these points within the generally accepted surveying tolerances, and ensure that they are acceptable for the work being performed.

149.3.02 Equipment

Furnish surveying equipment, stakes, and all materials necessary to perform the work, subject to the Engineer's approval.

149.3.03 Preparation

A. General Pre-Construction

Before beginning construction:

1. Ensure that plan dimensions, alignment, and elevations are compatible with existing field conditions. Make adjustments where necessary.
2. Ensure alignment tie-ins by coordinating construction layout with that of other Contractors whose work abuts any portion of the work. All adjustments are subject to the Engineer's approval.

B. Widening and Reconstruction

Before beginning construction where existing pavement is to be retained either for widening or for reconstruction:

1. Take three-point levels of the pavement throughout the length to be retained.

   Normally, the three-point levels will be required at 50 ft (15 m) intervals. However, the Engineer may adjust these intervals according to existing field conditions. Three-point levels are not required on asphalt shoulder widening projects and earth shoulder reconstruction projects.
2. From the three-point levels, prepare a graphic grade plot that "best fits" the existing pavement to minimize the leveling requirements (if any) of the existing roadway. Cross slopes may be varied within the ranges shown on the Plans or adjusted by the Engineer to produce the "best fit."
3. On passing lane or widening Projects where existing pavement is not to be overlaid:
   a. Profile and plot the outside edge of the existing pavement to obtain a smooth profile grade.
   b. Transfer this grade to the new edge of paving using the proper cross slope.
4. Furnish data to the Engineer for approval before beginning widening and reconstruction.

5. On widening, reconstruction, or passing lane projects, obtain the Engineer’s approval of the “best fit” profile. Ensure that grade stakes are set to control the construction of any required widening based upon the “best fit” profile and cross slope. Construct proposed widening flush with the existing edge of paving. Provide positive drainage in all cases.

C. Existing Bridge Widening or Modification

To widen or modify existing bridges, do the following before ordering materials or beginning construction:

1. Verify existing elevations and dimensions as well as confirm or determine required new cap elevations.
2. Profile the removal line and cross section the existing deck.
3. Use this profile information to determine a “best fit” finished grade for the widened portion.
4. Compute the new cap elevations based on this “best fit” information.
5. Furnish survey data, layout sketch, and calculations to the Engineer for approval.

D. Retaining Wall Construction Layout

Set stakes, take necessary cross sections, and perform necessary calculations at each wall before beginning wall construction to ensure that the geometric design of the retaining wall conforms to actual conditions.

149.3.04 Fabrication

General Provisions 101 through 150.

149.3.05 Construction

A. Verify Plan Elevations

Verify plan elevations for all bridge bearing seats on the substructure.

B. Verify Bent Layout

After bent construction has begun, verify bent layout at each major phase of the construction to ensure that the bent is properly positioned in relation to adjacent bents.

C. Establish the Centerline

Establish the centerline as follows:

1. Establish or reestablish the centerline from the monuments and/or reference points the Department will provide.
2. On widening or reconstruction Projects, establish the horizontal and vertical alignment of the existing roadway and bridges.
3. Modify the Plan horizontal and vertical alignment to conform to the existing alignment as necessary.

D. Verify the Accuracy of the Bench Mark(s)

The Department will furnish at least one bench mark that the Contractor shall preserve, and if necessary, relocate as follows:

1. Verify the accuracy of the bench mark(s) and report discrepancies to the Engineer.
2. Establish additional benchmarks needed for construction.
3. Maintain the bench marks for necessary Department checks.

E. Flag In-Place Survey Control Monuments

Flag and protect in-place survey control monuments and reference points, including Right-of-Way/property line intersections, as follows:

1. Pay for and replace destroyed or disturbed stakes or monuments.

2. When included as Pay Items, stake Right-of-Way markers.

F. Line, Grades, and Stakes

Set other line and grade stakes needed to construct the job, including stakes needed to relocate utilities. Stake the Right-of-Way and maintain throughout the life of the project. Restake flattened slopes, minor grade or alignment changes, and other incidentals.

G. Stake Centerline Control Alignments

Stake centerline control alignments shown on the Plans or adjusted as described above when the Department needs accurate measurement of quantities for payment. Stake these control alignments as follows:

1. Stake the alignments to an accuracy of 1:5000.
2. Stake the alignments just before the Department takes aerial photography or field cross sections for both original and final cross sections.
3. Provide the Department with elevations of positions staked for the Department's quantity measurements. Ensure that these elevations are of third order accuracy, or better. Determine them using the differential leveling method.
4. Take intermediate cross sections required because of stage construction, detours, or other reasons.

H. Provide Graphic Sketches

Prepare and use graphic sketches of superelevation runout on curves on multi-lane roadways and of tie-ins of ramps to mainline on freeways and expressways to help provide positive drainage, adequate superelevation, and a pleasing appearance. Prepare and use similar sketches for street or roadway intersections.

I. Maintain the Stakes

After construction has begun in any segment of the Project, maintain the stakes that identify construction station numbers and locations as follows:

1. Ensure that stakes are placed at intervals not to exceed 200 ft (60 m) and use even, 100 ft (30 m) stations. On asphalt shoulder widening and earth shoulder reconstruction projects use mile post numbers when stations are not used.

   Mark and flag stakes so that they are visible to DOT Project personnel in that segment of the Project until construction is complete.
2. During grading activities in fills or cuts over 20 ft (6 m), extend slope stakes up or down the slopes in intervals of 10 ft (3 m) or less to achieve an accurate cross section.
3. Denote the offset distance to the construction centerline on the station number stakes, when the station number is maintained in a location other than on the construction centerline. On asphalt shoulder widening and earth shoulder reconstruction projects use the offset to the edge of pavement on the stakes.

J. Traffic Markings

When traffic markings are to be placed by either the Contractor or others, furnish the layout and clean and preline the surface to allow the placement of permanent pavement markings on the Project.

When traffic markings are not included in the Project plans, the Department will provide striping plans and/or standard drawings for the Contractor's use.

K. Provide Bridge Construction Layout

Provide alignment control, grade control, and calculations to set these controls for bridge construction.

For new bridges, the Department will furnish the necessary input data forms for the Department's "Bridge Geometry" computer program upon the Contractor's request. The Department will process the data to help the Contractor obtain finished deck elevations.

Data processing is available only as an alternate service to determine elevations. If this service is elected for use, prepare the input data and the Department will furnish the output data. The following limitations apply:

- The Department will not assume liability for the accuracy of either input or output data.

- The Department will limit this service to two programs per bridge.
- This service is not available for existing bridges that are to be widened. Finished deck elevations for bridges that are to be widened will not be furnished.

149.3.06 Quality Acceptance

The Engineer's acceptance of all or any part of the Contractor's layout shall not relieve the Contractor of responsibility to secure proper dimensions for the completed work. Correct at the Contractor's expense work incorrectly located due to layout error.

149.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150

149.4 Measurement

This item is not measured for payment.

149.4.01 Limits

General Provisions 101 through 150

149.5 Payment

This work is not paid for separately. The costs for performing layout work as described in this Specification are included in the bid for the items of work to which the layout is incidental.

Any unnecessary work, overruns, costs, etc., resulting from inaccurate data submitted by the Contractor will be deducted from Contractor payments.

149.5.01 Adjustments

General Provisions 101 through 150

May 19, 2006

Section 165—Maintenance of Temporary Erosion and Sedimentation Control Devices

Addition to the Standard Specifications:

165.1 General Description

This work consists of providing maintenance on temporary erosion and sediment control devices, including but not limited to the following:

- Silt fence
- Sediment basins
- Silt control gates
- Check dams
- Silt retention barriers

It also consists of removing sediment that has accumulated at the temporary erosion and sediment control devices.

165.1.01 Definitions

General Provisions 101 through 150.

165.1.02 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

General Provisions 101 through 150.

165.1.03 Submittals

General Provisions 101 through 150

165.2 Materials

General Provisions 101 through 150.

165.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

165.3 Construction Requirements

165.3.01 Personnel

General Provisions 101 through 150.

165.3.02 Equipment

General Provisions 101 through 150.

165.3.03 Preparation

General Provisions 101 through 150.

165.3.04 Fabrication

General Provisions 101 through 150.

165.3.05 Construction

A. General

As a minimum, clean the sediment from all temporary erosion control devices (except sediment basins) installed on the project when one half the capacity, by height, depth or volume has been reached. Clean the sediment from all temporary sediment basins installed on a project when one third the capacity of the storage volume has been filled.

Handle sediment excavated from any erosion or sediment control device in one of the following ways:

- Remove sediment from the immediate area and immediately stabilize it to prevent the material from refilling any erosion or sediment control device
- Place and mix it in the roadway embankment, or
- Waste it in an area approved by the Engineer.

Repair or replace at no cost to the Department, any erosion or sediment control devices that are not functioning properly or are damaged due to negligence or abuse.

B. Temporary Silt Fence

Maintenance of Temporary Silt Fence consists of furnishing all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0 % filled). Also included is the removal of sediment accumulations on the fabric by tapping the fabric on the downstream side.

C. Silt Control Gates

Maintenance of Temporary Silt Control Gates consists of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0% filled). When applicable, this item will include the removal of sediment accumulations on the fabric by tapping the fabric on the downstream side.

D. Erosion Control Checkdams

Maintenance of Temporary Erosion Control Checkdams or Ditch Checks shall consist of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0% filled). This item also includes the removal of any material deposited in sump holes. When applicable, this item will include the removal of sediment accumulations on the fabric by tapping the fabric on the downstream side.

E. Silt Retention Barrier

Maintenance of Temporary Silt Retention Barrier consists of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0% filled).

F. Temporary Sediment Basins

Maintenance of Temporary Sediment Basins consists of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original bottom of the basin. This also includes removing accumulated sediment from the rock filter and restoring the rock filter to its original specified condition and any work necessary to restore all other components to the pre-maintenance conditions.

G. Baled Straw Erosion Check

Maintenance of Temporary Baled Straw Erosion Check consists of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0% filled).

H. Triangular Silt Barrier

Maintenance of Triangular Silt Barrier consists of all labor, tools, materials, equipment and necessary incidentals to remove and dispose of accumulated sediment down to the original ground line (0% filled).

I. Retrofit

Maintenance of the retrofit device consists of all labor, tools, materials, equipment and necessary incidentals to remove and properly dispose of accumulated sediment in the permanent detention pond being utilized as a temporary sediment basin. This item also includes any maintenance that is required to ensure the retrofit device is maintained per Plan details and any maintenance of the stone filter to maintain its filtering ability, including cleaning and replacement.

J. Construction Exit:

Maintenance of the construction exit consists of all labor, tools, materials, equipment and incidentals, including additional stone and geotextile fabric as required to prevent the tracking or flow of soil onto public roadways. This includes, scarifying existing stone, cleaning existing stone, or placement of additional stone.

Cleaning of the construction exit by scraping and/or brooming only will not be measured for payment.

K. Inlet Sediment Trap

Maintenance of inlet sediment traps consists of all labor, tools, materials, equipment and necessary incidentals to remove and properly dispose of accumulated sediment in the trap and/or the excavated area adjacent to the trap. It also includes any maintenance that is required on the material selected to construct the inlet sediment trap.

165.3.06 Quality Acceptance

General Provisions 101 through 150.

165.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

165.4 Measurement

A. Temporary Silt Fence:

Maintenance of temporary silt fence, Type A, B, or C, is the actual linear feet (meter) of silt fence, measured in place, where sediment is removed.

B. Silt Control Gates:

Maintenance of temporary silt control gates, type I, II, III or IV, as specified on the Plans, is measured as a single unit.

C. Erosion Control Checkdams:

Maintenance of temporary erosion control checkdams/ditch checks as specified on the Plans is measured as a single unit.

D. Silt Retention Barrier:

Maintenance of temporary silt retention barrier as specified on the Plans, is measured by the linear foot (meter) where sediment is removed.

E. Temporary Sediment Basins:

Maintenance of temporary sediment basins as specified on the Plans, is measured as a single unit.

F. Baled Straw Erosion Check:

Maintenance of temporary baled straw erosion check as specified on the Plans, is measured by the linear foot (meter), where sediment is removed.

G. Triangular Silt Barrier

Maintenance of triangular silt barrier as specified on the plans, is measured by the linear foot (meter) where sediment is removed.

H. Retrofit

Maintenance of retrofit device at the location specified on the Plans is measured per each.

I. Construction Exit

Maintenance of construction exit at the location specified on the Plans, or as directed by the Engineer is measured per each.

J. Inlet Sediment Trap

Maintenance of inlet sediment trap at the location specified on the Plans, or as added by the Engineer is measured per each.

165.4.01 Limits

General Provisions 101 through 150.

165.5 Payment

A. Temporary Silt Fence

Maintenance of temporary silt fence, Type A, B, or C, is paid for at the contract unit price bid per linear foot (meter).

B. Silt Control Gates

Maintenance of temporary silt control gates, Type I, II, III, or IV as specified on the Pans is paid for at the contract unit price bid per each.

C. Erosion Control Checkdams

Maintenance of temporary erosion control checkdams/ditch checks as specified on the Plans is paid for at the contract unit price bid per each.

D. Silt Retention Barrier

Maintenance of temporary silt retention barrier as specified on the Plans is paid for at the contract unit price bid per linear foot (meter).

E. Temporary Sediment Basins

Maintenance of temporary sediment basins as specified on the Plans is paid for at the contract unit price bid per each.

F. Baled Straw Erosion Check

Maintenance of temporary baled straw erosion check as specified on the Plans is paid for at the contract unit price bid per linear foot (meter).

G. Triangular Silt Barrier

Maintenance of triangular silt barrier as specified on the Plans is paid for at the contract unit price bid per linear foot (meter).

H. Retrofit

Maintenance of the retrofit device at the location specified on the Plans is paid for at the contract unit price bid per each.

I. Construction Exit

Maintenance of the construction exit at the location specified on the Plans or as added by the Engineer is paid for at the contract unit price per each.

J. Inlet Sediment Trap

Maintenance of the inlet sediment trap at the location specified on the Plans or at the location specified by the Engineer is paid for at the contract unit price per each.

Payment will be made under:

Item No. 165	Maintenance of temporary silt fence Type____	per linear foot (meter)
Item No. 165	Maintenance of silt control gate Type ____	per each
Item No. 165	Maintenance of erosion control check dams/ditch checks	per each
Item No. 165	Maintenance of silt retention barrier	per foot (meter)
Item No. 165	Maintenance of temporary sediment basin, Sta. No. ____	per each
Item No. 165	Maintenance of baled straw erosion check	per linear foot (meter)
Item No. 165	Maintenance of triangular silt barrier	per linear foot (meter)
Item No. 165	Maintenance of retrofit, Sta. No.____	per each
Item No. 165	Maintenance of construction exit	per each
Item No. 165	Maintenance of inlet sediment trap	per each

165.5.01 Adjustments

General Provisions 101 through 150.

January 20, 2006

Section 170—Silt Retention Barrier

Delete Subsection 170.3 and substitute the following:

170.3 Construction Requirements

170.3.01 Personnel

General Provisions 101 through 150.

170.3.02 Equipment

General Provisions 101 through 150.

170.3.03 Preparation

General Provisions 101 through 150.

170.3.04 Fabrication

General Provisions 101 through 150.

170.3.05 Construction

Install a silt retention barrier as follows: Barriers shall be either staked or floating depending upon current, tides, water depth, and other variables, or as shown in the plans and contract.

A. Floating Silt Retention Barrier

1. Confine dredged materials to ponding areas or settlement basins using standpipes or weirs.
2. Place the barrier approximately 25 ft (7.5 m) outside the affected construction area, and at a depth within 5 ft (1.5 m) of the bottom.

3. If the body of water has a significant current, place the barrier parallel to the water flow. Ensure that the fabric is permeable or impermeable.

4. Vary the dimensions and methods to suit the conditions and to meet the requirements of other local and State water control agencies to ensure that silt dispersion is effectively controlled.

5. Provide a fabric that is weighted to prevent the bottom of the barrier from floating.

B. Staked Silt Retention Barrier

1. Where a staked barrier is used to protect a stream or inundated area, ensure the fabric:
    a. Extends to the bottom of the stream or inundated area and is weighted to prevent it from floating
    b. Is permeable or impermeable and not trenched in at the bottom
    c. Extends 1 foot (300 mm) above normal water elevation

2. Posts:
    a. Options: 2 inch (50 mm) x 4 inch (100 mm) wood; or 2 ½ inch (62.5 mm) min. diameter wood; or steel at a minimum of 1.33 pounds per foot (1.980 kg/m).
    b. Space posts at a minimum spacing of 4 feet (1.2 m).
    c. Ensure posts are a minimum of 5 feet (1.5 m) in length.
    d. Extend post a minimum of 18 inches (450 mm) into the soil.

170.3.06 Quality Acceptance

General Provisions 101 through 150.

170.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

February 1, 2004

Section 201—Clearing and Grubbing Right of Way

Delete Section 201 and Substitute the following:

201.1 General Description

This work includes clearing, grubbing, removing and disposing of vegetation, buildings and debris within the entire Right-of-Way and easement areas adjacent to the Right-of-Way or as designated by the Engineer. Except, do not remove objects designated to remain or removed according to other sections of these Specifications. This work also includes preserving (from injury and defacement) vegetation and objects designated to remain in place.

201.1.01 Definitions

Clearing: Removing and disposing trees, brush, stumps, logs, grass, weeds, roots, decayed vegetable matter, poles, stubs, rubbish, refuse dumps, sawdust piles, and loose boulders of 1 yd^3 (1 m^3) or less existing outside of the construction limits, debris resting on or protruding through the ground surface, or appearing on the Right-of-Way before final acceptance of the work.

Clearing also includes removing and disposing of obstructions, such as fences, bridges, buildings, and other incidental structures within the Right-of-Way unless the work or a portion of the work is:

- Removed as excavation.

- Shown in the Proposal as a separate Pay Item.
- Performed by others.

Grubbing: Removal from the Right-of-Way and proper disposal of all objectionable matter defined above under clearing, which is embedded in the underlying soil.

Grubbing also includes removing and properly disposing of parking lots, abandoned pavements, sidewalks, driveways, catch basins, drop inlets, pipes, manholes, curbing, retaining walls, utilities, foundations, paved floors, underground tanks (for removal of underground tanks see Section 217), and other structures within the Right-of-Way unless the work or portions of the work are:

- Obstructions removed as one of the excavation items
- Shown in the Proposal as separate Pay Items
- Removed by others
- To be incorporated in the project.

Objectionable Roots: Any of the following types of roots:

- Matted trees and brush roots (regardless of the size of the roots)
- Individual roots more than 0.75 in (20 mm) diameter
- Individual roots more than 3 ft (1 m) long regardless of size
- Large quantities of smaller roots present in the top 1 ft (300 mm) of the finished subgrade or road surface when detrimental to the work as determined by the Engineer.

Stumps: The butt of a tree with a diameter of 4 in (100 mm) or more. Measure the stump 6 in (150 mm) above the ground line.

201.1.02 Related References

A. Standard Specifications

Section 107—Legal Regulations and Responsibility to the Public

Section 109—Measurement and Payment

Section 160—Reclamation of Material Pits and Waste Areas

Section 161—Control of Erosion and Sedimentation

Section 208—Embankments

Section 215 – Removal of Solid Waste

Section 217—Removal of Underground Storage Tanks

B. Referenced Documents

General Provisions 101 through 150.

201.1.03 Submittals

General Provisions 101 through 150.

201.2 Materials

General Provisions 101 through 150.

201.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

201.3 Construction Requirements

201.3.01 Personnel

General Provisions 101 through 150.

201.3.02 Equipment

General Provisions 101 through 150.

201.3.03 Preparation

General Provisions 101 through 150.

201.3.04 Fabrication

General Provisions 101 through 150.

201.3.05 Construction

A. General

Establish Right-of-Way and construction lines. The Engineer will designate which trees, shrubs, and plants will remain in the ground. Preserve things designated to remain.

Apply the requirements of Subsection 107.22, Subsection 107.23, and Section 161 to clearing and grubbing operations.

Strip grass immediately ahead of grading.

To prevent the spread of "Introduced Invasive Pest Species", do the following:

1. Adhere to the restrictions of Section 155.3.05.A for moving soil, mulch, sod or plants, stump wood or timber with soil attached.
2. Adhere to the requirements of Section 155.3.05.B for cleaning of equipment, except that the USDA inspection will not be required for vegetative matter.
3. Dispose of vegetative parts of plants that may reproduce (roots and aboveground parts that bear fruit) by burning on site (where permitted) or bury with a minimum cover of 3 feet (1 meter) at an approved site. Obtain the Engineer's approval for any other methods of disposal.

B. Clearing

Clear objects within the Right-of-Way and easement areas as follows:

1. Choose a method of clearing that prevents damage to property, trees, or retained shrubbery in or outside of the Right of Way.
2. Remove stumps that are part of the clearing operations as specified under Subsection 201.3.05.C, "Grubbing" .
3. Cut the stumps not grubbed as specified in this section.
4. Dispose of cleared materials as specified in Subsection 201.3.05.E.

C. Grubbing

Grubbing consists of removing and disposing objectionable matter embedded in the underlying soil (defined in Subsection 201.3.05.B, "Clearing") from the Right-of-Way and easement areas.

1. Grubbing Operations

   When grubbing, remove abandoned obstructions referenced in Subsection 201.1.01 “Definitions” to the following depths:

   a. Under Pavements: Remove to a depth of at least 3 ft (1 m) below the finished subgrade.

   b. Underneath Other Structures: Remove to at least 3 ft (1 m) below the foundations of any proposed structure, including installations such as guard rail posts and utility poles.

   c. Elsewhere in the Right-of-Way and easement areas: Remove as follows:

      1) Remove to at least 3 ft (1 m) below the finished surface of slopes and shoulders and 1 ft (300 mm) below natural ground outside construction lines.

      2) Thoroughly crack or break abandoned structures that may impound water. These structures include concrete floors, basements, and catch basins within 10 ft (3 m) of finished grade.

      3) Break floors so that no section greater than 10 ft² (1 m²) remains intact.

2. Except as modified under Subsection 201.3.05.D, use the following procedure to perform grubbing:

   a. Remove stumps and other matter that cannot be removed by a root rake. Remove stumps to a minimum depth of 2 ft (600 mm) below the ground line.

   b. Rake areas containing objectionable roots to a depth of at least 6 in (150 mm) below the surface.

   c. Remove remaining objectionable matter by hand or other suitable means. When necessary, remove small roots (see Subsection 201.1.01 “Objectionable Roots”) detrimental to the work.

   d. Backfill stump holes and compact backfill to the approximate density of the surrounding soil.

   e. Harrow the area with a heavy-duty disc harrow that penetrates and turns the ground to at least 6 in (150 m) deep.

   f. Remove objectionable matter exposed by the harrowing.

   g. Level the harrowed areas with blading equipment. Leave the grubbed areas smooth enough for a power mower.

D. Modifications of Clearing and Grubbing

Modify clearing and grubbing as follows:

1. In Excavation Areas

   Modify clearing and grubbing in excavation areas as follows:

   a. Harrowing and leveling may be omitted.

   b. Do not fill stump holes except when the bottom of any stump hole extends below the elevation of the finished subgrade. In this case, fill the portion of each hole below subgrade elevation with suitable material compacted to at least the density of the surrounding soil.

2. In Embankment Areas

   Modify clearing and grubbing in embankment areas as follows:

   a. Under 4.5 ft (1.4 m):

      Clear and grub areas without modification where the original ground and finished grade differ in elevation 4.5 ft (1.4 m) or less.

   b. Over 4.5 ft (1.4 m):

      Clear, but do not grub areas covered by embankments exceeding the 4.5 ft (1.4 m) elevation difference specified in step (a) above. Except the removal of unsound or decayed stumps.

      Remove and backfill stumps according to Subsection 201.3.05.C.2. When leaving sound stumps in place, cut them off to no more than 6 in (150 mm) above the original ground line.

c. Embankment Areas Over Old Roads:

Clear and grub without modification ditches and slopes of old roads to a depth that removes all objectionable matter to provide a firm foundation.

3. Areas Outside of Roadway

Except as specified in this section, clear and grub the entire Right-of-Way and easement areas outside construction limits and leave it smooth and free from loose boulders and debris that would interfere with power mowers. Exceptions to the above requirements are as follows:

a. Selective Clearing

When the Engineer directs to preserve certain trees and plants, protect them from injury. Trees to be removed shall be felled to prevent injury to standing trees, plants, and improvements to be preserved.

Cut off tree branches overhanging the roadway within 20 ft (6 m) of the finished grade close to the boles. Also, remove other branches to create a balanced appearance. Treat scars from branch removal with a heavy coat of asphaltic tree paint. Grub areas adjacent to selected trees and shrubs without damage to living roots of the selected trees or shrubs.

b. Special Treatment Areas

Clear special treatment areas according to the Plan notes.

c. Steep Slopes

Clear or selectively clear slopes that are too steep for power mowers (slopes steeper than 3 horizontal to 1 vertical) and clear or selectively clear slopes that are subject to excessive erosion. Do not grub in these areas.

d. Grassed Areas

Do not grub (if the Engineer approves) reasonably large areas outside construction limits covered with grasses and smooth enough for power mowers. Remove stumps, trees, and other objectionable matter.

4. Bridge Sites

Modify clearing and grubbing at bridge sites as follows:

a. Stream Bridges

Clear the Right-of-Way for stream bridges for the full length of the proposed structure. Cut stumps and brush flush with the ground line.

The Engineer will require a second cutting if high water prevents cutting stumps flush with the ground. If the Engineer requires more than two cuttings, see Subsection 201.5 for payment.

Remove drift and stumps where necessary to permit installation of rip rap, piling, piers, abutments, wing walls, and bents. Properly backfill the holes.

Preserve stump and brush root systems at river and stream banks when they have been cut flush with the ground line.

b. Other Bridges

Clear and grub bridges (other than stream bridges) as specified within this specification for roadway areas and areas outside of the roadway.

E. Removal and Disposal of Materials

1. Merchantable Timber and Buildings

The Department may dispose of merchantable timber and buildings, or may allow a property owner to remove them from the land granted for Right-of-Way before the Contractor begins operation. Therefore, the Department does not guarantee that merchantable timber or buildings will be on the Right-of-Way when the work begins.

Material salvaged from removing timber or buildings becomes the property of the Contractor. Demolish, remove, and dispose of all building structures within the right of way and easement areas including concrete slabs, footings, foundations, etc. except building structures designated to remain in place. Grade to drain all disturbed ground to a reasonably smooth and pleasing appearance, free from loose boulders and other debris that would interfere with the use of power mowers. Grass all disturbed areas.

Prior to demolition or removal:

a. Inspect all building structures for the presence of asbestos. The inspection shall be done by an EPA Asbestos Hazard Emergency Response Act (AHERA) accredited inspector whose certification is current.

b. Provide a copy of all inspection reports including the inspector's credentials to the Engineer.

c. Provide written notice of intent to demolish to the Georgia Environmental Protection Division (EPD) of the Georgia Department of Natural Resources in accordance with EPD regulations with a copy to the engineer. This notice is required even if there is no asbestos present.

If there is asbestos present, its removal shall be done by a contractor licensed with the EPD in accordance with the Rules of Georgia Department of Natural Resource Environmental Protection Division chapter 391-3-14-04. All asbestos removal and disposal shall be done in accordance with EPD regulations. All asbestos removal shall be considered as Extra Work and payment will be made in accordance with Subsection 109.05.

2. Combustible Material

Abide by Federal, State, and local codes when the Right-of-Way (or any portion of the Right-of-Way) lies within an area where burning is restricted. All combustible material except sawdust piles may be burned on the Right-of-Way except where prohibited by Federal, State, or local air pollution control regulations.

a. Prevent fire from spreading to adjacent areas and damaging living trees and shrubs designated to remain on the Right-of-Way and easement areas.

b. Prevent damage to public and private installations either within or adjacent to the Right-of-Way and prevent damage to traveling public.

c. Obtain suitable areas for burning the combustible material when necessary (at the Contractor's expense). Burning area are subject to the approval of the Engineer.

d. Dispose of unburned combustible material according to Subsection 201.3.05.E.3. If the disposal area is located on private property, present written authority to the Engineer (signed by the property owner) granting the Contractor and the Department permission to use the area for the purpose intended. Reclaim the disposal area according to Section 160 except that the reclamation is at the Contractor's expense.

e. Completely remove sawdust within the construction limits. Haul the sawdust to approved disposal areas, or deposit it on the Right-of-Way in a layer less than 3 in (75 mm) deep. Immediately mix the sawdust with the underlying soil by discing and harrowing. Leave the harrowed surface smooth.

3. Solid Waste Material

Place solid waste material either in the embankment (provided the material is satisfactory for embankment construction) or in a Department-approved solid waste disposal site.

The classification of non-regulated and regulated solid waste materials are defined by the Environmental Protection Division (EPD) of the Georgia Department of Natural Resources (GDNR) rules and regulations. Dispose of these materials using the following procedures.

a. Non-regulated Solid Waste Material

1) Excess material such as soil, rock, brick, concrete (with and without reinforcement), and cured asphalt may be placed within the Right-of-Way, provided there is available room. Place these materials according to Section 208 and as directed by the Engineer.

2) Common fill such as soil, rock, brick, and concrete (with and without reinforcement) may be placed outside the Right-of-Way. Place the material in uniform layers 3 ft (1 m) thick or less and distributed to avoid pockets. Fill voids with finer material. Cover the last layer of fill with at least 2 ft (600 mm) of soil. Construct the fill according to Section 208, except compact it to at least 90 percent of the maximum laboratory dry density.

3) Materials that may be recycled or reused such as asphaltic concrete, Portland cement concrete, plastic, metal, and materials that qualify under EPD regulations for sale or use may be reclaimed by the Contractor.

b. Regulated Material

1) Obtain an inert landfill permit according to GDNR/EPD rules for the following material deposed of off the R/W: Inert waste items listed in Subsection 201.3.05.E.3.a if not properly layered and compacted, and organic debris such as stumps, limbs and leaves, cured asphalt. Or, take the material to a permitted solid waste landfill.

2) Take other regulated construction/demolition and non-hazardous solid waste, such as forms, barrels, plastic, and other by-products of construction to a construction/demolition landfill or to a municipal solid waste landfill.

3) Dispose of oils, solvents, fuels, untreated lead paint residue, and other solid hazardous waste through a properly licensed hazardous waste disposal facility.

Remove municipal solid waste discovered during construction or shown on the Plans according to Section 215.

201.3.06 Quality Acceptance

General Provisions 101 through 150.

201.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

201.4 Measurement

The Department does not measure clearing and grubbing separately for payment. The area is considered the full Right-of-Way width for the length of the Project including slope and construction easement areas shown on the Plans.

201.4.01 Limits

General Provisions 101 through 150.

201.5 Payment

Payment for this Item, completed and accepted, will be made at the lump sum price bid. The payment will be full compensation for all work specified in this Section including final cleanup as required.

If the Engineer requires more than two cuttings to clear the Right-of-Way for stream bridges (according to Subsection 201.3.05.D.4.a), the additional cuttings will be paid for as a Force Account according to Subsection 109.05.

No separate payment will be made for the disposal of solid waste materials.

Payment will be made under:

Item No. 201	Clearing and grubbing.	Per lump sum

201.5.01 Adjustments

General Provisions 101 through 150.

October 20, 2006

Section 208—Embankments

Delete Section 208 and substitute the following:

208.1 General Description

This work includes placing embankments, backfilling structures, and constructing earth berms and surcharges with suitable material excavated under Section 204, Section 205, Section 206, and Section 207.

Complete the work according to the lines, grades, and typical cross- sections shown on the Plans or established by the Engineer.

The work also includes preparing areas by backfilling stump holes and correcting surface irregularities where the embankment is to be constructed. This includes forming, compacting, and maintaining the embankment and placing and compacting approved material where unsuitable material has been removed.

Payment for this work is included in other appropriate Pay Items unless a specific Pay Item is set up in the Contract.

Apply all provisions of Section 161 to the work in this Section.

Perform Shoulder Construction according to Section 216.

208.1.01 Definitions

General Provisions 101 through 150.

208.1.02 Related References

A. Standard Specifications

Section 161—Control of Soil Erosion and Sedimentation

Section 201—Clearing and Grubbing Right-of-Way

Section 204—Channel Excavation

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 207—Excavation and Backfill for Minor Structures

Section 209—Subgrade Construction

Section 216—Unpaved Shoulders

Section 810—Roadway Materials

Section 811—Rock Embankment

Section 813—Pond Sand

B. Referenced Documents

GDT 7

GDT 20

GDT 21

GDT 24a

GDT 24b

GDT 59

GDT 67

208.1.03 Submittals

General Provisions 101 through 150.

208.2 Materials

Embankment material classes are defined in Section 810, Section 811, and Section 813. The material incorporated into the roadway will be subject to the following limitations:

A. Embankment Material

Use embankment material classified as Class I, II, III, V, or VI except as noted below:

1. Inundated Embankments

   A Special Provision in the Proposal will contain required gradation and other characteristics of materials for constructing embankments through reservoirs.

2. Intermittently Inundated Embankments

   Build intermittently inundated embankments using any material suitable for embankment.

3. Embankments at Structures

   Embankment materials placed within 10 ft (3 m) of any bridge structure shall be classified as Class I or II. Ensure that materials do not contain rock larger than 3 in (75 mm) for any dimensions.

B. Rock Embankment

Ensure that rock embankment placed as indicated on the Plans meets the requirements of Section 811 unless specified otherwise in the Plans or in the Special Provisions.

C. In-Place Embankment

Construct in-place embankment with Class I, II, III, V, or VI material.

D. Backfill Material

Backfill material furnished and stockpiled shall be Class I or Class II as defined in Subsection 810.2.01.A.

E. Pond Sand Embankment

Use pond sand that meets the requirements of Section 813 as embankment material. Material is subject to the following approval limitations:

1. Pond sand will be approved on a stockpile basis only.
2. Pond Sand will not be approved for Type I or normal backfill materials or for backfill for mechanically stabilized walls.
3. Pond sand shall be encapsulated, when used as fill, with 2 ft (600 mm) of soil on the slopes and 3 ft (1 m) of soil on top.
4. Pond sand shall not be used on sidehill fills or fill widenings where any of the following conditions exist:
   a. The proposed fill slope is steeper than 2:1.
   b. The thickness of the proposed fill at its thinnest point, as measured perpendicularly from the new fill line to the existing ground slope/fill slope, is less than 7 ft (2.1 m), including 2 ft (600 mm) of soil cover.
   c. The fill height exceeds 30 ft (9 m).

208.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

208.3 Construction Requirements

208.3.01 Personnel

General Provisions 101 through 150.

208.3.02 Equipment

General Provisions 101 through 150.

208.3.03 Preparation

General Provisions 101 through 150.

208.3.04 Fabrication

General Provisions 101 through 150.

208.3.05 Construction

A. Benching Excavation for Embankment

This work includes excavating material forming benches in the existing ground beneath proposed embankments. Form benches to increase the bond between the existing ground and the proposed embankment.

This work is required where embankments are placed on hillsides or against existing embankments, which will be indicated on the Plans.

Construct the benches approximately 12 ft (3.7 m) wide unless otherwise shown on the Plans. Use material removed in the excavation in the embankments. The Department will make no additional payment for this work.

B. Embankments

Follow these requirements when constructing embankments:

1. Preparation for Embankments

   Before starting embankment construction, clear and grub the embankment area according to Section 201 and install Drainage Structures according to Section 550.

   a. Depressions and Undercut Areas

      Fill depressions below the ground surface and undercut areas with suitable material. Remove unsuitable or unstable material and compact according to Subsection 208.3.05.B.1.c before beginning embankment construction.

   b. Scarification and Other Preparation

      Plow and scarify the entire area upon which the embankment is to be placed (except inundated areas) at least 6 in (150 mm) deep.

      Before placing the embankment, recompact loosened soil to the approximate density of the underlying soil. Cut benches as specified in Subsection 208.3.05.A..

   c. Compaction Under Shallow Fills

      When the depth of fill and surfacing is 3 ft (1 m) or less, compact the original ground compact at least 1 ft (300 mm) deep to at least 95 percent of the maximum laboratory dry density as determined from representative samples of the compacted material using, GDT 7, GDT 24a, GDT 24b, or GDT 67whichever applies. The in-place density of the compacted fill will be determined according to GDT 20, GDT 21, or GDT 59, whichever applies.

d. Embankments Over Existing Roads, Parking Areas, and Floors

Thoroughly plow or scarify all portions of existing unpaved roads and flexible pavements. Destroy cleavage planes before placing the embankment.

1) Remove the old pavement with rigid surfaces if the new embankment is not more than 3 ft (1 m) high.

2) Break remaining rigid pavements that are within 10 ft (3 m) of the finished grade so that no section larger than 10 ft^2 (1 m^2) remains intact.

2. Embankment Formation

Use the following requirements when constructing the embankment formation:

a. Layer Construction

Except as noted in Subsection 208.3.05.B.2.d, construct the embankments in parallel layers. Deposit the material and spread in horizontal layers not more than 8 in (200 mm) thick, loose measurement, for the full width of the cross-section. Use motor graders, bulldozers, or other approved equipment to keep layers uniform. Compact the layers using a sheepsfoot roller. The Engineer may permit the use of vibratory rollers whenever the embankment soils consist of Class IA1, IA2, or IA3 materials.

b. Moisture Content

Compact each layer within the range of optimum moisture content to achieve the compaction specified below.

Do not construct successive layers on previous layers that exhibit excessive pumping under construction equipment regardless of compaction.

Dry material if it contains too much moisture. Ensure the moisture content is sufficient for stability and compaction.

Add water if the material is too dry and uniformly mix it with the soil for stability and compaction. The Department will not measure water added to the material under this requirement for payment. It is considered incidental to the satisfactory completion of the work.

c. Degree of Compaction

Compact the embankment at bridge structures to at least 100 percent of the maximum laboratory dry density. Compact for the full depth of the embankment, beginning at the toe of the slope and extending 100 ft (30 m) from the end of the bridge.

Compact embankment other than at bridge structures to at least 95 percent of the maximum laboratory dry density to within 1 ft (300 mm) of the top of the embankment. Compact the top 1 ft (300 mm) of the embankment to at least 100 percent of the maximum laboratory dry density.

If grading and paving are let in separate contracts, the paving Contractor shall recompact the top 6 in (150 mm) to at least 100 percent of the maximum laboratory density.

The maximum laboratory dry density will be determined from representative samples of the compacted material using GDT 7, GDT 24a, GDT 24b, or GDT 67, whichever applies. The in-place density of the compacted fill will be determined according to GDT 20, GDT 21, or GDT 59, whichever is applicable.

d. Special Conditions

Follow these special requirements:

1) Build layers as parallel as possible. In certain cases the Engineer may permit steeper slopes at ends of the embankments.

2) In swamp or inundated areas that will not support the equipment, build the lower part of the fill by dumping successive loads in layers no thicker than necessary to support the hauling equipment.

3) Build and compact the remainder of fills in layers as specified above.

e. Embankments at Structures

Use Class I or II material when constructing embankments over and around pipes, culverts, arches, and bridges according to Subsection 810.2.01.A.1.

1) Compact the material as specified in Subsection 208.3.05.B.2.c.

2) Place the specified material on both sides of bridge structures for a distance of at least 10 ft (3 m).

NOTE: Do not place rock larger than 4 in (100 mm) diameter within 2 ft (600 mm) of any drainage structure.

Before any traffic is allowed over any structure, provide a sufficient depth of material over and around the structure to protect it from damage or displacement.

f. Method of Handling Classes of Soils

Handle the different classes of soils using the following methods:

1) Class IIB3and Better Soils

Distribute and compact these soils in 8 in (200 mm) uniform layers over the entire width of the embankment. Use these soils (when available in sufficient quantities) in the top 1 ft (300 mm) of the roadbed. Reserve these soils for this purpose when directed by the Engineer.

2) Class IIB4 Soils

Distribute and compact these soils in 8 in (200 mm) layers over the entire width of the embankment.

3) Class III Soils

Do not use these soils in embankments except when directed in the Plans or ordered by the Engineer. If directed, place them in the same manner as Class IIB4 soils.

Class IIIC4, chert clay soils in District 6 with less than 55 percent passing the No. 10 (2 mm) sieve may be used for subgrade.

4) Class IV Soils

Do not use these soils in embankments. Waste these soils or (when designated in the Plans or directed by the Engineer) stockpile them and use them for blanketing fill slopes.

5) Class V Soils

Place these soils in the same manner as Class IIB4 soils. Pulverize large particles to obtain the proper compaction.

6) Class VI Rock

Place rock in uniform layers not over 3 ft (1 m) thick and distribute it over the embankments to avoid pockets. Fill voids with finer material.

Do not place rock larger than 6 in (150 mm) in diameter within 3 ft (1 m) of the finished surface of the embankment.

Do not place rock larger than 6 in (150 mm) in diameter within 2 ft (600 mm) of the outer limits of proposed posts or utility poles.

Do not place rock at bridge end bents within 10 ft (3 m) of pile locations.

7) All Classes

Place mixtures of the above classes together with random material such as rock, gravel, sand, cinders, slag, and broken-up pavement so that coarse particles are dumped near the outer slopes and finer particles near the center of the roadway.

Produce a gradual transition from the center to the outside. If material is too large to place in 8 in (200 mm) layers, treat it as rock or break it down and place it in 8 in (200 mm) layers.

3. Embankment Consolidation at Bridge Ends

When consolidating embankments at bridge ends, use the following specifications:

a. When a waiting period is required in the Plans or by Special Provision, place end fills at bridges in time for consolidation readings to indicate that both the fill and the natural ground have reached the desired degree of stability.

b. Delay constructing bridge portions during the period of consolidation as shown on the Plans or as required by a Special Provision.

The Plans or the Special Provisions will indicate the estimated time required to reach consolidation. The Engineer may extend or shorten this waiting period based on settlement readings taken on points placed in the fills. The longer or shorter waiting period will not constitute a valid claim for additional compensation.

Follow these specifications when extending a waiting period:

1) Extending an estimated waiting period may lead to increasing the Contract time. If the Contract is on a calendar day or completion date basis, the Department may increase the calendar days equal to the maximum number of calendar days involved in the extension.

2) When a time extension causes additional delay due to seasonal changes, the Engineer may recompute the time extension on an available day basis.

When the Contract is on an available day basis, the time increase will be equal to the greatest number of available days involved in the extension.

3) When time charges on separate Bridge Contracts are controlled by Special Provisions that set forth the availability of bridge sites, extending an estimated waiting period controls the availability of that bridge site only; time charges will be adjusted according to the Special Provision.

c. Construct the embankment at bridge ends full-depth to the subgrade template (except for the stage construction providing a bench for the end bent) unless otherwise stated in the Plans and compact thoroughly before driving a piling at bridge ends.

The minimum acceptable length of completed full-depth embankment is equal to the maximum width of fill between slope stakes at the end of the bridge. The Department will measure the minimum length of full-depth embankment along the roadway centerline away from the end-of-bridge Station.

C. In-Place Embankment

Construct embankments designated on the Plans and in the Proposal as “In-Place Embankment” using either a hydraulic or conventional dry land construction method and using materials obtained from within the construction limits of the Right-of -Way or from borrow pits, whichever is appropriate.

Regardless of the method of construction, the Department will measure the entire embankment for payment as in-place embankment.

1. Construction

- Build embankments according to this Section when hydraulic or conventional dry land construction methods are used.
- Furnish equipment suitable for the method chosen to complete the work. Equipment is subject to the Engineer’s approval.
- When using a hydraulic method is used, conform to these additional requirements:

  a. Using baffles for construction is permitted as long as the embankment slopes are not steeper than indicated on the Plans.

  b. Use of excess material placed outside the prescribed slopes to raise the fill is permitted.

c. Leave openings in the embankments at the bridge site as indicated on the Plans.

Dredge material that invades the openings or existing channels at no additional expense to the Department. Provide the same depth of channel at mean low water as existed before the construction of the embankment.

d. Do not excavate or dredge material within 500 ft (150 m) of the toe of the embankment or existing structures, unless otherwise shown on the Plans.

e. Place in-place embankment in areas previously excavated below the ground line in a uniform mass beginning at one end of the excavated area and continuing to the other end of the operation. Avoid forming of muck cores in the embankment.

f. Construct the embankment at the farthest points along the roadway from the bridge ends and progress to the end of the excavation area beyond the toe of the slope of endrolls at bridge ends.

g. Remove timber used for temporary bulkheads or baffles from the embankment.

h. Fill and thoroughly compact the holes.

2. Maintenance

a. Maintain the embankment at grade until it has been completed and accepted. Assume responsibility for slides, washouts, settlement, subsidence, or mishaps to the work while under construction.

b. Keep constructed embankment stable and replace displaced portions before Final Acceptance of the entire Contract.

c. Remove and dispose of excess materials, including fill, detours, and erosion deposits placed outside the prescribed slopes in wetland areas.

3. Permits

Obtain (at no additional expense to the Department) necessary permits or licenses from the appropriate authorities to operate dredges and other floating equipment in waters under their jurisdiction, unless otherwise provided for in the Contract.

4. Erosion Control

In addition to the provisions of Section 161, follow additional erosion, siltation, and pollution control measures specified in the Plans or Special Provisions.

D. Rock Embankment

This work includes furnishing materials either from the roadway excavation or other sources and hauling and the placing of rock embankment. Use materials that meet the requirements of Subsection 208.2.B, as shown on the Plans or directed by the Engineer.

1. Place the rock in uniform layers not over 3 ft (1 m) thick. Distribute rock over the embankment to avoid pockets.
2. Fill voids with rock fines. Do not use rock larger than 6 in (150 mm) for any diameter within 3 ft (1 m) of the finished grade of the embankment, or within 2 ft (600 m) of any structure.
3. Do not place rock at bridge end bents within 10 ft (3 m) of pile locations. Construct rock embankment and adjoining earth embankment concurrently. Ensure that neither is larger than 4 ft (1.2 m) higher than the other at any time.

E. Final Finishing

After constructing the entire embankment, shape the surface of the roadbed and the slopes to reasonably true grade and cross-sections as shown on the Plans or established by the Engineer.

Open ditches, channels, and drainage structures (both existing and those constructed or extended) to effectively drain the roadway. Maintain the embankment areas until Final Acceptance of the Project.

208.3.06 Quality Acceptance

General Provisions 101 through 150.

208.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

208.4 Measurement

The following section details measurement for payment for the work described in this Section:

A. Except as provided herein, there will be no measurement for payment for the work covered by this Section.

B. The Department will compute the quantity of in-place embankment or rock embankment using the average end area method, or other acceptable methods, when embankment is in place and accepted.

   The quantity will be calculated as the neat volume, above the original ground surface, between the template line shown on the Plans or authorized changes by the Engineer, and the original ground surface.

   The original ground surface is determined by conventional field, photogrammetric, or other methods.The Department will not deduct for the volume of culverts and manholes.

   In-place embankment necessary for the construction of temporary detours will not be measured for payment and is considered incidental to the completion of the work unless specifically stated otherwise on the Plans.

   Where work includes excavating of unstable materials below the ground line, the volume of embankment required for backfill below the ground line is calculated based on the neat line measurement for the cross-section shown on the Plans or established by the Engineer by the average end area method or other acceptable methods.

   Where permitted by the Engineer or required by the Plans, material removed from the existing roadbed, special ditches, berm ditches, or dry land borrow pits and used in making embankment will be paid for as in-place embankment regardless of the method of excavation.

208.4.01 Limits

General Provisions 101 through 150.

208.5 Payment

Except as provided for herein, the Department will not make separate payment for placing embankments, backfilling structures, and constructing earth berms, including surcharges.

Payment will be included at the Contract Unit Price for the items covered by Section 204, Section 205, and Section 206. Prices are full compensation for The Work covered by this Section.

The Unit Prices bid per cubic yard (meter) for in-place and rock embankments (when included as Contract bid Items) are full compensation for furnishing suitable material, hauling, placing, compacting, finishing, and dressing according to these Specifications or as directed by the Engineer.

Payment will be made under:

Item No. 208	In-place embankment	Per cubic yard (meter)
Item No. 208	Rock embankment	Per cubic yard (meter)

208.5.01 Adjustments

General Provisions 101 through 150.

September 16, 2005

Section 209—Subgrade Construction

Delete Subsection 209.3.05.A and substitute the following:

A. Subgrade Construction

Construct subgrade as follows:

1. Plow, harrow, and mix the entire surface of the in-place subgrade to a depth of at least 6 in (150 mm).
2. After thoroughly mixing the material, bring the subgrade to Plan line and grade and compact it to 100 percent of the maximum laboratory dry density.
3. If the subgrade needs to be stabilized, or if a subsequent contract provides for base construction, do not apply density requirement at this stage.

   If a subsequent Contract provides for base construction, eliminate mixing and compact the in-place subgrade to 95 percent of the laboratory maximum dry density.
4. Ensure that the subgrade can firmly support construction equipment before placing subsequent layers of base and paving materials. The subgrade must support construction equipment without excessive movement regardless of compaction.
5. Rework unstable areas of subgrade to a moisture content that will provide stability and compaction. The Engineer may direct the Contractor to proof roll the subgrade with a loaded dump truck.
6. Compact the subgrade using a sheepsfoot roller.

   The Engineer may permit the use of vibratory rollers whenever the subgrade soils consist of Class IA1, IA2, or IA3 materials.
7. Ensure that subgrade material used underneath soil-cement base meets the requirements of Subsection 301.3.03.A.

June 22, 2007

Section 210—Grading Complete

Delete Section 210 and substitute the following:

210.1 General Description

This work includes:

- Excavating of all materials including ditches, undesirable material (including removal and replacement), and borrow (if required)
- Hauling
- Forming embankments
- Constructing shoulders and subgrades
- Finishing, dressing, and disposing of undesirable or surplus material
- Clearing and grubbing according to Section 201 and Section 202 unless these items are established as Pay Items in the Contract

- Removing and disposing of miscellaneous roadway items, including but not limited to curbs, drainage structures, and pavements (unless established as separate contract items).

Ensure that the completed grading work conforms to the horizontal and vertical alignment and typical cross- sections shown on the Plans or as directed by the Engineer.

210.1.01 Definitions

General Provisions 101 through 150.

210.1.02 Related References

A. Standard Specifications

Section 109—Measurement and Payment

Section 201—Clearing and Grubbing Right-of-Way

Section 202—Random Clearing and Grubbing

Section 204—Channel Excavation

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 207—Excavation and Backfill for Minor Structures

Section 208—Embankments

Section 209—Subgrade Construction

B. Referenced Documents

General Provisions 101 through 150.

210.1.03 Submittals

General Provisions 101 through 150.

210.2 Materials

Use materials required for grading construction that conform to the requirements of Section 204, Section 205, Section 206, Section 207, Section 208, and Section 209.

210.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

210.3 Construction Requirements

210.3.01 Personnel

General Provisions 101 through 150.

210.3.02 Equipment

Use equipment approved by the Engineer that will not damage base, pavement, or other appurtenances to be retained.

210.3.03 Preparation

Before placing base material, finish the subgrade according to Subsection 209.3.05.E.

210.3.04 Fabrication

General Provisions 101 through 150.

210.3.05 Construction

Perform The Work according to the appropriate portions of Section 201, Section 202, Section 204, Section 205, Section 206, Section 207, Section 208, and Section 209 of the Specifications. Measurement and payment shall be according to the provisions of this Section. See Subsection 210.4 and Subsection 210.5, below.

210.3.06 Quality Acceptance

When the Engineer determines that the existing material in areas where fills are to be placed is undesirable, the Engineer may require the Contractor to remove the undesirable material and replace it with suitable material.

- Compact the replacement materials according to the applicable portions of Section 208.
- In cut areas, where the material below the template line is undesirable for subgrade or shoulders, undercut it to a depth established by the Engineer and replace it with suitable material.
- Compact the replacement materials as specified herein.

210.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

210.4 Measurement

A. Grading Complete

The Work under this Item is not measured separately for payment.

B. Grading Per Mile (Kilometer)

This Item is measured in linear miles (kilometers) along the centerline of the road or the median, including ramps where shown on the Plans.

C. Undercut Excavation

The amount of undercut excavation (when directed by the Engineer and not addressed in the Plans) measured for payment is the product of the length, width, and depth of excavation. Replacement material for undercut excavation is not measured for payment. There will be no separate payment for undercut excavation required by the Plans or rock excavation required under Subsection 205.3.

210.4.01 Limits

General Provisions 101 through 150.

210.5 Payment

A. Grading Complete

This Item completed and accepted will be paid for at the Lump Sum Price bid. Payment is full compensation for all work and materials specified in this Section.

B. Grading Per Mile (Kilometer)

This Item will be paid for at the Contract Unit Price per linear mile (kilometer) complete in place and accepted. This price is full compensation for furnishing the materials and performing the work specified in this Section.

C. Undercut Excavation

Undercutting areas not shown in the Plans when directed by the Engineer will be paid for at the rate of $7.50 per cubic yard ($9.80 per cubic meter) for quantities up to 750 yd^3 (575 m^3).

Quantities exceeding 750 yd^3 (575 m^3) will be considered Extra Work as defined in Subsection 109.05, and will be paid for accordingly. Payment is full compensation for excavating and disposing of undesirable material and supplying, placing, and compacting replacement material.

Payment will be made under:

Item No. 210	Grading complete	Per lump sum
Item No. 210	Grading per mile (kilometer)	Per mile (kilometer)
Item No. 210	Undercut excavation	Per cubic yard (meter)

210.5.01 Adjustments

General Provisions 101 through 150.

September 16, 2005

Section 301—Soil-Cement Construction

Delete Subsection 301.3.03.A and substitute the following:

A. Subgrade or Subbase Preparation

Prepare the subgrade or subbase as specified in Subsection 300.3.03.C, “Preparing the Subgrade” or Subsection 300.3.03.D, “Preparing the Subbase” if the base, subbase, or shoulders will be composed entirely of new materials, whether mixed-in-place or central plant mixed. In addition to the above requirements, ensure that subgrade material used underneath soil-cement base meets the sulfates and pH requirements of Subsection 814.2.02.A. Place materials only on dry, thawed subgrade or subbase.

November 18, 2005

Section 432––Mill Asphaltic Concrete Pavement

Delete Subsection 432.5 and Substitute the following:

432.5 Payment

Milling asphaltic concrete pavement, measured as specified, will be paid for at the Contract Unit Price bid per square yard (meter). The price bid for this item includes the credit value of all Reclaimed Asphalt Pavement (RAP) recovered, and no adjustment in the unit price for this item or other items will be considered for variations in the amount of RAP actually recovered.

Payment is full compensation for furnishing equipment, milling, hauling, stockpiling milled material, and satisfactorily performing the work.

Payment will be made under:

Item No. 432	Mill asphaltic concrete pavement, ___ in (mm) depth	Per square yard (meter)
Item No. 432	Mill asphaltic concrete pavement, variable depth	Per square yard (meter)

432.5.01 Adjustments

General Provisions 101 through 150.

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November 18, 2005

Section 433—Reinforced Concrete Approach Slabs

Delete Subsection 433.3 and substitute the following:

433.3 Construction Requirements

433.3.01 Personnel

General Provisions 101 through 150.

433.3.02 Equipment

General Provisions 101 through 150.

433.3.03 Preparation

General Provisions 101 through 150.

433.3.04 Fabrication

General Provisions 101 through 150.

433.3.05 Construction

Construct the approach slab before placing the adjacent roadway paving, unless otherwise specified in the Plans.

A. Approach Slabs

Finish, cure, and protect the approach slabs as specified in Subsection 500.3.05.Q, “Place Concrete” and Subsection 500.3.05.Z.3, “Bridge Deck Curing.”

B. Curbs

Construct curbs of the dimensions required monolithic with the approach slab, when specified on the Plans. Place, finish, and cure the curb as specified in Section 441.

C. Barriers

Construct and finish the barriers according to Section 500, Section 621 and Plan details. Use concrete that is Class A or better and proportioned and mixed according to Section 500.

D. Final Finish

When the concrete has hardened and standing water and moisture sheen have disappeared, give the concrete a final finish, manually or mechanically, according to requirements in Section 500 for bridge decks.

433.3.06 Quality Acceptance

The riding quality of approach slabs will be tested with the Lightweight Profiler as part of the bridge deck according to Subsection 500.3.06.E, “Ride Quality Test”.

433.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

November 18, 2005

Section 441—Miscellaneous Concrete

Delete Subsection 441.3 and substitute the following:

441.3 Construction Requirements

441.3.01 Personnel

General Provisions 101 through 150.

441.3.02 Equipment

A. Forms

Forms are subject to the Engineer’s approval. Use forms that are:

- Wood or metal that is readily available
- Straight and oiled before each use

Use metal divider plates and templates.

Use the slip form placement method when applicable. If the slip form method does not produce a product with the proper quality, shape, grade, or alignment, the Engineer may require using fixed forms.

B. Weep Holes

Provide weep hole drain pockets filled with coarse aggregate to use with weep hole drain pipe or formed openings according to the Plan details.

441.3.03 Preparation

Before placing the concrete, excavate for toe walls, edge walls, and weep hole drain pockets; place coarse aggregate in weep hole drain pockets; and grade, finish, and compact the subgrade surface. Use mechanical tamps for compaction if necessary.

441.3.04 Fabrication

General Provisions 101 through 150.

441.3.05 Construction

A. Extent and Thickness of Pavement

See the Plans to determine the areas to be paved and the dimensions.

Thicknesses are subject to a minus tolerance of 0.5 in (13 mm). Do not perform overlay pours.

B. Preparation of Subgrade

Finish the subgrade for miscellaneous concrete to the line and grade on the Plans and the following:

1. Compact the subgrade to the same degree as the roadway on which it is placed. Compact the subgrade according to Section 209.
2. If a Contract involves a Roadway and a Bridge Contractor, the Roadway Contractor shall complete the grading for the slope paving.

   The Bridge Contractor shall complete final grading, compacting, dressing, placing, and maintenance to the structures until completion.
3. When placing paving on the front slopes of ditches and shoulders, place any required special materials during the roadway construction.
4. Do not excavate for velocity dissipators, spillways, and slope drains below the foundation elevation. Do not excavate wider than necessary to provide working space or to remove soft, unsuitable material. Backfill with selected material.
5. When fitting spillways to concrete pavement, set the specified dowel bars into the pavement when it is laid. Use metal parting strips to hold the ends of dowels bent into the grooves.

C. Concrete

1. Mixing

   Mix Class B concrete as specified in Section 500 with the following exceptions:

   a. Use of small capacity job-site batchers and one-bag mixers is allowed. The rate of concrete placement in Subsection 500.3.05.P, “Meet the Minimum Placement Rates” is waived for miscellaneous concrete.

   b. Proportion concrete ingredients volumetrically if the Engineer has approved equipment calibration and operation and the operator is certified by the Office of Materials and Research.

2. Placing and Finishing

   Place and finish concrete as follows:

   a. Deposit concrete within forms or against other pavements on a compacted and wetted subgrade to the depth to produce the specified thickness.

NOTE: Do not place concrete on a muddy or frozen surface.

   b. Vibrate the headwalls.

   c. Strike off the concrete to a plane surface and finish it with a Type IV or Type V finish as defined in Subsection 500.3.05.AB, “Finish Concrete” and complete the following:

      1) **Concrete Slope Paving**. Give a final finish with a stiff-bristle broom. With the Engineer’s approval, mechanically convey the concrete to the forms.

      2) **Concrete Sidewalks**. Give a Type V finish unless otherwise noted on the Plans. Test the surface with a 10 ft (3 m) straightedge laid parallel to the center line. Eliminate irregularities greater than 0.25 in (6 mm) per 10 ft (3 m) while the concrete is still plastic.

         Ensure that concrete sidewalk constructed as curb cut (wheelchair) ramps has a rough or textured finish.

3) **Concrete Paved Ditches**. Ensure that the surface of the bottom and sides of paved ditches are uniform and true to grade and cross section.

Ensure that straight-grade tangents do not deviate more than 1 in (25 mm) within 10 ft (3 m) when tested with a 10 ft (3 m) straightedge. Do not allow deviation if it reduces the ditch paving thickness, causes water to pond, or alters the direction of flow.

Finish the ditch paving by floating with wood or metal floats to bring mortar to the surface to cover the coarse aggregate.

Use reinforcing that conforms to Plan details if required.

4) **Concrete Curbs, Gutters, and Median**. Finish according to Subsection 441.3.05.C.2, “Placing and Finishing.” Remove face forms as soon as possible and finish the exposed surfaces with a wood float.

Use a straightedge to test the edge of the gutter and top of the curb and median to conform to the requirements for the adjacent pavement. Irregularities shall not exceed 0.25 in (6 mm) in 10 ft (3 m).

Place the curb and gutter using a machine as long as the results are satisfactory.

5) **Curb Cut Wheel chair Ramps**. Construct a Type A, B, C, or D ramp according to the Special Details in the Plans. Tie ramps into adjacent paved or unpaved sidewalk and use a rough or textured finish.

3. Joints

Follow these procedures to construct joints on slopes, ditches, sidewalks, and curbs, gutters, and medians.

a. Slope Paving

Place paving on slopes in horizontal or vertical courses, but not a mixture of both.

1) Construct horizontal courses approximately level and at least 3 ft (1m) but no more than 6 ft (1.8 m) wide measured along the slope.

When needed, construct trapezoidal courses at the top and bottom to accommodate sloping berm and ditch line conditions.

2) Edge the paving at construction joints between courses with a 0.25 in (6 mm) radius tool.

3) Provide vertical contraction or construction joints spaced along the horizontal course at right angles to the horizontal construction joints at approximately 40 ft (12 m) intervals, in line not staggered.

No other vertical lines will be required in horizontal courses.

When using vertical contraction joints, cut them with a tool one-third the depth of the paving during the finishing operation. Edge the contraction joints the same as construction joints.

Vertical courses approximately equal and at least 3 ft (1 m) but no more than 5 ft (1.5 m) wide across the plane of the slope. The desired width is 4 ft (1.2 m). Horizontal lines are not required in vertical courses.

Separate slope paving from the masonry of structures, sidewalks, curbs, and rigid-type roadway pavements of preformed joint filler that are 0.5 in (13 mm) thick.

b. Concrete Paved Ditches

Form joints in concrete paved ditches as follows:

1) Space contraction joints at 30 ft (9 m) intervals.

2) Place expansion joints only where the paved ditch joins the roadway pavement or some other structure.

3) Do not use joint sealers for expansion or contraction joints.

c. Concrete Sidewalk

Form transverse contraction joints using a tool designed to form a groove one-third the depth of the sidewalk at intervals shown on the Plans.

Where sidewalks abut the curb and gutter, ensure that alternate joints coincide. Round the edges with a 0.25 in (6 mm) edger. Make expansion joints according to the materials, dimensions, and locations specified on the Plans.

d. Concrete Curbs, Gutters, and Medians

Form contraction joints or expansion joints on curbs, gutters, and medians.

1) **Contraction Joints**. Ensure that joints in curb, gutters, and medians are spaced the same as the joints in paving. Form joints by using metal divider plates or sawing them as in Section 430.

Form joints at least one-fifth but not greater than one-fourth the depth of the concrete. Except for sawed joints, finish the joints with a 0.25 in (6 mm) edging tool.

For curbs, gutters, and medians adjacent to pavement other than concrete, contraction joints shall be as follows:

- For header curb and combination curb and gutter, install contraction joints spaced no more than 20 ft (6 m) apart.
- For gutter median, install contraction joints spaced no more than 20 ft (6 m) apart.

2) **Expansion Joints**. Form expansion joints according to the Plan details or as directed. Ensure that they coincide with the expansion joints in the adjoining pavement or gutter.

Cut the joint fillers to the same cross section as the construction. Trim flush the material that protrudes after the concrete is finished.

When miscellaneous concrete items are not adjacent to concrete construction, provide expansion joints at an interval of at least 500 ft (150 m).

e. Curb Cut Wheelchair Ramps

Locate and form expansion joints for curb cut wheelchair ramps according to the Special Details in the Plans for ramp Type A, B, C, or D.

4. Curing

Use curing methods specified in Subsection 430.3.05.L, “Cure the Concrete.” Ensure that the membrane curing compound is Type 2, if used. Pack honeycombed areas immediately after removing the forms.

D. Backfilling

Backfill the areas as soon as possible without damaging the work.

E. Clean-Up

When concrete work is complete, clean each surface. Protect the work from stains or other damage until Final Acceptance.

441.3.06 Quality Acceptance

General Provisions 101 through 150.

441.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

November 18, 2005

Section 446—Placement of Pavement Reinforcement Fabric

Delete Section 446 and substitute the following:

446.1 General Description

This work includes installing Type II pavement reinforcement fabric and high strength pavement reinforcement fabric over cracks, joints, and patches in existing pavement. Install the fabric in strips or full width before placing an overlay where shown on the Plans or as directed by the Engineer. Install high strength pavement reinforcement fabric on interstate projects.

446.1.01 Definitions

General Provisions 101 through 150.

446.1.02 Related References

A. Standard Specifications

Section 150—Traffic Control

Section 400—Hot Mix Asphaltic Concrete Construction

Section 413—Bituminous Tack Coat

Section 881—Fabrics

B. Referenced Documents

General Provisions 101 through 150.

446.1.03 Submittals

General Provisions 101 through 150.

446.2 Materials

Use the reinforcement fabric that meets the requirements of Subsection 881.2.06.

Bituminous binder materials, when required, shall meet the requirements of Section 413, “Bituminous Tack Coat”.

446.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

446.3 Construction Requirements

446.3.01 Personnel

General Provisions 101 through 150.

446.3.02 Equipment

A. Template

When using fabric strips, use a template or other method satisfactory to the Engineer to apply the bituminous tack coat uniformly.

B. Mechanical Device

Use a mechanical device approved by the Engineer when placing the fabric full width on the pavement to ensure the fabric is placed smooth, free of wrinkles, and with no uplifted edges.

C. Roller

Place the fabric in total contact with the underlying pavement. Roll the fabric with a static drum or pneumatic roller to ensure adequate adhesion to the pavement surface.

446.3.03 Preparation

Before an existing pavement surface is milled, mark the location of joints and cracks with an offset reference so that they can be located after milling has been completed.

A. Cleaning the Pavement

Immediately before applying the bituminous tack coat, clean the pavement surface to remove rocks, dirt, debris, and other materials that may prevent a clean bonding surface.

B. Repairing Potholes, Spalls, or Cracks

Before placing the fabric, repair potholes, spalls, or cracks greater than 3/16 in (5 mm) wide. Repair spalls and potholes using asphaltic concrete that meets the requirements of Section 400 or other materials such as cold mixes approved by the Engineer.

Fill cracks with PG 64-22 asphalt cement or other materials approved by the Engineer.

446.3.04 Fabrication

General Provisions 101 through 150.

446.3.05 Construction

Do not install reinforcement fabric when ambient temperatures are less than 45 °F (7 ºC).

Use a bituminous tack coat when temperatures are between 45°F (7 ºC) and 70°F (21ºC) for all reinforcement fabric types.

When ambient temperatures are a minimum of 70 °F (21 ºC) and rising, reinforcement fabric with a self-adhesive backing may be installed at the Contractor’s option without applying a bituminous tack coat except when the fabric is placed on a milled surface.

Use a bituminous tack coat when fabric is placed on a milled surface regardless of the temperature.

A. Applying Bituminous Binder

Use a bituminous tack coat to bond self-adhesive fabric to the pavement and apply the bituminous tack coat at a rate of 0.10 gal/yd² (0.45 L/m²) over non-milled surfaces and 0.20 gal/yd² (0.90 L/m²) over milled surfaces. Heat the bituminous tack coat and apply within a temperature range of 350 °F to 375 °F (175 ºC to 190 ºC).

Use bituminous tack coat to bond non-self-adhesive fabric to the pavement and apply at a rate of 0.10 gal/yd² (0.45 L/m²) over non-milled surfaces and 0.25 gal/yd² (1.13 L/m²) over milled surfaces. Heat the bituminous tack coat and apply within a temperature range of 350 °F to 375 °F (175 ºC to 190 ºC).

Where using fabric strips, use a template or other method satisfactory to the Engineer to apply bituminous tack coat uniformly.

Do not allow the width of the bituminous tack coat applied to exceed the width of the fabric by more than 1 in (25 mm) on each side.

B. Placing the Fabric

For self-adhesive reinforcement fabric, remove the release liner of the fabric and place the adhesive side to the pavement. Place self-adhesive reinforcement fabric no more than 24 hours in advance of the paving operation to ensure proper adhesion of the fabric to the pavement.

Place non-self-adhesive reinforcement fabric at least 1 hour but no more than 24 hours in advance of the paving operation to ensure proper adhesion of the fabric to the pavement. Place fabric on the pavement immediately after the bituminous tack coat has been applied to the pavement. Place the non-woven polyester side of the fabric on the pavement.

Install the fabric so that it is smooth, free of wrinkles with no uplifted edges. Provide a minimum of 5 in (125 mm) overlap on all sides of the repair area. Center the material over the repair area within a 2 in (50 mm) tolerance. When placed full width, use a mechanical device approved by the engineer to place the fabric on the pavement.

Immediately after the fabric is placed on the pavement, ensure that the fabric is in total contact with the underlying pavement. Roll the material with a static drum or pneumatic roller to ensure adequate adhesion to the pavement surface.

Any fabric with loose edges, corners or other improperly bonded areas shall be replaced at the expense of the Contractor prior to placement of the overlay or opening the fabric section to traffic.

C. Overlapping Fabric.

If more than one strip of fabric is required to cover the repair area, the seams that are created shall be butt or lapped seams. When waterproofing is required, use lap seams with a minimum 2 in (50 mm) overlap. Make all lapped seams in the direction of the paving operation to prevent pickup by the paving train. The width of the fabric strips shall be shown on the plans.

Make joint overlaps to prevent pickup by the paving train that places the asphaltic concrete.

D. Protecting Fabric

When full width fabric is used, schedule work so that the fabric will be covered with asphaltic concrete prior to reopening the section to traffic. Do not allow traffic, other than necessary construction equipment or emergency vehicles, on unprotected fabric. If approved by the Engineer, traffic will be allowed to use a section with applied fabric strips for a maximum of 7 days. Coordinate all activities to conform to this restriction. Replace any damaged fabric prior to paving at the Contractor’s expense. When short-term pavement markings are required, the markings shall meet the requirements of Section 150.

When in-place fabric is exposed to moisture prior to application of the overlay, make sure the fabric is completely dry before the overlay is placed.

If the fabric sticks to tires of trucks or paving equipment during the construction overlays, hot mix asphalt may be broadcast over the fabric for protection.

E. Placing Overlay

Use an asphaltic concrete overlay that meets the requirements of Section 400.

Prior to placement of the overlay, apply a bituminous tack coat over the fabric at a rate determined by the Engineer as described in Subsection 400.3.03.A.3.

The minimum thickness of asphaltic concrete over the strip shall be 2 in (50 mm). Milling may be required to provide the minimum thickness.

When using a vibratory roller for compaction, avoid the use of excessive amplitude. The use of excessive amplitude during the compaction process may result in an undesirable riding surface.

446.3.06 Quality Acceptance

General Provisions 101 through 150.

446.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

446.4 Measurement

The reinforcement fabric complete, in place, and accepted is measured by the square yard (meter) for full-width fabric, or by the linear foot (meter) for fabric strips. No allowance will be made for laps.

446.4.01 Limits

General Provisions 101 through 150.

446.5 Payment

Payment will be made at the Contract Unit Price per square yard (meter) or per linear foot (meter) of reinforcement fabric as shown in Subsection 446.4, "Measurement."

Payment is full compensation for the work specified in this section, including cleaning the surface and furnishing and placing the pavement reinforcement fabric.

Payment for Pavement Reinforcing Fabric Strips also includes all milling required to place the fabric according to the plans.

Payment will be made under:

Item No. 446	Pavement Reinforcement Fabric Strips, Type II, 18 inch (450 mm) Width	Per linear foot (meter)
Item No. 446	Pavement Reinforcement Fabric Full Width, Type II	Per square yard (meter)
Item No. 446	High Strength Pavement Reinforcement Fabric, 18 inch (450 mm) Width	Per linear foot (meter)

446.5.01 Adjustments

General Provisions 101 through 150.

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November 18, 2005

Section 451—Patching Portland Cement Concrete Pavement (Spall Repair)

Delete Subsection 451.3.05 and substitute the following:

451.3.05 Construction

A. Concrete Patching

Patch concrete one lane at a time, safely and rapidly to minimize inconvenience to the traveling public.

1. Accomplish the work with other operations in progress within an area if possible.
2. Complete the work before the grinding operation begins, if grinding is specified.
3. Remove and replace completed concrete patches that contain cracks, shrinkage, compression failures, or are damaged by construction or traffic before Final Acceptance at no additional cost to the Department.

B. Placing Patching Material

Use Repair Method 1 unless the State Materials Research Engineer gives written approval to use Repair Method 2. Use Repair Method 1 when the average daily temperature is 50 ºF (10 ºC) or above. Use of Repair Method 2, if approved, is limited to the manufacturer's written recommendations.

For the following repair methods, begin the placement when the surface within the repair area is dry and thoroughly free of contaminants.

Ensure that the finished surface including joints meets a surface tolerance of 1/8 in (3 mm) per 10 ft (3 m).

Use approved measures as necessary to keep pavement surfaces adjacent to this operation free of excess grout and other materials. Unless otherwise specified, complete the patching operations and open the lanes to traffic before sunset each day.

1. Repair Method 1: Twenty-four Hour Accelerated Strength Concrete

   Use this method as follows:

   a. Completely coat the concrete surface areas within the repair area with a film of Type II epoxy approximately 10 to 20 mils (0.25 to 0.50 mm) thick.

   b. Mix the concrete on site in a portable mixer. Obtain approval for the mix design and mixing method from the laboratory. The material must meet a slump range of 1.0 in. (25mm) to 3.0 in. (75mm).

   c. Deposit the concrete in the repair area while the epoxy is still tacky. Vibrate it to form a dense, homogeneous mass of concrete that completely fills the patch area.

   d. Screed the concrete to the proper grade and do not disturb it until the water sheen disappears from the surface.

   e. Cover the concrete with wet burlap or membrane curing compound. Allow the curing to continue for at least three hours. The Engineer may require longer curing to ensure sufficient concrete strength development before opening to traffic.

2. Repair Method 2: Rapid Setting Patching Material for Portland Cement Concrete Pavement (Type I, II, IV, and V)

   a. In addition to the requirements outlined in Subsection 451.3.03.A, "Removing and Preparing the Repair Area," prepare the surfaces in the repair areas according to the manufacturer's written recommendations.

   b. Perform the patching material handling, mixing, placing, consolidating, screeding, and curing according to the manufacturer's written instructions as approved by the laboratory.

   c. Continue curing for at least one hour and until opening the section to traffic.

C. Special Requirements

The following special requirements apply to this work:

1. If repairing adjacent to an unstable shoulder, place a form the full depth of the repair area to maintain a true, straight shoulder joint and to prevent the patching material from intruding onto the shoulder area.

2. After curing the patching material, remove the form and repair the shoulder at no cost to the Department.

3. During sandblasting, protect traffic in the adjacent lanes.

4. After the sandblasting operations:

   a. Thoroughly clean the area to be repaired with compressed air.

   b. Remove sand from the sandblasting operation from the roadway and shoulders.

5. Do not "over-cut" the pavement beyond marked areas whenever possible.

6. Remove saw slurry and other contaminates from the over-cutting.

7. Repair the over-cuts by filling full-depth with an approved low-viscosity epoxy compound using a Type II epoxy adhesive specified in Section 886. Make these repairs as soon as possible, but not after the joint is resealed.

8. Re-establish original transverse and longitudinal joints by sawing and sealing the joints with silicone that meets the requirements of Subsection 833.2.06, the Plan details, and Section 461.

   Re-establish the joints within 60 days after placing the patch. Ensure that re-established joints are at least 3/8 in (10 mm) wide.

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November 17, 2006

Section 500—Concrete Structures

Delete Section 500 and substitute the following:

500.1 General Description

This work consists of manufacturing and using Portland cement concrete to construct structures.

500.1.01 Definitions

General Provisions 101 through 150.

500.1.02 Related References

A. Standard Specifications

Section 104—Scope of Work

Section 211—Bridge Excavation and Backfill

Section 431—Grind Concrete Pavement

Section 507—Prestressed Concrete Bridge Members

Section 511—Reinforcement Steel

Section 530—Waterproofing Fabrics

Section 531—Dampproofing

Section 621—Concrete Barrier

Section 800—Coarse Aggregate

Section 801—Fine Aggregate

Section 830—Portland Cement

Section 836—Special Surface Coating for Concrete

Section 838—Graffiti-Proof Coating for Concrete

Section 853—Reinforcement and Tensioning Steel

Section 865—Manufacture of Prestressed Concrete Bridge Members

B. Referenced Documents

ASTM A 653/653M

ASTM A 924/924/M

ASTM A 681

ASTM C 685

ASTM D 260, Type I or Type II

AASHTO Specifications

AASHTO M 148 or C 309

AASHTO M 171

AASHTO M 194

AASHTO T 22

AASHTO T 126

AWS D 2.0

Laboratory Standard Operating Procedure, Quality Assurance for Ready Mix Concrete Plants in Georgia Standard Operating Procedure for Ready Mix Concrete

American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members Federal Specification TT-P-641d, Type II

Georgia Standards 4948 and 9031-L

QPL 10

QPL 17

QPL 23

GDT 134

DOT 525

500.1.03 Submittals

A. Concrete Mix Designs

The Contractor is responsible for all concrete mix designs. Ensure that concrete mixes contain enough cement to produce workability within the water- ratio specified in Table 1—Concrete Mix Table , below.

Design concrete mixes that meet the requirements of the Table 1—Concrete Mix Table , below. The Office of Materials and Research will determine the concrete properties using the applicable method in Section 500 of the Sampling, Testing, and Inspection Manual.

Table 1—Concrete Mix Table

English								
Class of Concrete	**(2) Coarse Aggregate Size No.**	**(1 & 6) Minimum Cement Factor lbs/yd^3**	**Max Water/Cement ratio lbs/lb**	**(5) Slump acceptance Limits (in) Lower-Upper**		**(3 & 7) Entrained Air Acceptance Limits (%) Lower-Upper**		**Minimum Compressive Strength at 28 days (psi)**
“AAA”	67,68	675	.440	2	4	2.5	6.0	5000
“AA1”	67,68	675	.440	2	4	2.5	6.0	4500
“AA”	56,57,67	635	.445	2	4	3.5	7.0	3500
“A”	56,57,67	611	.490	2	4	2.5	6.0	3000
“B”	56,57,67	470	.660	2	4	(3)	6.0	2200
“CS”	56,57,67 Graded Agg.*	280	1.400	-	3½	0.0 3.0	7.0	1000 (4)
Metric								
Class of Concrete	**(2) Coarse Aggregate Size No.**	**(1 & 6) Minimum Cement Factor kg/m^3**	**Max Water/Cement ratio kg/kg**	**(5) Slump acceptance Limits (mm) Lower - Upper**		**(3 & 7) Entrained Air Acceptance Limits (%) Lower-Upper**		**Minimum Compressive Strength at 28 days (MPa)**
“AAA”	67,68	400	.440	50	100	2.5	6.0	35
“AA1”	67,68	400	.440	50	100	2.5	6.0	30
“AA”	56,57,67	375	.445	50	100	3.5	7.0	25
“A”	56,57,67	360	.490	50	100	2.5	6.0	20
“B”	56,57,67	280	.660	50	100	(3)	6.0	15
“CS”	56,57,67 Graded Agg.	165	1.400		90	0.0 3.0	7.0	7 (4)

Notes:

1. Portland cement may be partially replaced with fly ash as provided in Subsection 500.3.04.D.4 or with granulated iron blast furnace slag as provide for in Subsection 500.3.04.D.5.
2. Specific size of coarse aggregate may be specified.
3. Lower limit is waived when air entrained concrete is not required.
4. The mixture will be capable of demonstrating a laboratory compressive strength at 28 days of 1000 psi (7 MPa) + 0.18 R*. Compressive strength will be determined based upon result of six cylinders prepared and tested in accordance with AASHTO T 22 and T 126.

   * Where R = Difference between the largest observed value and the smallest observed value for all compressive strength specimens at 28 days for a given combination of materials and mix proportions prepared together.
5. Designed slump may be altered by the Office of Materials and Research when Type “F” water reducers are used.
6. Minimum cement factor shall be increased by 50 lbs/yd^3 (30 kg/m^3) when size No. 7 coarse aggregate is used.
7. When Class A is specified for bridge deck concrete, the entrained air acceptance limits shall be 3.5% to 7.0%.

Submit all concrete mix designs to the Office of Materials and Research (OMR) for review. The Department will approve mixes that contain materials from approved sources and produce concrete that meets these Specifications.

Submit concrete mix design proportions for approval by one of the following methods:

1. Request Approval of Specific Proportions

   When requesting approval of specific concrete mix design proportions for classes of concrete, include the following information:

- Source of each material
- Apparent specific gravity of the cement and the fly ash, if used
- Bulk specific gravity (saturated surface dry) of each aggregate
- Percent absorption of each aggregate
- Amount of each material required to produce a cubic yard (meter) of concrete
- Proportions of admixtures per cubic yard (meter) of concrete and any use limitations
- Proposed slump and air content of the design
- Evidence that the proposed mixture complies with Subsection 500.1.03, .

Concrete mix designs that do not have a proven performance record and have not been used by the Department must meet minimum laboratory strength requirements.

2. Obtain Ready-Mix Design Proportions for commonly used materials.

   Get approved concrete mix designs from authorized ready-mix concrete plants.

   Ready-mix concrete plants approved according to Laboratory Standard Operating Procedure “Quality Assurance for Ready Mix Concrete Plants in Georgia” are authorized to submit concrete mix designs for approval. See QPL 10 for a list of approved plants.

3. Use Laboratory-Designed Proportions for commonly used materials

   Use laboratory-designed concrete mix proportions from either of the following sources:

   a. Laboratory-designed proportions are available for commonly used combinations of materials. Request these mixes in writing from the State Materials and Research Engineer.

      Request specific classes of concrete and specify the source of ingredients.

   b. Select a combination of materials from approved sources and request that the laboratory determine a mix that meets requirements in the Table 1—Concrete Mix Table above. The laboratory will establish proportions for strength and workability under laboratory conditions.

B. Delivery Tickets

Have the concrete plant transmit delivery tickets (DOT Form 525) with each load of concrete delivered to the work site. Give the Engineer one of these delivery tickets.

Ensure that the following information is on the delivery ticket:

- Project designation
- Date
- Time
- Class and quantity of concrete
- Actual batch proportions
- Free moisture content of aggregates
- Quantity of water withheld
- Concrete mixing revolutions

If available forms do not provide the required information, ask the Engineer to provide one.

C. Formwork Plans

The Engineer may require detailed formwork plans for review. If so, prepare the formwork plans and submit them to the Engineer. In no case will the Contractor be relieved of responsibility for the formwork plans.

When constructing permanent steel bridge deck forms, submit bar support details and types to the Department for approval before placing the deck form reinforcement.

D. Falsework Plans

Submit, for review by the Engineer, detailed falsework plans for spans under which traffic flows.

The Engineer may require plans for spans that do not accommodate traffic.

E. Shop and Erection Drawings

Submit fabricators' shop and erection drawings to the Engineer for review and approval. Indicate the following in the drawings:

- Grade of steel
- Physical and section properties for permanent steel bridge deck form sheets
- Locations where the forms are supported by steel beam flanges subject to tensile stresses

F. Hauling Vehicle Information

Before hauling starts on new bridges, submit the following information for each vehicle:

- Weight on each axle, empty
- Weight on each axle, fully loaded
- Center-to-center distances of axles
- Center-to-center distances of wheels measured parallel to each axle

G. Cold Weather Concrete Curing and Protection Plan

Secure the Engineer's approval of a "Cold Weather Concrete Curing and Protection Plan" for bridges and structures. Emphasize protection for the underside of bridge decks when using metal forms and include the protection procedures to be used.

Protection procedures shall keep the concrete above 50 °F (10 °C) for 72 hours after placement and above freezing for 6 days after placement. Choose the protection method from Table 2 based on the expected temperature within 48 hours after concrete placement.

Table 2—Cold Weather Protection

Protection Procedure	Expected Temperatures Within 48 Hours
Heated enclosures	Below 25 °F (-4 °C)
Commercial blankets	Below 25 °F (-4 °C)
Batt insulation	Below 25 °F (-4 °C)
Heavy-duty polyethylene	25 °F (-4°C) or above

500.2 Materials

Ensure that materials meet the Specification requirements of Table 3:

Table 3—Materials Specifications

Material	Section
Coarse Aggregate (1)	800.2.01
Fine Aggregate Size No. 10	801.2.02
Dampproofing or Waterproofing Material (Bituminous)	826.2.01
Portland Cement (2)	830.2.01
Portland-Pozzolan Cement (2)	830.2.03
Admixtures:	
Air-Entraining Admixtures	831.2.01
Retarding Admixtures	831.2.02
Water Reducing Admixtures	831.2.02
Granulated Iron Blast-Furnace Slag	831.2.03.A.3
Fly Ash	831.2.03.A
Curing Agents	832
Joint Fillers and Sealers	833
Special Surface Coating	836
Linseed Oil	870.2.06.A.
Mineral Spirits	870.2.06.A.4
Water	880.2.01
Graded Aggregate (3)	815.2.01
Graffiti Proof Coating	838.2.01
Concrete used in Bridge Construction	500.3.04.F
1. Use either Class A or Class B coarse aggregate of the designated size, except when using limestone or dolomite in bridge structures. When using limestone or dolomite, use Class A coarse aggregate.	
2. Use Type I or Type II Portland cement or Type IP Portland-Pozzolan cement unless otherwise specified. Do not use air-entraining cement.	
3. The gradation requirements of graded aggregate are modified to require 30% to 45% by weight passing the No. 10 (2.00 mm) sieve.	

Construct bridge sections containing duct enclosures for stressing tendons using concrete with a maximum stone size of No. 7.

Use concrete manufactured at plants that qualify as approved sources according to the Standard Operating Procedure for Ready Mix Concrete. See QPL 10 for a list of approved plants.

For a list of approved deck oil protective surface treatment sources, see QPL 23.

500.2.01 Delivery, Storage, and Handling

A. Aggregate Stockpile

Stockpile aggregate as follows:

1. Keep stockpile areas firm, reasonably level, well-drained, clean, and free of sod or foreign matter.
2. Stockpile aggregate separately by type and source.

3. Form stockpiles using methods and equipment that do not cause the aggregate to segregate, become contaminated, or degrade. The Engineer may reject improperly formed stockpiles.

4. Stockpile aggregate long enough for the moisture content to stabilize.

5. Do not use aggregates stored in pits or silos that contain water.

B. Aggregate Handling

Operate aggregate handling equipment carefully to minimize segregation, breaks, spills, contamination, and mixing of the sizes and types of aggregates.

C. Cement Storage

Store cement as specified below. Reject all caked, lumpy, or contaminated cement.

1. Bulk Cement

   Use bulk cement unless the Engineer allows bag cement to be used.

   Store bulk cement in bins or silos designed for this purpose. Provide moisture-proof storage containers with a mechanism that allows cement to flow freely from the discharge opening.

2. Different Brands

   Store and use cement of different brands and types, or from different mills separately.

D. Admixture Storage and Handling

Carefully store and dispense admixtures as recommended by the manufacturer to prevent contamination.

E. Concrete Handling and Placing

Handle and place concrete according to the following:

1. Haul Time Limitations

   Ensure that concrete reaches its final position in the forms within one hour after adding the cement to the aggregates.

   If retarders or water reducers are used, the allowable time limit increases to 1-1/2 hours. Test concrete immediately for acceptance tolerances before placing in forms using limits established in Table 1—Concrete Mix Table.

2. Placement Limitations

   After delivering the concrete to the job site or the staging area at the site or after mixing the concrete at the site, transport it carefully to the placement point to prevent excessive slump loss or segregation. Use any of the following equipment:

   - Buckets
   - Buggies
   - Pumps
   - Other approved means

F. Form Storage

Store forms off the ground.

G. Precast Unit Handling

Except as noted below, the applicable portions of Subsections 507.2.01, “Delivery, Storage, and Handling,” 507.3.05.A, “Prepare Bearing Areas,” 507.3.05.B, “Erecting PSC Bridge Members,” and 507.3.05.D, “Concrete Finish,” shall govern.

Handle precast, nonprestressed units as follows:

1. Do not lift the units from the casting bed until the concrete reaches a strength of at least 1,500 psi (10 MPa).

2. Do not transport or erect the units until they reach a strength of at least 3,000 psi (20 MPa).
3. Restrict live loads (including erection equipment) on the units until they reach a minimum strength of 4,500 psi (30 MPa).

500.3 Construction Requirements

500.3.01 Personnel

A. Supervision, Personnel, and Skilled Workers

Provide enough supervision, personnel, and skilled workers to do the following:

1. Properly produce, place, and finish concrete in each pour unit according to Subsection 500.3.05.P, Table 5—Minimum Placement Rates or as required by the Plans.
2. Check screed clearances and tolerances before beginning deck pours.
3. Place concrete without delays.

B. Plant Operator Certification

Volumetric proportioning requires that the operator be certified by the Office of Materials and Research.

500.3.02 Equipment

A. Equipment Restrictions

Do not use delivery, conveyance, or vibratory units that leak grout, water, oil, or gas.

Provide enough equipment, tools, and materials to properly produce, place, and finish concrete in each pour unit according to the Subsection 500.3.05.P, Table 5—Minimum Placement Rates or as required by the Plans.

The Engineer may prohibit equipment that delays concrete placement.

B. Volumetric Proportioning Equipment

When concrete ingredients are proportioned volumetrically, obtain the Engineer's approval for the equipment and its calibration and operation.

Ensure the following:

- The equipment meets the specifications in ASTM C 685.
- The concrete producer conducts calibration tests at least every 6 months.
- The equipment is calibrated for each new concrete mix before production.

C. Batching Plant Equipment

Ensure that batching plants have the following equipment and that the equipment meets the standards listed.

1. Bins

   Ensure that bins and bin compartments meet the following standards:

   - Adequate capacity for the required concrete production
   - Supported on a rigid framework on a stable foundation capable of holding the bins securely
   - Designed to discharge efficiently and freely into the weigh hopper
   - Positive means of control that slows down and shuts off the material flow when the weigh hopper has the correct quantity.
   - Discharging mechanisms that prevent material leaks when closed

- Leak-free aggregate storage bins
- Divided aggregate storage bins for fine aggregate and each size of coarse aggregate
- Partitioned aggregate storage bin compartment that prevents the materials from mixing
- Leak-proof, moisture-proof cement bins with a vibrator or other mechanism to discharge cement

2. Weigh Hoppers

Ensure that weigh hoppers meet the following standards:

- Have suitable containers freely suspended from scales
- Have adequate capacity to maintain the Subsection 500.3.05.P, Table 5—Minimum Placement Rates
- Have a discharge mechanism that prevents material leaks when closed
- Have vents to permit air to escape
- Have vibrators or other equipment that ensures complete and efficient discharge of materials
- Have a dust seal and a port or valve for sampling cement

3. Scales

Scales used for weighing concrete materials shall have accuracy within plus or minus one percent under operating conditions.

Ensure the following:

- When directed by the Engineer, the owner demonstrates the accuracy of the scales.
- Scales are kept clean and in good operating condition.
- The scale operator can clearly see indicating devices.
- The scale operator can easily access controls.

D. Mixers and Agitators

Ensure that mixers and agitators meet the following requirements:

1. General Requirements for Mixers and Agitators

Provide mixers and agitators that meet these requirements:

a. Capacity Plates

Ensure that the mixer or agitator has a legible metal plate or plates attached in an easily visible location. The plates shall indicate the rated capacity in cubic yards (meters) for mixing and agitating.

b. Concrete Production

The mixer shall produce concrete that meets the requirements in the Table 1—Concrete Mix Table .

c. Mixer Performance Test

The mixer or agitator may be required to pass a mixer performance test. Mixer performance will be evaluated at the discretion of the Engineer.

Mixer performance tests will include the following by the OMR:

1) Taking samples of concrete at the one-quarter and three-quarter points of the batch discharge
2) Measuring the slumps of each concrete sample

If the two slump values differ by more than 2 in (50 mm), do not use the mixer or agitator until it meets the requirements of the test.

The Engineer may permit the equipment to be used if the 2 in (50 mm) tolerance can be met by using a longer mixing time or a smaller batch.

2. Mixing Speed

Follow these guidelines for mixing speed:

- Do not exceed 150 revolutions at mixing speed.
- Discharge all concrete from truck mixers before drum or blades reach 300 revolutions, including revolutions at agitating speed.
- Use the mixing speed defined by the manufacturer for the mixing equipment.
- If the manufacturer's definition of mixing speed is not available, use a mixing speed of 6 to 18 revolutions per minute.

3. Mixer and Agitator Maintenance

Maintain mixers and agitators as follows:

a. When mixers and agitators are discharged, remove the entire contents before adding materials for the next batch.

b. Clean mixers and agitators often to prevent concrete and grout accumulation.

c. Do not discharge cleaning water into any pipe, catch basin, or structure.

d. If cement or aggregates accumulate in mixers and agitators when cleaning water is discharged, remove them immediately at no expense to the Department.

4. Mixer Types

Use stationary mixers or truck mixers.

a. Stationary Mixers

Ensure that stationary mixers meet the following standards:

1) Combine the concrete ingredients into a homogeneous, uniform mass within the specified time and when loaded to capacity.

2) Efficiently and uniformly discharge the concrete within the tolerances allowed in Subsection 500.3.02.D.1.c, "Mixer Performance Test."

3) Permit discharge only after the specified mixing time has elapsed using a locking device.

b. Truck Mixers

Ensure that truck mixers meet the following standards:

- Meets the requirements listed in Subsection 500.3.02.D.4.a, "Stationary Mixers"
- Has an approved revolution counting device in good operating condition
- Does not haul more than the rated capacity in cubic yards (meters) as shown on the attached capacity plates

5. Agitator Types

Use truck agitators or truck mixers operating at agitating speed.

Ensure that agitators meet the following requirements:

a. Keeps the mixed concrete in a homogeneous, uniform mass

b. Efficiently and uniformly discharges the concrete within the tolerances allowed in Subsection 500.3.02.D.1.c, "Mixer Performance Test."

E. Concrete Buckets

Keep concrete buckets clean and in good working condition.

F. Concrete Buggies

Keep concrete buggies clean and in good working condition.

G. Concrete Pumps

Concrete pumping equipment is subject to the Engineer’s approval. Use pumping equipment that has adequate capacity and is suitable for the proposed work.

H. Chutes and Troughs

Do not use chutes longer than 50 ft (15 m) without the Engineer’s permission.

Flush chutes and troughs with water after each run. Do not discharge this water into freshly placed concrete or into conveyance unit.

Promptly remove hardened concrete from chutes and troughs.

Ensure that chutes and troughs meet the following requirements:

1. Metal or metal lined
2. Slope not exceeding one vertical to three horizontal
3. Baffles or a series of short lengths placed to reverse the direction of the concrete flow, when used on steep slopes

I. Pipes or Tubes

Use pipes or tubes to place concrete when the operation requires dropping the concrete more than 5 ft (1.5 m). Thoroughly clean the pipes or tubes after each pour.

Use pipes made of metal or other approved material and long enough to deposit the concrete as close to its final position as possible.

J. Vibrators

Provide enough vibratory units, including at least one additional stand-by unit in good working condition, to compact concrete immediately after it is placed. Have a stand-by unit at the site before each pour is started.

On Projects consisting entirely of small pours (10 yd^3 [8 m^3] or less), the Engineer may waive the stand-by requirement.

Ensure that vibrators meet the following conditions:

- Approved internal rotation-type design
- A power supply that constantly vibrates the concrete at frequencies of not less than 4500 impulses per minute
- A vibration intensity that visibly affects a mass of concrete with a 1 in (25 mm) slump through at least a 18 in (450 mm) radius

K. Screeds

Do not use vibratory screeds (screeds that use a transverse strike-off motion) without the Engineer’s approval. Use screeds that are:

- Mechanically operated
- Designed and constructed to screed with the strike-off parallel to the center line
- Readily adjustable
- Capable of maintaining proper adjustment throughout the screeding operation

The two screed types are:

1. Longitudinal Screeds

Unless otherwise noted on the Plans, use longitudinal screeds only on pour lengths of 70 ft (20 m) or less.

2. Transverse Screeds

Use transverse screeds on any pour, unless otherwise noted on the Plans. However, transverse screeds are required on pour lengths above 70 ft (20 m).

Support screeds outside the pour area that will receive a surface finish. Do not use intermediate supports or guides.

Adjust screeds to the camber specified on the Plans. Check the camber as often as necessary.

Have the Engineer approve the following for screeds and their supports:

- Weight
- Durability
- Adjustability
- Accuracy
- Mechanical condition
- Operational results

Furnish the equipment necessary to check screed clearances and tolerances before pouring decks.

L. Underwater Placement Equipment

Place concrete under water using the following underwater placement equipment:

1. Tremie

Use a tremie when depositing concrete in water above 10 ft (3 m) deep. Ensure that tremie is:

- At least 8 inches in (200 mm) diameter
- Constructed in sections with watertight couplings

2. Bottom Dump Bucket

Where the Engineer permits, use a bottom dump bucket in water up to 10 ft (3 m) deep.

Ensure that the bottom of the bucket opens only when it touches the surface that receives the charge and that the top of the bucket has a lid or cover.

M. Fogging Equipment

To supply additional moisture to the concrete, use fogging equipment with the following characteristics:

- A heavy-duty pump capable of delivering 2 gal (7.6 L) of water per minute to a 0.062 in (1.6 mm) diameter tip at an air pressure of 100 psi (700 kPa).

  An example of a suitable pump is the Alemite Pump 7878-A.
- The ability to consume approximately 22 ft^3/min (0.6 m^3/min) of compressed air
- A 3/8 in (10 mm) inside diameter hose long enough to reach all areas of the deck
- An adjustable spray gun and tip to provide various patterns of atomized spray or fog for changing finishing conditions

  An example of a suitable spray gun is the Gun Jet No. 43 with a 120-2 Multee Jet Nozzle.

If necessary, substitute other equipment that is capable of equal performance.

500.3.03 Preparation

A. Pre-Pour Conference

Before beginning deck placement operations on each Project, and for individual deck pours of an unusual nature, the Engineer will schedule a pre-pour conference with Project supervisory personnel and a representative of the concrete supplier, if applicable.

Conference topics of discussion include the following:

- Reinforcing steel support method
- Final screed setting check
- Anticipated placement rate
- Personnel number
- Equipment type
- Curing methods
- Adverse weather placement procedures
- Emergency procedures
- Other Work-related details

500.3.04 Fabrication

A. Measure Materials

Measure materials as follows:

1. **Cement.** Weigh bulk cement on scales to plus or minus one percent of the designated weight. If the Engineer allows bag cement, proportion the batch to use only whole bags.
2. **Aggregates.** Weigh all aggregates on scales to plus or minus two percent of the designated weight. Apply the proper corrections for aggregate surface moisture.
3. **Water.** Measure water by volume or weight to within plus or minus one percent.
   a. Construct the measuring system to be independent of water pressure fluctuation.
   b. Ensure that measuring systems have outside taps and valves to facilitate plant calibrations.
   c. You may use recycled wash water provided that it meets the requirements of Subsection 880.2.02.
4. **Admixtures**. Measure admixtures by weight or volume within plus or minus three percent of the required amount.

B. Control Concrete Batching

Control batching as follows:

1. Mix batches of concrete according to the proportions of an approved mix design.
2. Ensure that concrete materials are from the designated sources.
3. Correct the batch weights to account for surface moisture in aggregates.
4. Conduct batching control tests according to the procedures in the Sampling, Testing, and Inspection Manual.

C. Prestressed Concrete Deck Panel Requirements

Do not use prestressed concrete deck panels unless approved by the Engineer.

D. Add Admixtures to Concrete

Additives are required when specified herein or as directed by the Engineer.

1. Air-Entraining Admixtures

   a. All bridge structure concrete uses air-entraining additives, except for seal concrete and non-exposed footings.

   b. The Contractor may use air-entraining additives in other concrete to improve workability when job or material conditions dictate.

      When using air-entraining additives as an option to improve workability or when required, do not exceed the upper limit of the entrained air content requirement in the Table 1—Concrete Mix Table.

2. Retarding Admixtures

   Use concrete-retarding additives in bridge concrete when the average temperature is above 65 °F (18 °C) (the average of the expected high and the predicted low).

   a. Normally, concrete-retarding additives are not required for bridge curbs, handrails, crosswalks, or other appurtenances constructed separately from the decks.

   b. The Engineer may waive the use of retarders in substructure concrete when concrete can be placed within one hour after batching.

3. Water-Reducing Admixtures

   The Contractor may use water-reducing admixtures in Class AA concrete for bridge decks when conditions do not require a retarder. The Contractor may use water-reducing admixtures in other concrete when job or material conditions dictate a reduction in water requirements or when minimal set retardation is desired.

   The laboratory may allow Type F water-reducing admixtures when the Contractor requests it. The Contractor may construct bridge sections containing duct enclosures for stressing tendons with concrete using Type F (AASHTO M 194) water reducer as approved by the laboratory.

4. Fly Ash

   The Contractor may use fly ash as an additive in concrete to promote workability and plasticity. The Contractor may use fly ash as a partial replacement for Portland cement in concrete if the following limits are met:

   a. Replace no more than 15 percent of the cement by weight.

   b. Replace cement with fly ash at the rate of 1.0 to 1.5 lbs (1.0 to 1.5 kg) of fly ash to 1.0 lb (1.0 kg) of cement.

   c. Ensure that the fly ash mix meets the requirements of Subsection 500.1.03.A, Subsection 830.2.03, "Portland Pozzolan Cement" and Subsection 831.2.03.A, "Fly Ash".

   d. Calculate water-cement ratio based on the total cementious material in the mix including fly ash.

   e. Do not use Type IP cement in mixes containing fly ash.

5. Granulated Iron Blast-Furnace Slag

   If high-early strengths are unnecessary, the Contractor may use granulated iron blast-furnace slag as a partial replacement for Portland cement in concrete if the following limits are met:

   a. Replace no more than 50 percent of the cement by weight.

   b. Replace the cement with slag at the rate of 1.0 lb (1.0 kg) of slag to 1.0 lb (1.0 kg) of cement.

   c. Ensure that the slag mix meets the requirements of Subsection 500.1.03.A.3, Subsection 830.2.02, "Portland Blast-Furnace Cement" and Subsection 831.2.03.A.3, "Granulated Iron Blast-Furnace Slag".

   d. Calculate the water-cement ratio based on the total cementitious material in the mix including granulated iron-blast furnace slag.

   e. Do not use Type IP cement or fly ash in slag mixes.

E. Mix Concrete

1. Central-Mixed Concrete

Mix central-mixed concrete as follows:

a. Establish the mixing time.

The Engineer will determine the mixing time for central mixed concrete, but the minimum mixing time will be one minute for stationary mixers of up to 1 yd^3 (1 m^3) capacity. Mixing time may be adjusted in the following situations:

- The Engineer will increase the minimum time by 15 seconds for each additional cubic yard (meter) or fraction thereof.
- For mixers with a capacity above 3 yd^3 (2 m^3), the minimum mixing time may be 90 seconds if the resulting mixture is homogeneous and meets the requirements of Subsection 500.3.02.D.1.c, "Mixer Performance Test."
- The Engineer may waive mixing time requirements for stationary mixers of improved types or new designs that produce homogeneous concrete in less time than that established for a particular capacity by the foregoing. For these types of mixers, the Engineer may establish a minimum mixing time of one minute.

b. Start the mixing time when all cement and aggregates have been placed in the mixer.

c. Add some water to the mixer before adding the cement and aggregates, but ensure all water is in the mixer by the end of the first 1/4 of the specified mixing time.

2. Shrink-Mixed Concrete

Mix shrink-mixed concrete as follows:

a. Mix the batches as specified in Subsection 500.3.02.D.2."Mixers and Agitators."

b. Do the initial mixing in a stationary mixer for at least 30 seconds to thoroughly mix the ingredients. Do the final mixing in truck mixers.

c. Discharge all concrete before the drum or blades exceed 300 revolutions.

d. Do not allow truck mixing at mixing speed to exceed 100 drum or blade revolutions except as allowed when adding water according to Subsection 500.3.05.M, "Add Water to Concrete."

3. Transit-Mixed Concrete

Mix transit-mixed concrete as follows:

a. For concrete mixed completely in a truck mixer, place all concrete ingredients into the mixer at the concrete plant except the quantity of water that may be withheld according to Subsection 500.3.05.M, "Add Water to Concrete."

b. After loading the truck, begin operating at either agitating or mixing speed; however, start the mixing speed within 30 minutes after loading the truck mixer.

c. Mix the concrete for 70 to 150 revolutions at mixing speed.

For revolutions above those specified for mixing speed, use agitating speed.

d. Discharge all concrete before exceeding 300 drum or blade revolutions.

F. Concrete Used in Construction

1. Requirements

Use Type I or Type II Portland cement or Type IP Portland-Pozzolan cement for bridge construction, unless otherwise specified.

NOTE 1: Do not use air-entraining cement.

NOTE 2: Do not use accelerators (24-hour accelerated strength concrete) that contain chlorides in any bridges where the concrete containing the additive will contact the reinforcing steel.

a. Concrete Types: Use the tabulated results from the Table 1—Concrete Mix Table for the classes and specific requirements for each class of concrete. Use the appropriate class of concrete shown in the Plans or Specifications for each component of a structure, of the type as follows:

- Class AAA–Prestressed concrete
- Class AA1–Precast concrete as called for on the Plans

  If approved by the Engineer, you may use this class as high early-strength concrete and may use Type III cement in concrete used for this purpose.

  The Engineer may also specify the rate of compressive strength development when this concrete is used.

NOTE: The Department will not add compensation to the Contractor for Class AA1 concrete when it is used at the request of the Contractor.

b. Class AA–Bridge superstructure concrete or precast concrete as called for on the Plans

c. Class A–General purposes

NOTE: Do not air-entrain Class A concrete deposited in water (seal concrete). Ensure that the concrete has 10 percent additional cement and sufficient water to provide a 6- to 8-in (150- to 200-mm) slump.

d. Class B–Massive sections or lightly reinforced sections or miscellaneous non-structural concrete

e. Class CS–(Portland cement concrete subbase). Use this class as a subbase where required by the Plans. Concrete subbase may be composed of a mixture of Portland cement and graded aggregate or Portland cement, aggregate, and sand.

2. Acceptance of Design

Determine laboratory acceptance strength by at least 8 compressive test specimens prepared and cured according to AASHTO T 126.

a. Make the specimens from two or more separate trial batches.

b. Make an equal number of specimens from each batch.

c. Calculate the minimum average strength or acceptance strength (X) as follows:

$X = f'c + 2.0s$

Where:

$f'c$ = required minimum compressive strength for each class of concrete from the Table 1—Concrete Mix Table

s = average standard deviation of all 28-day specimens made in the field representing concrete of a given class from all ready-mix plants

Use the standard deviations shown in Table 4:

Table 4—Standard Deviations for Calculating Acceptance Strength

Class of Concrete	Standard Deviation (s)	
	Psi	(MPa)
B	370	(2.5)
A	650	(4.5)
AA	620	(4.3)
AA1	540	(3.7)
AAA	500	(3.4)

500.3.05 Construction

A. Meet General Responsibilities

General construction responsibilities include:

1. Batch, mix, deliver, and place concrete according to the Specifications.
2. Have enough production and placement capacity to continuously mix, place, and finish the concrete in each pour unit during daylight hours.

   If necessary, place concrete at night when adequate lighting facilities exist and the Engineer approves of the operations and facilities.
3. If a pour cannot be completed, do the following:
   a. Form an approved construction joint.
   b. Remove the partial pour.
   c. Take other remedial measures directed by the Engineer at no additional expense to the Department.

B. Construct Falsework

Accept responsibility for the design, construction, protection, and performance of falsework. Repair or remove and replace (as the Engineer directs) concrete, other material, or portions of the structure that are damaged or destroyed due to falsework failure.

Construct falsework for prestressed post-tensioned concrete structures according to the Contract Special Provisions.

Construct falsework for structures other than post-tensioned box girders as follows:

1. Meet Design Criteria

   Ensure that falsework structural components that have similar functions in an individual permanent span have the same geometric properties and are made of the same materials.

   When designing and centering formwork, treat concrete as a liquid, and use the following weights:

   - 150 lbs/ft^3 (23.6 kN/m^3) for vertical loading
   - 85 lbs/ft^3 (13.4 kN/m^3) for horizontal loading
   - 75 lbs/ft^2 (3.6 kN/m^2) live load for deck placement operations

   Use the following falsework design criteria:

   - Design and construct falsework logically so the Bridge Design Office can analyze it using a commonly accepted structural design theory.
   - Avoid exceeding safe working values for material stresses.
   - Provide support for the imposed loads, without settling or deforming and a way to compensate for settlement, if it occurs.

2. Support Falsework

   Support falsework using one of these methods:

   - Support on piling driven and removed as directed
   - Found on a footing approved by the Engineer

3. Construct Falsework

   Construct and set falsework to provide the finished structure the specified camber and finished grade.

   Place “telltales” at locations directed by the Engineer to observe how much the falsework settles.

C. Meet Form Design Criteria

Ensure that forms meet the following design criteria:

- Provide wet concrete and other loads and forces of construction support without bulging between the supports or bracing and without deviating from the lines and contours shown on the Plans.
- Meet the design criteria for falsework in Subsection 500.3.05.B.1, “Meet Design Criteria.”
- Account for the use of retarded concrete.

Ensure that bracing, ties, and supports are placed accurately.

If the formwork appears to be inadequately supported, tied, or braced (before or during concrete placement), the Engineer may require that the Work stop until the defects are corrected.

D. Use Acceptable Form Materials

Except as noted, fabricate forms from the following materials:

- Lumber
- Plywood
- Metal
- Plastic
- Combinations of these

Use material free of defects that materially affect form strength or materially impair the accuracy or appearance of the concrete surface.

Use the form materials as follows:

1. Lumber Forms

   Construct wood forms as follows:

   a. Size and dress the lumber.
   b. Use lumber at least 1 in (25 mm) thick.
   c. Use lumber for header forms used as screed supports and for curb face forms at least 2 in (50 mm) thick.
   d. Avoid using scrap material or doing patchwork.
   e. Stagger all joints but those between abutting panels.
   f. Line the lumber used to form outside vertical surfaces of exterior beams or girders with an approved form liner.
   g. Use chamfer strips mill-produced from high-quality lumber, free of defects.
   h. Dress and finish chamfer strips on all three sides.
   i. Size chamfer strips to the proper dimensions.

2. Plywood Forms

   Construct plywood forms as follows:

   a. If plywood is the type made for general concrete forms and is at least 5/8 in (16 mm) thick, use it in place of 1 in (25 mm) thick lumber to construct forms, if necessary.

   b. Ensure that plywood used to form open joints and to line forms is at least 1/4 in (6 mm) thick.

   c. When nailing plywood directly to form studs, do not space the studs more than 16 in (400 mm) apart.

   d. Use plywood in full sheets wherever practical. Do not do patchwork with small, irregular pieces.

   e. Have the Engineer inspect and approve plywood sheet layout.

3. Metal or Plastic Forms

   Construct metal or plastic forms as follows:

   a. Use metal or plastic to form concrete only if the Engineer approves the forms and if the forms produce satisfactory results.

   b. Use metal forms that produce finished concrete equal to or superior to concrete made from comparable wooden forms.

   c. Countersink bolts and rivets in the surfaces of metal forms that touch concrete.

   d. Grind welds smooth in the surfaces of metal forms to provide a smooth plane surface.

4. Other Material Uses

   Use tempered fiberboard for form liners when necessary if it is at least 1/4 in (6 mm) thick. Use tempered fiberboard 1/8 in (3 mm) thick only to form open joints. Support the fiberboard with suitable spacers arranged properly.

   Use approved synthetic materials for forming open joints and for other special uses, if necessary.

E. Construct Form Supports

Construct form supports using metal ties, anchors, and hangers as follows:

1. Construct supports that will remain in the finished concrete so they can be removed from the concrete face to a depth of at least 1 in (25 mm) without damaging the concrete.
2. Weld form supports to girder or beam flanges in continuous or cantilever spans only in the flange areas which are in compression.
3. When ordinary wire ties or snap ties are permitted, cut them back at least 3/8 in (10 mm) from the face of the concrete.
4. Design metal tie fittings that minimize the cavities made when they are removed. Fill all cavities after removing metal tie fittings.

F. Construct Temporary Forms

Construct temporary forms as follows:

1. Construct and maintain forms in a mortar-tight condition.
2. Construct forms so that they can be removed easily without damaging the concrete, unless using forms that will remain in place.
3. Build, line, and brace forms so that the formed concrete surface conforms with the dimensions, lines, and grades shown on the Plans.
4. Build headwall forms for skewed pipe parallel to the roadway centerline or at right angles to the radius on curves. Construct headwall forms as follows:

   a. Lay enough pipe to extend through the headwall form.

b. After the concrete is poured and hardened, carefully cut and dress the protruding pipe ends so no ragged edges remain.

The Contractor may choose, as an alternate to the above method, to build a circular form that exactly fits the pipe circumference and face of the headwall form.

5. Construct form liner using plywood or other approved form liner as follows:

   a. Use form liner in large sheets. Do not do patchwork.

   b. Avoid irregular joint location in form liners.

   c. Have the Engineer inspect and approve the proposed liner layout.

6. Bevel forms at beam copings, girders, and other projections to ease removal.

7. Place chamfer strips to chamfer exposed edges of the concrete by the required amount. Use ¾ in (19 mm) chamfers unless otherwise shown on the Plans.

8. Patch with tin or other metal only in those areas of the superstructure lying between and including the inside faces of the exterior beams.

9. When shown on the Plans, splice water stops to form continuous water-tight joints. Hold stops in position while placing concrete.

10. Immediately before erecting forms or just before placing bar reinforcement steel, coat forms with a clear oil or other bond breaker to keep concrete from sticking to the forms.

    a. Do not allow the substance to stain or soften the concrete surface.

    b. Do not apply by reaching or pouring through previously placed reinforcement steel.

11. Wait to place concrete in any form until the Department inspects and approves the form.

    Inspection and approval does not diminish the responsibility to produce concrete surfaces free of warping, bulging, or other defects.

12. When removing forms, remove chamfer strips, blocks, and bracing.

13. Do not leave any part of a wooden form in the concrete.

14. If concrete surfaces do not meet finish specifications, correct the problems with the following steps, as directed by the Engineer:

    - Repair the defects using approved methods.
    - Remove and replace the affected portion of the Work.

G. Reuse Forms

Reuse forms and form material in good condition and satisfactory as determined by the Engineer. Do not use forms or form materials that are warped, cracked, split, bulging, have separated plies, or have unsatisfactory form liner.

Ensure that used forms are mortar tight and produce a finished concrete equivalent to that produced by new forms.

H. Construct Permanent Steel Bridge Deck Forms for Concrete Deck Slabs

Unless otherwise designated on the Plans, construct and use permanent steel bridge deck forms for concrete bridge deck slabs according to these Specifications. Do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

Provide a structurally satisfactory slab when using permanent steel bridge deck forms.

1. Fabricate permanent steel bridge deck forms and supports from steel that conforms to ASTM A 653/653M Designation SS, Grade 80/550, Coating Designation G-165/Z-500 and ASTM A 924/924M.

2. Design permanent steel bridge deck forms as follows:

   a. Account for the dead load of the following:

- Form
- Reinforcement steel
- Plastic concrete

b. Add 50 lbs/ft² (2.4 kN/m²) for construction loads.

c. Ensure that the unit working stress in the steel sheet does not exceed 0.725 of the specified minimum yield strength for the material furnished. However, do not allow the unit working stress to exceed 36,000 psi (250 MPa).

d. Account for deflection under the weight of the forms, the plastic concrete, and the reinforcement as follows:

   1) If deflection exceeds 1/180 of the design span or 1/2 in (13 mm), whichever is less, use intermediate supports.

   2) Do not base deflection on a total load of less than 120 lbs/ft² (5.7 kN/m²).

e. Base the permissible form camber on the actual dead load condition.

f. Do not use camber to compensate for deflection that exceeds the above limits.

g. Compute the form sheets design span using the clear span of the form, plus 2 in (50 mm), measured parallel to the form flutes.

h. Compute physical design properties according to the requirements of the latest published edition of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members.

i. Ensure that all bottom reinforcement has a minimum concrete cover of 1 in (25 mm) as shown in Figure 1 (Figure 1 metric).

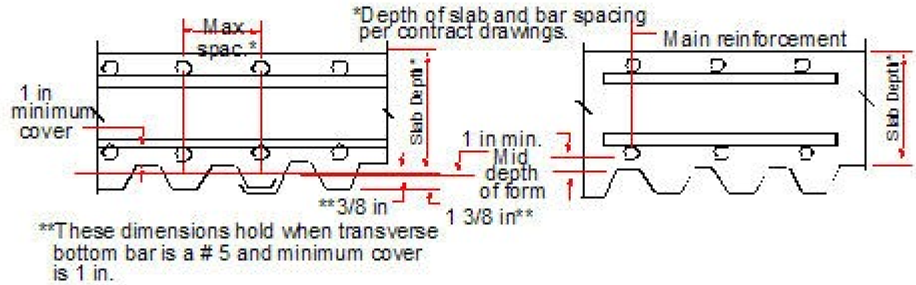

Figure 1

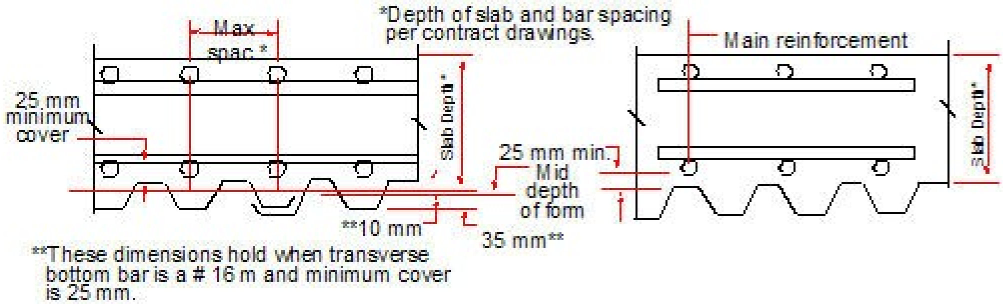

Figure 1 (metric)

j. Maintain the Plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

k. Do not use precast mortar blocks to support the deck reinforcement.

l. Do not treat permanent steel bridge deck forms as lateral bracing for the compression flanges of supporting structural members.

3. Do not weld to flanges in tension or to structural steel bridge elements fabricated from non-weldable steel grades.

   Have welders certified by the Department weld metal deck forms or supports for metal deck forms.

I. Install Forms

Install and maintain forms in a mortar-tight condition and according to approved fabrication and erection Plans.

Place transverse construction joints at the bottom of a flute. Field drill 1/4 in (6mm) weep holes no less than 12 in (300 mm) on center along the line of the joint.

1. Highway Bridge Forms

   Install highway bridge forms using either Method 1 or Method 2:

   - **Method 1**. Place forms so the ribs of the forms align with how the bottom transverse reinforcing in the slab is spaced.
   - **Method 2**. Place forms with a 1 in (25 mm) minimum clearance between the top of the form and the bottom of the main deck reinforcement. See Figure 1 (Figure 1 metric).

2. Railroad Bridge Forms

Install railroad bridge forms as follows:

a. Place the forms so the tops of the form ribs adjacent to the beam flange are at the bottom of the deck slab specified by the Plans.

b. Maintain the full slab depth detailed on the Plans.

c. Do not allow form ribs to project above the Plan bottom of the deck slab.

d. Do not place form sheets directly on top of the stringer or floor beam flanges.

e. Securely fasten form sheets to form supports using self-drilling screw fasteners, not by welding. If the Engineer approves, use fastener pins driven into place by a power tool.

f. Ensure that form sheets have a minimum bearing length of 1 in (25 mm) at each end.

g. Do not leave loose sheets or accessories on the deck at the end of a day’s work.

h. Place form supports so that they contact the flange of the stringer or floor beam.

i. Attach form supports using welds, bolts, clips, or other approved means.

j. Do not weld form supports to the flanges of non-weldable steel or to portions of the flange subject to tensile stresses.

k. Ensure that welding and welds comply with AWS D 2.0 for fillet welds. However, 1/8 in (3 mm) fillet welds are permitted.

J. Repair Damaged Forms

Repair permanently exposed form metal to the Engineer’s satisfaction if the galvanized coating is damaged.

1. Clean the damaged area.
2. Go over the damaged area with a wire brush.
3. Paint the area with two coats of zinc oxide-zinc dust primer that meet Federal Specification TT-P-641d, Type II and has no color added.
4. Do not touch up minor heat discoloration in weld areas.

K. Construct Runways

Provide runways into a deck pour area for moving buggies. If the Engineer approves, use runways to bridge a previous pour that has not reached the minimum strength or age requirements in Subsection 500.3.05.AF.4, “Live Loads—Pouring Equipment.”

Construct and support runways to protect the forms and the reinforcement steel position.

L. Construct Work Bridges

Provide a work bridge on deck pours. Support the bridge outside the area of the pour receiving a surface finish. If two or more spans will be poured on the same day, the Engineer may require two work bridges.

Design and construct work bridges to meet the following:

- Do not allow the bridge to sag into the fresh concrete.
- Construct the bridge so that transverse finish and curing material can be applied easily regardless of the screed type.

M. Add Water to Concrete

Add water to the concrete at the concrete plant. Do not add indiscriminate amounts of water at the job site.

If placement conditions require concrete of a more workable consistency, add small amounts of water at the job site if approved by the Engineer.

Add water at the job site as follows:

1. Determine the quantity of water required to provide the necessary consistency.

   The Engineer will not approve additions of water that cause the total amount of water to exceed the maximum water/cement ratio established in the Table 1—Concrete Mix Table.

   The Engineer will reject concrete with water added to it that produces a higher slump than specified in the Table 1—Concrete Mix Table.

2. Do not add water to concrete that has begun to set because of excessive mixing or to concrete that has exceeded mixing or haul time limitations.
3. When adding the water, carefully control the conditions.
4. Position the delivery so the measuring operation is not affected.
5. Measure the water carefully.
6. Inject the water into the mixer forcefully to facilitate uniform mixing.
7. Add water before discharging an appreciable amount of concrete.
8. Do not add more water after concrete discharge begins.
9. After adding the water, mix the concrete an additional 30 revolutions.
10. Finish mixing the concrete before the total revolutions at mixing speed exceed 150.

N. Volumetrically Proportion Concrete

Concrete ingredients may be proportioned volumetrically when non-air entrained concrete is used in miscellaneous concrete, non-exposed footings, or culverts smaller than bridge culvert size.

O. Prepare for Concrete Placement

Prepare for concrete placement as follows:

1. Ensure that an adequate supply of concrete will be furnished and placed to meet the requirements specified in Subsection 500.3.05.P, Table 5—Minimum Placement Rates.
2. To ensure a full bond between prestressed concrete deck panels and the cast-in-place concrete, clean the panel before placing the slab concrete.
3. Immediately before placing cast-in-place slab concrete, saturate the prestressed concrete deck panels with water.
4. Immediately before placing concrete in the forms, the concrete will be measured for acceptance tolerances. Acceptance tolerances for each class of concrete are listed in the Table 1—Concrete Mix Table .

   Conduct the applicable tests according to the procedures in the Sampling, Testing, and Inspection information.

P. Meet the Minimum Placement Rates

If concrete is not produced, placed, and finished according to the minimum placement rates, the Engineer may reject the pour. Concrete pours of a similar nature and size will not be allowed until the problem is corrected and the placement rate met.

The minimum placement rates are listed in Table 5:

Table 5—Minimum Placement Rates for Bridges, Culverts and Retaining Walls

1. Bridge Substructure

Pour Size in Cubic Yards (Meters)	Minimum Placement Rate in Cubic Yards (Meters) per Hour
0-25 (0-19)	10 (8)
26-50 (20-39)	15 (12)
51-75 (40-59)	20 (15)
76-100 (60-75)	25 (20)
101 and over (76 and over)	30 (25)or as designated on the Plans or in the Special Provisions

The minimum placement rate for columns shall be the same as for culvert sidewalls and wingwalls.

2. Bridge Superstructure

Pour Size in Cubic Yards (Meters)	Minimum Placement Rate in Cubic Yards (Meters)per Hour
0–25 (0-19)	15 (12)
26–50 (20–39)	20 (15)
51–75 (40–59)	25 (20)
76 and over (60 and over)	30 (25) or as designated on the Plans or in the Special Provisions

Pour handrail, parapet, curb, and barriers at a rate satisfactory to the Engineer.

3. Culverts

Structure	Minimum Placement Rate in Cubic Yards (Meters)per Hour
Footings and slabs	Same as for bridge substructures
Sidewalls and wingwalls	Use placement rates so that fresh concrete is not placed on concrete that has attained its initial set. Cover all concrete with fresh concrete within 45 minutes.

4. Retaining Walls

Structure	Minimum Placement Rate in Cubic Yards (Meters)per Hour
Footings	Same as for bridge substructures
Walls	Same as for culvert sidewalls and wingwalls

Q. Place Concrete

Place concrete as follows:

1. Do not allow aluminum to touch the concrete while mixing, transporting, handling, or placing it.
2. Transport, handle, and place concrete quickly so that it reaches its final position in the forms within the haul time limitations in Subsection 500.2.01.E.1, “Haul Time Limitations.”
3. Manipulate the delivery or conveyance unit to avoid vibration damaging to partially set concrete.
4. Immediately before placing the concrete, thoroughly clean and wet the forms.
5. Place concrete as close as possible to its final position in the forms.
6. Use chutes, troughs, or tubes to pour the concrete in the forms, without displacing reinforcement steel.
7. Modify or stop using the equipment if chutes, troughs, or tubes cause honeycombed or otherwise inferior concrete.
8. When placing concrete by pumping, operate the pumping equipment so that the concrete is produced in a continuous stream without air pockets.

NOTE: Convey and place concrete by pumping only when specified in the Contract or when authorized by the Engineer.

9. When concrete placement requires dropping the concrete more than 5 ft (1.5 m), use pipes or tubes to place the concrete.

   Do not allow concrete to free-fall more than 5 ft (1.5 m) from the pipe or tube.
10. Place concrete in horizontal layers no more than 18 in (0.5 m) thick.
11. Place and compact succeeding batches in each layer before the preceding batch takes its initial set.
12. Place each succeeding layer before the underlying layer sets.
13. Consolidate the concrete to avoid cold joints between layers.
14. If the forms sag or bulge while concrete is being placed, remove the concrete causing the distortion and the concrete in adjoining areas if the Engineer requires. Removal prevents cold joints and displaced or damaged reinforcement.
15. Work the concrete around reinforcement bars without displacing them.
16. Compact concrete using suitable tools and vibration.
17. Vibrate concrete where it is deposited and vibrate other concrete while it is fresh. Vibrate as follows:
    a. Insert and withdraw vibrators slowly.
    b. Manipulate vibrators to work the concrete around reinforcement and embedded fixtures and into corners of forms.
    c. Vibrate sufficiently to compact the concrete but avoid causing the concrete to segregate.
    d. Stop vibrating before local areas of grout are formed.
    e. Apply vibrators no farther apart than twice the radius through which the vibration is visibly effective.
    f. Do not use vibrators or any other means that could cause segregation to move masses of concrete in the forms.
    g. Do not apply vibrators to sections of concrete that are no longer plastic.
    h. Vibrate concrete-filled steel grid floors by applying the vibrators to the steel.
    i. Vibrate concrete for precast or prestressed units as specified above in steps a through g, unless the Engineer approves alternate methods.
    j. Stop vibration when a mortar line appears on the face of the form and when the coarse aggregate particles are submerged in the concrete mortar.
18. Supplement vibration with spading to ensure smooth surfaces and dense concrete along form faces and in locations difficult to reach with vibrators.
19. After concrete sets initially, do not disturb the forms or the projecting reinforcing bars.

R. Create Construction Joints

Place construction joints according to the Plans or as directed by the Engineer.

If an emergency affects continuous placement, the Engineer will decide if a construction joint is allowed. If allowed, the Engineer will provide instructions about where and how to make the joint.

The Engineer may eliminate certain construction joints if placement, finishing and forming methods can produce satisfactory results.

Create construction joints as follows:

1. Remove mortar splashed on form surfaces and projecting reinforcement steel before concrete reaches its initial set.
    a. Do not puddle dried mortar chips and dust into the plastic concrete.

b. If excess mortar is not removed from reinforcement steel before the concrete reaches its initial set, delay cleaning until the concrete is thoroughly hardened.

2. If joining fresh concrete and hardened concrete, clean the hardened surface of laitance and incompletely bonded, loose, or foreign material.

   Ensure that laitance is completely removed from the following:

   - Joints between decks and curbs
   - Tops of seal courses
   - Construction joints in concrete exposed to sea water

3. Ensure that the surface of the concrete is dry before pouring the concrete against it.
4. Immediately before placing fresh concrete, tighten the forms against the existing concrete.
5. Use tremies or pumps to coat areas where fresh concrete will be poured with mortar or cement grout.
6. Begin placing concrete immediately after placing the mortar or grout.
7. Apply enough vibration to blend the material with the concrete at the construction joint.

S. Protect Fresh Concrete

Do not drive pile, blast, or perform other operations that vibrate the formwork or the concrete noticeably before the concrete reaches a strength of 2,000 psi (15 MPa) and is 3 days old.

Protect fresh concrete from rainfall with waterproof material such as tarpaulins or plastic film. Ensure that the waterproof material is ready before pouring and is sufficient to cover the area of the pour.

T. Place Bridge Deck Concrete

Do not use calcium chloride or any other admixture containing chloride salts in concrete placed on permanent steel bridge deck forms.

Ensure that the tolerances are accurate for bar reinforcement placement in cast-in-place concrete so the top clearance to the bar reinforcement complies with Subsection 511.3.05.G.6, “Bridge Deck Slab Tolerances.”

Place bridge deck concrete according to the Contract Specifications and as follows:

1. Before pouring decks, set substantial bulkheads or headers and shape them to the required deck surface cross section.
2. Ensure that pouring sequences, procedures, and mixes comply with the Plans and Specifications.
3. Pour the deck according to the numbered sequence as follows:

   a. Unless otherwise shown on the Plans, pour each deck in one continuous operation.

   b. When dividing deck pours within any one complete unit (a simple span or a continuous or cantilever unit), pour and finish the concrete in the numbered sequence shown on the Plans, beginning with the lowest number.

   c. Make pours with the same number before pours with higher numbers. Make pours with the same number in any sequence.

   The numbered sequence shown on the Plans also applies to sidewalk pours, but it need not apply to curb, parapet, and handrail pours.

   d. Pour diaphragms between steel or prestressed concrete roadway beams at least 24 hours before pouring the deck slab.

   e. Unless otherwise authorized by the Engineer, pour all diaphragms within a complete unit before pouring decks.

   f. When constructing concrete T-Beams, place girder stems in uniform layers before placing slabs.

g. If T-Beam spans are supported without intermediate false bents, begin deck placement as soon as the first four stems are placed. After the first four stems, avoid getting more than three stems ahead of the advancing line of the deck pour and lagging by more than the space between stems.

h. If T-Beam spans are supported by intermediate false bents, place decks and stems the same as for T-Beam spans supported without intermediate false bents. However, ensure that the slab is placed before a cold joint develops between the stem and slab.

4. Do not make the deck pour until any previously poured concrete in the complete unit has set for 24 hours.

   This requirement may be waived under certain conditions if the succeeding pour can be completed (except for final finishing) within four hours of the initial placement of the day. The Engineer must give written approval for this requirement to be waived.

   Unless otherwise shown on the Plans, do not place handrail, sidewalks, parapets, and curbs in a complete unit until all the deck slabs in the unit have been poured.

5. Ensure that the pour is the same as the overlap direction (as shown in the shop drawings).

6. Use the following deck pour method:

   a. If there is super-elevation, begin deck pours on either the high or the low side.

   b. Dump each batch against previously placed concrete.

   c. Pour at a rate that ensures fresh concrete along the advancing line of the pour.

   d. Vibrate or tamp concrete dumped on fresh concrete to make the grout flow as follows:

      - Forward with or slightly ahead of the concrete
      - Along the bottoms and sides of the forms
      - Around the reinforcement steel

7. Once the concrete is poured, vibrate it enough to avoid honeycomb and voids, especially at the following locations:

      - Construction joints
      - Expansion joints
      - Valleys and ends of form sheets Screed the concrete as follows:

   a. Use finishing devices operating parallel to the center line. As pouring proceeds, keep the concrete surface screeded to the required grade.

   b. Fill depressions ahead of the screed, and keep a small roll of grout on the leading edge of the screed. Perform further screeding with minimum disturbance to the surface already brought to the grade.

   c. Take care during the placement and screeding to obtain sound concrete at the construction joint located where the slab joins the curb, parapet, or sidewalk.

   d. Do not place excess grout on the leading edge of the screed and do not allow it to remain in this area.

   e. Use either a longitudinal screed or a transverse screed.

      - Longitudinal Screed

        Before doing the final screeding, place enough concrete in front of the screeding position to deflect the dead load.

      - Transverse Screed

        On beam or girder-supported spans with skew angles of 65° or less, place and operate the truss or beam supporting the strike-off parallel to the skew and make the advancing pour line parallel to the skew.

        On beam or girder-supported spans with skew angles between 65° and 90°, position the screed either on the skew or at right angles to the bridge center line.

On superstructures supported by non-deflecting falsework and on beam- or girder-supported spans with a total dead load deflection no more than 1/2 in (13 mm), position the screed at right angles to the bridge center line and make the advancing line of pour at right angles to the bridge center line.

f. As the pouring proceeds, keep the concrete surface screeded to the required grade.

g. Fill depressions ahead of the screed. Keep a small roll of grout on the leading edge of the screed.

h. Continue to screed without disturbing the surface already brought to the required grade.

i. Avoid producing unsound concrete where the slab joins the curb, parapet, or sidewalk. Remove excess grout from the leading edge of the screed at these construction joints.

8. Edge joints to be sealed, including dummy joints, as follows:

   a. Edge before the initial set or after the final set.

   b. If edging before the initial set, use edging tools of the proper radius as shown on the Plans.

   c. Carefully remove concrete from pouring operations on adjacent pours to achieve the required rounded edge.

   d. If edging after the final set, allow the joints to harden. After at least 12 hours, grind joints to approximate the plan radius either by hand or by mechanically operated grinding stones.

   e. To achieve full and uniform bearing, finish areas that are recessed for receiving joint members.

9. Finish bridge decks as follows:

   a. As soon as the concrete is hard enough and standing water and moisture sheen disappear, give the concrete a final finish by belting, brooming, or dragging.

      - Belt longitudinally using a wet canvas belt. Limit belting to spans no longer than 40 ft (12 m).
      - Drag transversely or longitudinally with a wet burlap drag.
      - Broom transversely using a stiff-bristled broom.

   b. Finish the following areas carefully:

      - Gutter lines
      - Joints
      - Drains

   c. After belting, dragging, or brooming and when shown on the Plans, groove the bridge deck and approach slabs perpendicular to the center line as follows:

      1) Do not begin grooving until the bridge deck is cured according to Subsection 500.3.05.Z, “Cure Concrete.”

      2) If necessary, groove in conjunction with planing required to make the surface corrections specified in Subsection 500.3.06.D, “Bridge Deck Surface Check.” Wait until the concrete is hard enough to support the equipment without distorting.

      3) Cut grooves into the hardened concrete using a mechanical saw device capable of producing grooves 0.125 in (3 mm) wide, 0.125 in (3 mm) deep, and 0.750 in (19 mm) apart, center-to-center.

      4) Extend the grooves across the slab to within 1ft (300 mm) of the gutter lines.

U. Place Concrete Parapet on Bridge Decks

Place concrete barrier or parapets on bridge decks. The slip form method with an approved self-propelled extrusion machine as specified in Section 621 is optional.

V. Place Seal Concrete

Deposit concrete in water only when required by the Plans or when considered necessary by the Engineer.

When depositing the seal concrete, follow these guidelines:

- Keep the water as motionless as possible.
- Place the concrete continuously from beginning to end.
- Ensure that the concrete surface remains as horizontal as possible.

Place seal concrete as follows:

1. Place seal concrete carefully in a compacted mass as near to its final position as possible using a tremie, a bottom dump bucket, or other approved means.
   a. Use tremies to place seal concrete as follows:
      1) Support tremies so that the discharge end can move freely over the entire top surface of the work.
      2) Support tremies so that they can lower rapidly to stop or retard the flow of concrete.
      3) At the beginning of the work, close the discharge end to keep water out of the tube.
      4) Keep the tube sealed.
      5) Keep the tremie tube full to the bottom of the hopper.
      6) When dumping a batch into the hopper, induce concrete flow by slightly raising the discharge end and keeping it within the previously deposited concrete. This maintains a seal and forces the concrete to flow into position by hydraulic head.
   b. Use bottom-dump buckets to place seal concrete as follows:
      1) Ensure that the bottom-dump bucket is level full.
      2) Open the bucket only when it rests on the surface that will receive the charge.
      3) In lowering and raising the bucket, do not move the water unnecessarily.
   c. When approved by the Engineer, place seal concrete by pumping.
2. Wait at least 24 hours after placement to begin dewatering seal concrete, unless the Engineer determines a longer waiting period is necessary.
3. Remove laitance from the seal concrete before placing the footing.
4. Bore seals under spread footings the entire depth of the seal as specified for foundations in Subsection 211.3.05.C, “Boring of Foundations and Seals.”
5. If laitance buildup on seals under spread footings exceeds 1/4 in/ft (20 mm/m) of seal depth, the Engineer may decide to core the seal to determine acceptability.
6. When placing concrete exposed to sea water, control the water content to produce concrete of maximum density and create construction joints and prepare their surfaces according to the requirements of Subsection 500.3.05.R, “Create Construction Joints.”

W. CS Concrete

Pour CS concrete as follows:

1. Meet CS concrete depth and surface finish requirements.
   - Ensure that the minimum depth is the same as shown on the Plans.
   - Do not vary the depth variation more than 1 in (25 mm).
   - Ensure that the surface finish is generally smooth and uniform.
   - Smooth or fill float marks, voids, and other deformities exceeding 1/2 in (13 mm) before placing approach slabs.
2. To prevent bonding:

a. Lay clean polyethylene sheeting uniformly over the CS concrete in the approach slab area before placing the slabs.

b. Use new, unused polyethylene sheeting free of holes, rips, and tears.

c. Use polyethylene bond-breaking material at least 8 mils (0.2 mm) thick with an overlap of at least 6 in (150 mm).

3. Maintain polyethylene sheeting in good condition throughout the construction process.

   Repair or replace sheeting deemed unsatisfactory as directed by the Engineer.

4. Cure CS concrete with the polyethylene sheeting used for bond breaking.

X. Pour Concrete in Cold Weather

When pouring concrete in cold weather, keep the concrete temperature at the point of delivery at least 50 °F (10 °C). Do not use accelerator-containing chlorides.

Mix and pour concrete in cold weather as follows:

1. Keep concrete materials at the right temperatures.
   - Do not use materials in concrete mix that contain frozen lumps.
   - Do not incorporate water and aggregates into the mix with temperatures more than 150 °F (65 °C).
   - If aggregates or water temperatures are above 100 °F (40 °C), discharge the aggregates and water into the mixer and allow the temperatures to equalize before adding the cement.
   - Heat aggregate with steam, hot water coils, or other methods that do not damage the aggregates. Do not heat aggregates with direct flame.
2. Protect the poured concrete.
   - Keep concrete above 50 °F (10 °C) for at least 72 hours after placement.
   - Protect concrete from freezing for 6 days after placement.

Y. Pour Concrete in Hot Weather

Reduce hazards and difficulties related to placing and finishing concrete in hot weather before pouring The Engineer may require measures to prevent concrete workability reduction, losses from cement hydration, evaporation, drying, or elevated concrete temperatures.

1. Place Concrete

   Cool forms and reinforcement with water immediately before placing concrete. Meet the minimum placement rates specified in Subsection 500.3.05.P, Table 5—Minimum Placement Rates.

2. Keep Concrete Cool

   Keep concrete cool as follows:

   a. Keep the concrete used for construction at no more than 90 °F (32.2 °C) when measured at the point of discharge from the delivery unit.

   b. If the concrete temperature might exceed 90 °F (32.2 °C) during concrete placement, begin placement when the air temperature cools if the Engineer requires.

   c. Cool the aggregates by fogging or other means that do not affect moisture content.

   d. Use chipped or crushed ice in the mix as a portion of the mixing water on a pound (kilogram) basis. If using ice, ensure that the ice melts before the batch is discharged from the mixing unit.

   e. If necessary, cool water by refrigeration to provide a lower concrete temperature.

3. Finish Concrete

Do not “splash on” water to aid screeding or finishing operations.

For bridge decks, fog the surface when required, according to Subsection 500.3.05.Z.3, “Bridge Deck Curing.”

If needed, use wind screens to prevent thermal or shrinkage cracks caused by rapid concrete surface drying.

Z. Cure Concrete

Concrete curing is an integral part of the concrete placement operation. Improperly cured concrete will be considered defective.

If the Engineer determines that curing procedures do not comply with these Specifications, stop placing concrete. Resume concrete placement after taking remedial measures to ensure proper curing.

Begin curing unformed surfaces when the water sheen disappears from the surface or immediately after applying the surface finish. Continue curing for 5 days.

Cure the formed surfaces after removing the forms. Remove them within 5 days after placing concrete. Continue curing until the concrete is 5 days old (from the time it is poured).

Cure concrete surfaces exposed to air using methods that prevent premature drying or moisture loss. Ensure that curing conditions are the same throughout separate curing areas.

Use either or a combination of the two methods specified for curing concrete except bridge decks. Cure bridge decks as described in Subsection 500.3.05.Z.3, “Bridge Deck Curing.”

1. General Curing—Supplying Additional Moisture

   Do not use a method that causes the concrete to be alternately wet and dry.

   Cure concrete properly by supplying additional moisture through ponding, sprinkling, or fogging and then retaining the moisture as follows:

   a. Use cotton mats, burlap, sand, hay, or straw coverings.

      Cover with at least 2 in (50 mm) of sand. Cover with at least 3 in (75 mm) of hay or straw.

   b. Do not use sawdust or coverings that cause unsightly discoloration of concrete.

   c. Place coverings after completing the finishing operations when there is no danger of surface damage.

   d. Keep coverings moist continuously.

2. General Curing—Preventing Moisture Loss

   Keep concrete moist before and during the rubbing from the Type III—Rubbed Finish.

   Start curing immediately after the rub using approved waterproof paper, plastic sheets, or membrane-forming curing compounds, except when curing compounds are prohibited.

   a. Waterproof Paper or Plastic Sheets

      Ensure that the sheets and paper meet the requirements of AASHTO M 171 and use them as follows:

      - Use the widest possible widths.
      - Lap adjacent sheets at least 6 in (150 mm).
      - Seal the laps with tape, mastic, glue, or other approved methods to form a waterproof cover of the entire area.
      - Keep the curing material from being displaced by wind.
      - Immediately replace or repair sheets or paper that tear, break, or become damaged during the curing period.

   b. Membrane-Forming Curing Compounds

      Use as the curing agent AASHTO M 148, membrane-forming curing compounds, Type 1-D, Class A or B, or Type 2, Class A or B, white pigmented. Use the curing agent as follows:

- Do not use membrane-forming curing compounds on bridge decks or prestressed concrete bridge members, or in construction joint areas.
- When the water sheen disappears from the concrete surface, apply the curing compound uniformly to unformed areas.
- Apply the compound to formed surfaces if the forms are removed during the 5-day curing period.
- Cure the areas to be rubbed with liquid membrane-forming compounds for curing concrete, Type1-D, Class A or B (non-acrylic).
- Apply curing compound with fine-spraying equipment.
- Thoroughly agitate the compounds just before using them.
- Spray the surface again immediately after the first application at right angles to the first application. Apply at least 1 gal (1 L) for each 150 ft² (3.7 m²) of surface.
- Do not apply curing compound to the following:
    - — Joints where a concrete bond is required
    - — Reinforcement steel
    - — Joints where joint sealer will be placed
- Close the surface to pedestrian or vehicular traffic for 7 days unless the surface is protected by planks, plywood, or a layer of sand at least 1 in (25 mm) thick.

Do not place this protection until at least 12 hours after applying the curing compound.

3. Bridge Deck Curing

Cure bridge deck concrete as follows:

a. Immediately after the water sheen disappears and the surface finish is applied, fog the surface to keep a film of water on the surface.
b. If surface damage occurs, delay fogging.
c. Keep the surface wet until after applying the sheet curing covers.
d. Thoroughly soak curing covers on the fabric side.
e. As soon as the concrete sets enough to prevent damage, apply the covers with the white-poly side up.
f. Use two-layer sheet curing material for bridge concrete according to AASHTO M 171.

   For the bottom layer, use a polyethylene film. For the top layer, use a white, burlap polyethylene sheet or a white, co-polymer-coated, absorbent, non-woven synthetic fabric.
g. Ensure that sheet curing material for bridge concrete meets Specification requirements for reflection and moisture retention and has no holes or tears.
h. Use enough sheet curing material to cover the deck surface.
i. Place the curing covers so that adjoining sheets overlap at least 18 in (450 mm).
j. Weight all laps and side edges to prevent cover displacement before curing is completed.
k. Weight and overlap covers so the curing sheets maintain intimate contact with the concrete surface.
l. If there is no moisture under the curing covers during the 5-day curing period, apply additional moisture.

4. Parapet, Sidewalk, End Post, and Curb Face Curing

The surface of parapets, sidewalk, end post, and horizontal and vertical faces of curbs are not considered part of the bridge deck. Cure these structures using the general curing methods in Subsections 500.3.05.Z.1, “General Curing—Supplying Additional Moisture,” and 500.3.05.Z.2, “General Curing—Preventing Moisture Loss,” unless the surfaces will receive a special surface coating (Subsection 500.3.05.AB.4, “Type III—Special Surface Coating Finish”).

Do not cure surfaces receiving a special surface coating with membrane-forming curing compounds.

Do not cure surfaces receiving protection surface treatment (75 percent boiled linseed oil and 25 percent mineral spirits solution) with membrane-forming curing compounds that contain acrylics.

AA. Prevent Plastic Shrinkage Cracking

Take precautions to prevent plastic shrinkage cracking of concrete by doing the following:

- Provide wind screens
- Provide fogging equipment
- Apply temporary wet coverings before moisture loss begins

The Engineer will evaluate the effects of plastic shrinkage cracks and will require repair of cracks that create structural defects and corrode reinforcement steel.

AB. Finish Concrete

Concrete surface finishes are classified according to whether the surfaces are formed or unformed. Refer to Table 6.

When other Sections of the Specifications for concrete work state that the requirements of Section 500 apply, finish the concrete according to the other sections.

Table 6—Concrete Finish Types

Surface	Finish Type
Formed	Type I—Ordinary Formed Surface Finish
	Type II—Special Formed Surface Finish
	Type III—Rubbed Finish
	Type III—Special Surface Coating Finish
Unformed	Type IV–Floated Surface Finish
	Type V–Sidewalk Finish
	Type VI–Stair Tread Finish

Except for bridge deck finishes, which are covered in Subsection 500.3.05.T, “Place Bridge Deck Concrete,” step 9, finish all structural concrete surfaces with one or more of the finishes described here, unless otherwise shown on the Plans.

1. Type I—Ordinary Formed Surface Finish

   Complete formed concrete surfaces with this finish. However, leave concrete exposed directly to sea water undisturbed unless the Engineer requires additional work. See Subsection 500.3.05.V, “Place Seal Concrete,” step 6.

   Achieve a Type I finish as follows:

   a. Immediately after removing the forms, remove fins and surface irregularities.

   b. Fill or point up the following:

      - Cavities produced by forms or ties
      - Holes
      - Broken corners or edges
      - Defects
      - Honeycombed edges

c. Remove and patch honeycombed areas to sound concrete.

d. Use patch mortar that consists of the same sand and cement as the concrete. Use the sand and cement in the same ratio as in the concrete.

   Use epoxy mortars in areas where heat generation and moisture will not decrease patch performance.

e. Cure the patches using one of the general curing methods specified in Subsection 500.3.05.Z.1, “General Curing—Supplying Additional Moisture” and 500.3.05.Z.2, “General Curing—Preventing Moisture Loss.”

f. Produce a sound and uniform finish.

g. If the Type I finish is not satisfactory, give the surfaces a Type III—Rubbed Finish where the Engineer considers it necessary to achieve a uniform and pleasing appearance.

2. Type II—Special Formed Surface Finish

   Give a Type II finish to the following:

   - Exposed portions of pipe headwalls and culverts
   - Parapets and wingwalls
   - Ends of culvert slabs and walls

   Achieve a Type II finish as follows:

   a. Use a form liner unless the forms are made of plywood or steel.

   b. Rub only when necessary if the surface has a pleasing, uniform appearance after completing the Type I finish and blending all pointed and patched areas.

   c. If the surface finish is not satisfactory, give surfaces the Type III—Rubbed Finish where the Engineer considers it necessary to achieve a uniform and pleasing appearance.

3. Type III—Rubbed Finish

   Apply a Type III finish to bridge areas checked in the table of Bridge areas Requiring a Type III Finish, below and to exposed areas of retaining walls, unless the Plans specify otherwise.

   Achieve a rubbed finish as follows:

   a. Begin the first rub immediately after removing forms, completing the Type I finish, and ensuring that all patches are thoroughly set, but before applying the required curing compound.

      If finishing is postponed or there is not enough labor to keep it up-to-date, the Engineer will order a stop to any other work until the finishing is satisfactory.

   b. Rub chamfered surfaces only once, but not during the first rubbing. Rub chamfered surfaces during either the second or the final rubbing.

   c. To rub, wet the moist concrete on the curing surface with a brush and rub with a medium-coarse carborundum stone or equal abrasive until a paste comes to the surface.

      Keep the entire concrete surface moist during rubbing to assure adequate curing.

   d. Continue rubbing until all form marks and projections disappear, leaving a smooth, dense surface with no pits or irregularities.

   e. Spread the paste material carefully and uniformly over the entire surface and leave it.

   f. No earlier than 24 hours after the first rub, do the final rub with a fine carborundum stone or equal abrasive, leaving a smoothly textured surface that is uniform in color.

   g. Finish the final rub before applying protective surface treatment required by the Plans.

   h. Do not “whitewash” finished areas by using separately mixed grout or paste on the rubbing stone or by spreading it on the surface to be rubbed.

i. Thoroughly clean and blend into the surrounding surfaces any areas that are disfigured by drips from concrete placement or rubbing.

Bridge Areas Requiring a Type III Finish (X)

	Single Bridge Over Stream	**Multiple Bridges Over Stream**	**Single Bridge Over Railroad**	**Multiple Bridges Over Railroad**	**Single Bridge Over Traffic Artery**	**Multiple Bridges Over Traffic Artery**	**Railroad Bridge Over Traffic Artery**	**Pedestrial Bridge Over Traffic Artery**
All exposed substructure areas, except tops and bottoms of caps. **(5)**					X	X	X	X
Outside surface of any exterior concrete beam, Lt. or Rt. **(1), (2)**		X		X				
Outside surface of any exterior concrete beam, Lt. and Rt. **(1), (3)**					X	X	X	X
Vertical surfaces of overhangs, curb, or sidewalk.	X	X	X	X	X	X	X	X
All vertical surfaces outside of exterior beam, Lt. or Rt. **(2)**		X		X				
All vertical surfaces outside of exterior beam, Lt. or Rt. **(3)**					X	X	X	X
End bent cap beyond outside beam or girder.	X	X	X	X				
End bent end walls beyond outside beam or girder.	X	X	X	X	X	X	X	X
End posts and end bent wingwalls all exposed surfaces.	X	X	X	X	X	X	X	X
Traffic face of curbs.	X	X	X	X	X	X		X
Entire handrails and posts, hand rail parapet, and barriers. (4), (5)	X	X	X	X	X	X	X	X
All other locations specified on Special Provisions.	X	X	X	X	X	X	X	X

Notes:

(1) —Including Prestressed Concrete Bridge Members.

(2) —"Lt. or Rt."–Rub the applicable surface when it can be seen from any adjoining bridge.

(3) —"Lt. and Rt."—Rub the applicable surfaces on both sides of centerline of each bridge.

(4) —rubbing of bottom surface of rail not required.

(5) —Bottoms of caps and handrails shall be given a Type II finish.

For bridges using PSC Beams or PSC Deck Units, a Type III Special Surface Coating Finish shall be used where a Type III finish is required for exterior beams. The Type III Special Surface Coating Finish shall also be used on the exterior vertical faces of the parapet, barrier, and overhangs where PSC Beams or PSC Deck Units are used.

4. Type III—Special Surface Coating Finish

A Type III—Special Surface Coating Finish may be substituted for a Type III—Rubbed Finish.

The special surface coating finish consists of either a Class A or a Class B coating system, applied to produce a masonry-like textured finish on concrete surfaces.

For contiguous structures, whether in the same Contract or in separate Contracts, use the same brand of special surface coating.

If contiguous structures are in separate contracts, coordinate the Work with the other Contractor so that coating is applied as near as possible to the same time.

If contractors cannot coordinate Work, the one who finishes the work last shall use the same brand or shall recoat all contiguous areas to provide a uniform appearance.

Achieve a special surface coating finish as follows:

a. Ensure that surface coating material meets the requirements of Section 836.

   Select coating material from the QPL 17.

b. Do not use form oils that affect the bonding of surface coatings.

c. Do not use wax-based or other curing compounds incompatible with surface coatings.

   Have the coating manufacturer or the laboratory determine compatibility.

d. Use the coating color required in Section 836.

e. On surfaces that will receive a coating finish, do not cure with membrane-curing compound or remove forms with bond-breaking agents or excessive oil.

f. Apply coatings as follows:

   - Class A coatings at a rate that develops a 1/16 in (1.5 mm) thick coating.
   - Apply Class B coatings at a maximum rate of 60 ft^2 per gallon (1.5 m^2 per liter).
   - Ensure that the temperatures of the air, concrete, and compound are above 50 °F (10 °C).
   - Apply a test section as directed by the Engineer to determine the acceptance of a coating under field conditions.
   - Apply the coatings using a method that produces an acceptable finish, such as spraying, rolling, or a combination of these.

g. Protect coated surfaces from rain or freezing temperatures for 24 hours after application.

h. Ensure that the final coating produces a smoothly textured surface that is uniform in color, thickness, and appearance.

i. Remove and reapply coatings that chip, crack, blister, peel, or present an unsatisfactory appearance.

j. If the final appearance is unsatisfactory, apply a rubbed finish to slip-formed and formed walls and barriers.

5. Type IV—Floated Surface Finish

Use a Type IV finish only on the horizontal surfaces of the following:

- Curbs and sidewalks
- Tops of caps and footings
- Surface of slope paving
- Other similar structures

Apply the Type IV finish as follows:

a. After compacting the surface and screeding to the correct cross sections, float the surface with a wood float.

b. While floating the surface, bring enough mortar to the surface to achieve the desired finish, but do not reduce the wearing quality of the surface.

c. Make the final finish with a wood float or stiff-bristle broom.

d. If brooming, make the marks transverse to the traffic.

6. Type V—Sidewalk Finish

Apply a Type V finish as follows:

a. After placing and compacting the concrete, strike it off and give it a Type IV finish.

b. Use an edging tool on all edges and along expansion joints unless the Plans require chamfers.

c. Mark off sidewalk surfaces in blocks with suitable grooving tools when required by the Plans or the Engineer.

d. Extend the rubbed finish on the traffic face of the curb to include the horizontal area of sidewalk between the curb corner and the longitudinal sidewalk groove.

7. Type VI—Stair Tread Finish

Achieve a Type IV finish using a stiff-bristled broom.

AC. Remove Forms

Do not remove forms and their supports, including falsework, until the Engineer approves. Use a removal method approved by the Engineer. Approval does not relieve responsibility for the safety of the Work.

1. Form Removal Time

Use a removal time shown on the Plans or specified by the Engineer.

Use Table 7 to help establish when forms can be removed safely. However, do not count days where the temperature at any time during the day is at or below 40 °F (4 °C), unless the cold weather concrete protective measures described in Subsection 500.1.03.G, "Cold Weather Concrete Curing and Protection Plan" were used.

Table 7—Estimate of Form Removal Time

Form	Time Required
Bottom of beams	10 days
Bottom of caps, trestle pile bents	4 days
Bottom of all other caps	7 days
Overhangs and slabs, including culverts	7 days
Columns and retaining walls	18 to 48 hours
Sides of beams, posts, rails, caps, footings, wingwalls, and parapets	12 to 24 hours
Bottoms of cast-in-place rails and diaphragms	48 hours
Front face of curbs	3 hours

If using high-early strength concrete, the Engineer may reduce the time limitations if the concrete develops satisfactory strengths.

2. Form Removal Method

Remove forms and falsework without injuring the concrete surface or overstressing the concrete members.

Ensure that the stress from the weight of the removal process is transferred gradually and uniformly to the concrete.

At the Contractor's request, time of removal may be controlled by field tests on cylinders, subject to the following conditions:

a. No tests will be performed until concrete is a least 3 day s old.

b. Required strengths will be shown on the Plans, as noted elsewhere in these Specifications, or as determined by the Engineer.

c. The Engineer may specify a minimum time in conjunction with minimum strength requirements.

d. Falsework and forms for culverts may be removed at such time as 75% of the concrete design strength is achieved.

AD. Apply Protective Surface Treatment

When the Plans specify a protective surface treatment, apply a boiled linseed oil mixture of 75 percent boiled linseed oil and 25 percent mineral spirits by volume to the concrete surfaces.

Use linseed oil that meets the requirements of ASTM D 260, Type I or Type II. Use a quality commercial mineral spirit that passes infrared spectroscopic analysis to the satisfaction of the laboratory.

Unless otherwise noted on the Plans or the manufacturer's recommendations, apply the mixture as a preservative seal coat to the top surfaces of bridge decks, curbs, and sidewalks and to the inside vertical faces of curbs, parapets, and end posts. Protect metal handrailing and metal handrail posts from treatment.

Apply the protective surface treatment as follows:

CAUTION: Because the linseed oil-petroleum spirits mixture has a low flash point and is readily flammable, protect the mixture from fire, especially cigarettes and sparks. Prohibit traffic from the treated area until the Engineer determines the concrete has regained its dry appearance.

1. Do not place the protective surface treatment until concrete work, including final rubbing, is completed and expansion joint sealing compound is placed.
2. Do not apply the treatment until the concrete is at least 14 days old.
3. Unless otherwise permitted by the Engineer, apply the treatment when the temperature of the concrete and air is at least 50 °F (10 °C).
4. Apply in time to allow the treatment to dry thoroughly before allowing traffic, including haul traffic, on the structure.

   If the structure meets the following exceptions, apply the treatment after using the structure for hauling.

   - Temperature limitations prohibit application.

     The Engineer will send a written notification to the Contractor (or Bridge Contractor) if temperature requirements prohibit application.

   - The structure is absolutely required for hauling to complete a Contract.

     Request a written approval from the Engineer if hauling across a structure before the treatment is placed.
5. If applying the treatment after using the structure for hauling, thoroughly clean the surfaces to be treated to allow the treatment to penetrate completely.
6. If there are separate bridge and roadway Contracts, have the roadway Contractor clean the surfaces immediately upon request by the Engineer.
7. Prepare the surface for the treatment as follows:
   a. Clean off oil, grime, and loose particles that prevent the mixture from penetrating.
   b. Ensure that the concrete surfaces have at least 48 hours to dry after rainfall or wet cleaning operations.
   c. Immediately before applying the treatment, direct an air blast over the surfaces to remove dust.
   d. Mask the exposed plates of joints.
8. Apply the mixture by hand or by spraying in one application at the rate of 1 gal (1 L) of mixture per 37.5 yd^2 (8.5 m^2).
   a. Thoroughly clean the inside of spraying equipment before putting the surface treatment in.
   b. Keep spray nozzles within 18 in (600 mm) of the concrete unless otherwise directed by the Engineer, Plans, or manufacturer.

AE. Apply Graffiti-Proof Coating

When the Plans specify a graffiti-proof coating, apply the coating system to concrete surfaces or over special surface coatings. Use material that complies with Section 838.

Apply the coating as follows:

1. Clean loose particles, dirt, grease, oil, and other foreign particles off the surface.
2. Apply the coating according to the manufacturer's recommendations for:

- Weather conditions
- Material preparation
- Coating application
- Number of coats

AF. Expose New Concrete to Loads

Prohibit dead or live loads during or after construction except as described in this section. If using high early strength concrete, the Engineer may reduce time limitations if the concrete develops adequate strength.

1. Dead Loads on the Substructure

   After pouring footings, do not begin work on columns or piers for at least 12 hours.

   After pouring columns, do not begin cap construction for at least 24 hours.

   Do not place beams on caps or place falsework and forming for concrete T-Beam construction before the cap concrete reaches a minimum strength of 2,500 psi (17 MPa).

2. Dead Loads on the Superstructure

   If necessary, stockpile construction materials on decks within a complete unit (a simple span or continuous or cantilever unit) if the following conditions exist:

   - The deck concrete of the complete unit reaches its 28-day cylinder strength.
   - The deck concrete is at least 10 days old.
   - The curbs are at least 5 days old.

   The Engineer must approve the location, height, and spread of the loads.

   On composite-design bridges (those that have prestressed concrete beams or steel beams with shear connectors), do not pour curbs, parapets, or sidewalks until the deck concrete reaches a minimum strength of 1,500 psi (10 MPa) or is at least 3 days old.

3. Dead Loads on Concrete Box Culverts

   Do not backfill any section of a concrete box culvert until the last concrete placed in that section is at least 14 days old, unless early cylinder breaks indicate otherwise.

   If early cylinder breaks indicate that design strength has been achieved, backfill sections of culverts when the concrete placed last is at least 7 days old.

4. Live Loads—Pouring Equipment

   Do not allow power-operated concrete buggies to cross a deck until the concrete reaches a minimum strength of 1,500 psi (10 MPa) or is at least 3 days old.

   Allow hand-operated buggies to cross after the concrete is 24 hours old.

5. Live Loads—Mixing and Lifting Equipment

   Do not place mixers on a deck in a complete unit (a simple span or continuous or cantilever unit) until the deck concrete of the complete unit reaches its 28-day cylinder strength and is at least 10 days old.

   When deck concrete reaches its 28-day cylinder strength and is at least 10 days old, allow mixer trucks on the unit during the curb concrete pour only if the pour is completed within 45 minutes of being started.

   Do not allow any equipment on the unit for 5 days after curb pours.

   The Engineer may allow concrete placement procedures that use heavy lifting equipment on the decks if the following conditions exist:

   - The deck concrete reaches its 28-day cylinder strength.

- The deck concrete is at least 14 days old.
- The curbs on the deck are at least 10 days old.

6. Live Loads—Hauling over Bridges

Use a new bridge for hauling only if no other practical haul routes are available and only if the Engineer permits it.

a. Govern hauling by the restrictions and requirements listed in Table 8. If any of the restrictions and requirements are violated, the Engineer will limit loads to the following:

- Single 32,000 lb (14 515 kg) axle when the bridge design loading is HS 20-44 and/or Military Loading
- Single 24,000 lb (10 886 kg) axle when the bridge design loading is HS 15-44 or H 15-44

Table 8—Weight Limits for Hauling on New Bridges

Axle Criteria	Bridge Design Loading	
	HS 20-44 and/or Military Loading	**HS 15-44 or H 15-44**
Maximum Axle Load Per Axle	60,000 lbs (27 216 kg)	44,000 lbs (19 958 kg)
Maximum Axle Load on Dual Axles Per Axle	45,000 lbs (20 412 kg)	33,000 lbs (14 969 kg)
Maximum Total Load	100,000 lbs (45 360 kg)	73,000 lbs (33 113 kg)

b. Ensure that bridge concrete, including curbs, parapets, barriers and sidewalks, is at least 14 days old and has a minimum compressive strength of 3,000 psi (20 MPa).

c. Apply the linseed oil special protective treatment, if required see (Subsection 500.3.05.AD, "Apply Protective Surface Treatment").

d. After applying the protective treatment (if required), apply water-repellent silicone materials to the handrail, handrail posts, end posts, and curb faces before hauling begins.

e. Do not allow more than one vehicle at a time on a simple or multiple-span unit.

f. Ensure that vehicle speeds, loaded or unloaded, do not exceed 5 miles/hr (8 km/hr) when the following loads occur:

- Bridges designed for HS 20-44 and/or Military Loading:

  —Loads on single axles exceed 32,000 lbs (14 515 kg)

  —Loads on each dual axle exceed 24,000 lbs (10 886 kg)

- Bridges designed for HS 15-44 or H 15-44 loading:

  —Loads on single axles exceed 24,000 lbs (10 886 kg)

  —Loads on each dual axle exceed 16,000 lbs (7257 kg)

When axle loads do not exceed these loads, ensure that vehicle speeds are 15 mph (24 kph) or less.

g. Place temporary guides on beams so wheels will track directly.

h. Keep earth approaches smooth and level with the bridge floor or approach slab to minimize impact. Stabilize sandy and other unstable soils (at no expense to the Department) with crushed stone or other suitable material for at least 10 ft (3 m) from the end of the bridge or approach slab.

i. Protect the ends of bridges or approach slabs with a timber strip at least 4 in (100 mm) wide, cut to rest on either the paving rest of the bridge end or the pavement subgrade at the end of the approach slab. Keep the strip in place for protection during incidental hauling. Remove it before constructing the adjacent pavement.

Keep the top of each timber strip flush with the top of the concrete surface. Fit the strip tightly against the end of the bridge or approach slab. If the timber strip is displaced, stop hauling until the strip is reset or replaced.

j. Clean spills off the bridge floor.

AG. Complete Corrective Work

After the Department gives the deck surface a Ride Quality Test described in Subsection 500.3.06.E, “Ride Quality Test,” complete corrective work at no cost to the Department and before doing the final surface texturing.

Complete corrective work as follows:

1. Plane the deck according to Section 431.
2. Limit concrete removal by planing so that the final bar cover is not less than the Plan cover minus 1/2 in (13 mm).
3. If the final bar cover limits cannot be met, perform the corrective work as directed by the Engineer.
4. Ensure that the final riding surface complies with this Specification and the requirements for a grooved finish.
5. If necessary, use a bump grinder to correct bumps with a profile base line of 5 ft (1.5 m) or less.
6. Have planed decks retested as described in Subsection 500.3.06.E, “Ride Quality Test,” to ensure that the ride quality meets the requirements of this Specification.

AH. Plane the Deck

Schedule the ride quality test at least 5 days before needed by contacting the Office of Materials and Research. Ensure that the area to be tested is clean and clear of obstructions.

When possible, delay expansion joint installation and temporarily bridge the joint to operate Lightweight Profiler and planning equipment across the joint.

Planning responsibilities are shown in Table 9:

Table 9—Planning Responsibilities

Area Planed	Person Responsible
Bridge decks	Bridge Contractor
Approach slabs constructed under the bridge Contract	Bridge Contractor
Approach slabs constructed under the roadway Contract	Roadway Contractor

AI. Perform Retaining Wall Incidentals

Retaining wall incidentals are as follows:

1. Drainage

   Unless otherwise shown on the Plans or in the Special Provisions, ensure that drainage for retaining walls is either Alternate A or Alternate B on Georgia Standards 4948 and 9031-L.

   Ensure that the Number 10 concrete sand complies with Subsection 801.2.02, “Fine Aggregate for Portland cement Concrete of All Types and for Mortar” and has a permeability coefficient of at least 100 ft (30 m) per day.

   The Engineer may waive the grading requirement for Number 10 concrete sand if the permeability coefficient of the material does not exceed 500 ft (150 m) per day.

   Omit the drainage blanket and stone for retaining walls only when the height does not exceed 6 ft (1.8 m).

   When the Plans specify different drainage details, furnish, place, or build the various items according to the Plan requirements.

2. Waterproofing and Dampproofing

   When waterproofing and dampproofing are specified in the Plans, comply with the requirements of Sections 530 and 531.

AJ. Place Utility Installation Hardware

When the Plans require placing utility installation hardware, the utility company involved will furnish the items.

Place the items as directed on the Plans or Shop Drawings. All other work, including painting as required, is the utility company's responsibility.

AK. Widen Bases and Pavement

When using narrow sections of Portland cement concrete to widen existing bases or bases and pavements, use Class B concrete as shown on the Plans or as directed by the Engineer.

AL. Open the Structure to Traffic

Open a structure to traffic other than haul traffic after all concrete in the decks, parapets, or curbs (sidewalks) reaches its 28-day cylinder strength and is at least 14 days old.

500.3.06 Quality Acceptance

A. Strength Requirement Tests

When job site test specimens fail to meet the strength requirements in the Table 1—Concrete Mix Table , determine the Final Acceptance or rejection of concrete in place by coring or non-destructive testing.

At the Contractor's request, the Department will determine the removal time for forms by conducting field tests on cylinders.

Tests are subject to the following:

1. Tests will be performed when the concrete is at least three days old.
2. The Plans will show the required strengths.
3. At the Contractor's request, the Engineer may specify a minimum time with minimum strength requirements.

B. Honeycombed Area Check

If there are honeycombed areas that extend beyond the reinforcement steel, the Engineer may reject the entire pour with the honeycombed area.

C. Bridge Deck Slab Concrete Inspection

The Engineer will carefully observe the construction methods used during all phases of the bridge deck slab construction. These phases include the following:

- Metal form installation
- Reinforcement location and fastening
- Concrete item composition
- Mixing procedures
- Concrete placement and vibration
- Bridge deck finishing

Provide the needed facilities for the Engineer to safely and conveniently inspect the concrete.

The concrete inspection procedure is as follows:

1. After the deck concrete has been in place for at least two days, the Engineer will sound a hammer on at least two areas of the deck for each slab pour. This test checks for concrete soundness and form bonding.

   The two areas will encompass at least 10 percent of the total area of the deck pour.
2. The Engineer will sound other areas of the deck randomly.
3. If the Engineer doubts the soundness of an area, or if the Engineer decides that the concrete placement procedures used call for an inspection of the underside of the deck, remove at least one section of the forms for each span in the Contract.

4. Remove the form section after the pour is strong enough and when the Engineer desires to provide visual evidence that the concrete mix and the placement procedures are acceptable.
5. Remove another form section if the Engineer decides changes in the concrete mix or in the placement procedures warrant additional inspection.
6. Where form sections are removed, do not necessarily replace the forms, but repair the adjacent metal forms and supports neatly and securely.
7. When the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects.
8. If the Engineer finds irregularities but determines that the irregularities do not justify rejection of the Work, repair the concrete as the Engineer directs and give it an ordinary surface finish according to the Contract Specifications.
9. If the concrete where the form is removed is not acceptable, remove additional forms as necessary to inspect and repair the slab.
10. Modify the construction methods as required by the Engineer to create satisfactory slab concrete.
11. Remove or repair all unsatisfactory concrete as the Engineer directs.

    If the construction methods used and the inspection results indicate that the slabs have sound concrete, the Engineer may moderate the amount of random sounding and form removal after a substantial amount of slab has been constructed and inspected.

D. Bridge Deck Surface Check

After the final strike-off of the concrete and as close behind the final strike-off as possible, the Engineer will check the surface with a 10 ft (3 m) straightedge.

Attach the straightedge to a broom-type handle for easy control and use.

Bridges and approach slabs must meet a 1/8 inch in 10 ft (3 mm in 3 m) straightedge check made longitudinally and transversely.

E. Ride Quality Test

After the bridge decks and approach slabs are completed, the Department will perform a Ride Quality Test using the Lightweight Profiler and a profile index value determined according to GDT 134.

The Department will conduct the test as follows:

1. Obtain Profile Index Values for bridge decks and approach slabs for:
    - State roads with four lanes or more
    - State roads with 2 lanes where the current traffic count is 2,000 vehicles per day or higher
    - Other roads designated on the Plans

    Bridges and approach slabs must meet the straightedge check limits described in Subsection 500.3.06.D, “Bridge Deck Surface Check.”
2. Obtain profiles in the wheel paths and in safety areas to within 6 ft (1.8 m) of barrier or curb lines.
3. Average the profile index values for bridge decks including the approach slabs for the left and right wheel path for each lane.

    The average value must not exceed 15 in/mile (235 mm/km) for each lane.

After the test is complete, correct individual bumps or depressions that exceed 2/10 in (5 mm) from the blanking band on the profiler trace.

The deck surface must then meet a 1/8 inch in 10 ft (3 mm in 3 m) straightedge check made transversely.

Correct bridge decks and approach slabs that do not pass the Ride Quality Test as described in Subsection 500.3.05.AG, “Complete Corrective Work.”

500.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

500.4 Measurement

This work is measured for payment either per cubic yard (meter), per Lump Sum, or per linear foot (meter), whichever is shown on the Plans.

- Seal Concrete. The quantity of seal concrete to be measured for payment is calculated using the horizontal seal dimensions specified on the Plans.
- Grooving. Grooving on bridge decks and approach slabs, completed acceptably according to Subsection 500.3.05.T, "Place Bridge Deck Concrete," step 9.c, will be measured and paid for by the square yard (meter). Payment is full compensation for furnishing the necessary equipment and performing the Work.
- Class B Concrete. Class B concrete used for base and pavement widening will be measured and paid for by the cubic yard (meter) complete in place and accepted.

500.4.01 Limits

A. Measurement for Separate Payment

There will be no separate measurement and payment for the following:

1. On permanent steel bridge deck forms for concrete deck slabs:
   - Extra reinforcing
   - Extra concrete
   - Other costs incurred because of the requirements of this Specification

   All costs are included in the Lump Sum prices bid for superstructure concrete and superstructure reinforcement.

B. Payment per Cubic Yard (Meter)

Measurement limits on payment per cubic yard (meter) are:

1. Bridges, Concrete Culverts, Headwalls, and Retaining Walls

   The quantity of concrete measured for payment is the algebraic summation of the Base Pay Quantity and authorized quantity changes.

   If additional quantities are necessary because of any of the following, these quantities are measured separately for payment:
   - Rocks were removed carefully but additional quantities are needed because footing depth and keyway dimension are irregular from unanticipated rock removal.
   - Voids or crevices exist within the spread footing area.
   - The Engineer authorized filling trenches cut in rock outside footing areas to ease dewatering.

   These additional quantities will be paid as filler concrete per cubic yard (meter).

2. Seals

   When the Plans do not require a seal but a seal becomes necessary, or when the Plans do not show seal dimensions, the maximum pay dimensions in each direction will be the Plan dimension of the structural footing plus 3 ft (1 m), with 18 in (600 mm) on each side.

   If the Contractor uses lesser dimensions, measurement is based on the lesser dimensions. Concrete placed beyond the maximum pay limits are not measured.

C. Payment per Lump Sum

For Lump Sum payment, determine the quantities required before submitting the bid.

The concrete quantity must conform to the Plan dimensions. Measurement is made as a unit, complete in place, and includes the following:

- Diaphragms
- Sidewalks
- Concrete parapets

Measurement does not include concrete in the following items that will be paid for separately:

- Concrete handrailing
- Barriers
- Prestressed bridge members.

Payments for parapets placed by slip-form method is included in the Lump Sum price bid for superstructure concrete.

Unless otherwise shown on the Plans, the cost of steel joints and metal bearing assemblies used in structures where there is no structural steel Pay Item are included in the Contract Price for superstructure concrete.

D. Retaining Wall Incidentals

Retaining wall incidentals will be measured for payment as follows:

1. Drainage Systems

   Drainage items required by Special Plans are measured for payment by the unit specified on the Plans only when they are set up as specific Pay Items and are paid for separately. Otherwise, their costs are included in the Contract Price for concrete.

   Payment is full compensation for the costs of excavation and backfill necessary to place the drainage items required by Special Plans.

   The following are not measured for separate payment. Costs are included in the Contract Price for concrete.

   - Sand blankets
   - Crushed or broken stone
   - Weep holes

2. Miscellaneous

   The following are not measured for separate payment. Costs are included in the Contract Price for concrete.

   - Expansion material
   - Rubber or polyvinyl plastic water stops

E. Utility Installation Hardware

The cost of placing utility hardware items is included in the Contract Price for the class of concrete the items are placed in.

500.5 Payment

This Work will be paid for at the Contract Price per cubic yard (meter), per Lump Sum, or per linear foot (meter), each complete in place and accepted.

Payment is full compensation for all things, including incidentals, and direct and indirect costs, to complete the Work.

Payment will be made under:

Item No.	Item	Payment
500	Superstructure concrete class_____, Bridge no._____	Per lump sum
500	Concrete handrailing (designation)	Per linear foot (meter)
500	Class_____concrete	Per cubic yard (meter)
500	Class_____concrete, high-early strength	Per cubic yard (meter)
500	Seal concrete	Per cubic yard (meter)
500	Class B concrete base or pavement widening	Per cubic yard (meter)
500	Class_____concrete including reinforcement steel	Per cubic yard (meter)
500	Class A concrete—filler	Per cubic yard (meter)
500	Class_____concrete—retaining wall	Per cubic yard (meter)
500	Grooved concrete	Per square yard (meter)
500	Concrete barrier	Per linear foot (meter)

500.5.01 Adjustments

A. Contractor Costs

Assume the following costs:

1. Costs related to rejected concrete and removing rejected concrete
2. Costs of forming an approved construction joint, removing a partial pour, or completing other remedial measures requested by the Engineer unless the fault lies solely with the Department
3. Costs of repairing, removing, and replacing falsework as directed by the Engineer
4. Costs of repairing, removing, or replacing forms
5. Costs of air-blown mortar to repair honeycombed areas, if required by the Engineer
6. Costs of using a higher class of concrete to widen existing bases or bases and pavements

B. Ride Quality Testing

The Department will conduct ride quality testing of bridge decks and approach slabs only twice per bridge at no cost to the Contractor.

The Department will conduct additional ride quality testing at the cost of $500 per test.

C. Plastic Shrinkage Crack Repair

The Engineer will determine how to repair cracks caused by plastic shrinking. Repair cracks at no cost to the Department.

D. Plan Quantities

For all bridges (except seal concrete), concrete culverts, headwalls, and retaining walls, the quantities shown on the Contract Plans, including Standard Plans, will be considered the Base Pay Quantity.

For seal concrete, the Plan quantities are approximate and are for estimating purposes only. The quantities will not be considered as Base Pay Quantities.

Calculated additions or deductions will be applied to the Base Pay Quantity when the Engineer makes authorized changes. Changes include, but are not limited to, authorized changes in the following:

- Footing dimensions
- Lengthening or shortening of concrete culverts
- Correcting Plan Quantities

- Dimension errors
- Multi-barrel culvert wall thicknesses
- Lengthening or shortening bridge columns
- Raising or lowering foundations

Calculations of the Base Pay Quantity and any changes will be made as follows:

1. No deductions will be made for the volume of concrete used by scorings, panels, and chamfers if the individual areas are less than 1 in^2 (625 mm^2).

   The volume of concrete in fillets of the same area will be neglected.

2. The volume of structural steel and of steel and concrete piling encased in concrete will be deducted.
3. The volume of timber piling encased in concrete will be deducted on the basis of 0.8 ft^3/linear foot (0.07 m^3/linear meter) of pile.
4. No deduction will be made for the volume of concrete displaced by the following:
   - Steel reinforcement
   - Shear connectors
   - Floor drains (unless they are paid for as separate Pay Items)
   - Incidentals such as expansion material
   - Joint sealing compound
   - Utility thimbles and hangers

E. Filler Concrete

Filler concrete, measured as described in Subsection 500.4.01.B.1, “Bridges, Concrete Culverts, Headwalls, and Retaining Walls,” will be paid at 40 percent of the Contract Price per cubic yard (meter) for Class A Concrete or Class AA Concrete.

F. Seal Concrete

If there is no Contract Price for seal concrete, payment will be per cubic yard (meter), measured as described in Subsection 500.4.01.B.2, “Seals,” and will be paid at 60 percent of the Contract Price per cubic yard (meter) for Class A concrete.

G. Lump Sum Payment Adjustments

Adjust the payment as follows:

1. Authorized Change Adjustments

   When authorized changes are made as described in Subsection 500.5.01.D, “Plan Quantities,” the lump sum payment may be adjusted on a pro rata basis or according to Section 104 and as determined by the Engineer.

   The Plans show tabulated quantities as a service. This does not relieve any responsibility to conform to Plan details.

2. Optional Plan Feature Adjustments

   If exercising an optional Plan feature, the Base Pay Quantity will not be changed if it is the only quantity change involved.

   However, if other changes are necessary, the quantity change resulting from the optional feature will be considered in the necessary quantity adjustments.

3. Falsework for Post-Tensioned Box Girder Bridge Adjustments

   When the falsework is completed for post-tensioned box girder bridges, 20 percent of the Lump Sum superstructure concrete price will be paid.

Additional payments made as the concrete is placed must be adjusted for the payment for falsework. In other words, payment for concrete placed will be based on 80 percent of the superstructure bid price.

4. When Metal Deck Forms are used and have been placed, payment in the amount of 5% of the Lump Sum Superstructure Concrete price will be made. For Post-Tensioned Box Girder Bridges, this percentage (5%) will apply to that part of the superstructure concrete in the top slab of the box only.

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January 20, 2006

Section 501—Steel Structures

Delete Subsection 501.1 and substitute the following:

501.1 General Description

This work includes furnishing and building with structural steel and miscellaneous metals to the lines, grades, and dimensions shown on the Plans or established by the Engineer.

The work does not include bearing devices for prestressed concrete bridge members, utility installation hardware, or any metal covered under another Pay Item.

501.1.01 Definitions

HTS Bolts: High Tensile-Strength bolts.

501.1.02 Related References

A. Standard Specifications

Section 109—Measurement and Payment

Section 500—Concrete Structures

Section 512—Shear Connectors

Section 535—Painting Structures

Section 851—Structural Steel

Section 852—Miscellaneous Steel Materials

Section 854—Castings and Forgings

Section 857—Bronze Bushings, Bearings, and Expansion Plates

Section 870—Paint

Section 881—Fabrics

Section 885—Elastomeric Bearing Pads

B. Referenced Documents

ANSI/AASHTO/AWS D 1.5

AISC Manual of Steel Construction

ANSI B1.13 Class 2A

ANSI 2.5, 3.2, 6.3, 12.5, 25, 46, 46.1 Part 1, 50

ASTM A 6/A 6M

ASTM A153/A 153M

ASTM A 325 (A 325M)

ASTM A 490 (A490M)

ASTM A 919

ASTM F 568M Class 4.6

501.1.03 Submittals

A. Pre-Inspection Documentation

Furnish documentation required by the latest ANSI/AASHTO/AWS D 1.5 under radiographic, ultrasonic, and magnetic particle testing and reporting to the State's inspector before the quality assurance inspection.

B. Shop Drawings

Prepare Shop Drawings for structural steel and other metal materials to be fabricated. Show the details necessary for shop fabrication and field erection.

1. **Description**. Use the standard sheet size of the Department's Bridge Office. Submit at least two complete sets of preliminary prints marked "NOT FOR FIELD USE" to the Department's Bridge and Structural Design Engineer (the Bridge Engineer) for review before fabricating materials.

   As an option, shop drawings may be submitted on plan sheet sizes of 12" x 18" (305 mm x 457 mm) or 11" x 17" (279 mm x 432 mm) for review and approval. Information contained on these sheets must be legible.

   After shop drawings have been approved, submit an electronic file that is compatible with Bentley Microstation J (Version 7) Cadd operating system, or an electronic file in Adobe Acrobat Portable Document Format (.pdf) to the Engineer. For bridges carrying railroads only, after shop drawings have been approved, submit one full size set of reproducible drawings to the Department.

2. **Review Process**. After the preliminary prints have been reviewed and revisions have been made, submit 5 or more complete sets of the final drawings to the Bridge Engineer. The Bridge Engineer will mark each drawing with a conditional approval stamp and return one stamped set to the fabricator. Furnish the Bridge Engineer with as many additional sets of final prints as required.

   The Bridge Engineer's review and conditional approval of Shop Drawings is a service for the Contractor. The Department assumes no responsibility for the accuracy of the drawings, and the Contractor will not be relieved of any responsibility for conforming to the Specifications and Plans.

3. **Railway Structures**. For structures carrying railway traffic and for other structures when specifically designated, furnish the Bridge Engineer a full set of permanent reproducibles of the final Shop Drawings.

4. **Welded Construction**. On Shop Drawings for welded construction, use the standard welding symbols of the American Welding Society. Explain special conditions in notes or details. Show the sequence and techniques for areas where shrinkage stress and distortion control is necessary.

5. **Changes and Substitutions**. Do not change a Shop Drawing after it has been conditionally approved unless the Bridge Engineer gives written consent. List and symbolize revisions on each drawing.

   Obtain written consent from the Bridge Engineer before substituting materials with dimensions and weights other than those shown on the Plans. Make changes associated with an approved substitution at no expense to the Department.

6. **Alternate Locations of Splices and Connections**. If splices or connections are desired at locations other than those shown on the Plans, submit a proposal and Shop Drawings to the Bridge Engineer to get written approval before proceeding.

7. **Steel Identification**. Upon request, furnish an affidavit certifying the identification of steel is maintained throughout fabrication.

On the Shop Drawings, show the grade of steel to be used and identify each piece. Give pieces made of different types or grades of steel different assembly or erection marks.

Maintain the identity of the mill test report number when assembly-marking individual pieces and when giving cutting instructions to the shop.

C. Fabrication Schedule

Ensure that the fabricator submits a proposed fabrication schedule to the State Materials and Research Engineer that includes the following:

- Correct project number, including county
- Bridge number
- Starting date
- Estimated completion date

D. Quality Control Program

Before fabrication begins, submit the fabricator's written Quality Control program to the Office of Materials and Research for approval. This program and its personnel will be subject to verification when the Department's Materials and Research Engineer deems necessary.

Even with a State inspection, continue to perform Quality Control (QC) on all nonfracture-critical and fracture-critical members and components.

E. Mill Orders and Shipping Statements

Furnish the number of copies of mill orders and shipping statements covering fabricated materials and related miscellaneous materials the Engineer directs. Show the weights of individual members on the statements.

F. Mill Test Reports

Furnish the Engineer two certified, legible copies of mill test reports that show the results of physical tests and complete ladle analyses for each heat and grade of steel ordered. Refer to the ASTM designation of tests used. Furnish mill test reports at no expense to the Department.

G. Welding Procedures

Before structural steel fabrication begins, submit welding procedures to the Engineer for review and approval.

H. Electrode Testing

Furnish a manufacturer's certification showing that the material requirements used for manufacturing the tested electrodes and furnished electrodes were the same for each lot of electrodes on the Project.

I. Falsework

If required, prepare and submit falsework plans for the Engineer's review. Continue to assume the responsibility to produce safe falsework. When erection is completed, remove falsework to the Engineer's satisfaction.

J. Camber Diagram

Furnish the Engineer a diagram showing the camber at each splice point for each girder. Base the diagram on measurements taken during shop assembly. In the case of partial shop assembly, base the camber diagram on theoretical calculated values.

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January 20, 2006

Section 507—Prestressed Concrete Bridge Members

Delete Subsection 507.1 and substitute the following:

507.1 General Description

This work consists of furnishing prestressed concrete bridge members, complete in place, except as noted for piling in this Specification. The work includes all items and work necessary to complete the erection according to the Plans and Specifications. All prestressed concrete bridge member nominal lengths shown on the plans are horizontal dimensions. The contractor will be responsible for adjusting the lengths, as necessary, to account for the final erected position of the member. Fabricate the ends of all members to be vertical in the final erected position. Slope bearing assemblies to accommodate the erected position of the member.

507.1.01 Definitions

PSC: Prestressed concrete. Prestressed concrete may be designated “PSC” in Specifications and on Plans and other documents.

507.1.02 Related References

A. Standard Specifications

Section 109—Measurement and Payment

Section 500—Concrete Structures

Section 501—Steel Structures

Section 506—Expanded Mortar

Section 520—Piling

Section 865—Manufacture of Prestressed Concrete Bridge Members

B. Referenced Documents

General Provisions 101 through 150.

507.1.03 Submittals

A. Erection Drawings

Furnish erection drawings to the Department only when the units are not interchangeable with respect to the following:

- Transverse placement within a span
- Longitudinal reversal within a span

The drawings shall cover superstructure unit placement, including bearing components.

B. Shop Drawings

Submit shop drawings to the Department on standard Plan size 22 in x 36 in (550 mm x 900 mm) sheets showing complete beam details of the following:

- Nonprestressed reinforcement
- The method of retaining depressed strands in place
- Calculations for determining the strand elongation required to produce the specified pretensioning force
- Detensioning schedule
- Increased length of beam due to vertical alignment

As an option, shop drawings may be submitted on plan sheet sizes of 12” x 18” (305 mm x 457 mm) or 11” x 17” (279 mm x 432 mm) for review and approval. Information contained on these sheets must be legible.

After shop drawings have been approved, submit an electronic file that is compatible with Bentley Microstation J (Version 7) Cadd operating system, or an electronic file in Adobe Acrobat Portable Document Format (.pdf) to the Engineer. For bridges carrying railroads only, after shop drawings have been approved, submit one full size set of reproducible drawings to the Department.

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January 20, 2006

Section 509—Prestressing Concrete by Post Tensioning

Delete Subsection 509.1 and substitute the following:

509.1 General Description

This work consists of prestressing concrete by post-tensioning cast-in-place concrete. The work includes furnishing, placing, and tensioning prestressing steel according to the Plan details and these Specifications.

509.1.01 Definitions

Working Force and Working Stress: The force and stress remaining in the prestressing steel after the following losses:

- Creep and shrinkage of concrete
- Elastic compression of concrete
- Creep of steel
- Loss in post-tensioned prestressing steel from the sequence of stressing
- Friction and anchor set (see Subsection 509.3.05.J, "Post-Tension the Tendons," steps 18 to 19)
- Other losses peculiar to the method, technique, or system of prestressing (see Subsection 509.3.05.J, "Post-Tension the Tendons," step 21)

509.1.02 Related References

A. Standard Specifications

Section 501—Steel Structures

Section 535—Painting Structures

B. Referenced Documents

AASHTO Specifications for Highway Bridge, Article 9.16.1

AASHTO Specifications for Highway Bridge, Article 9.16.2

ASTM C 109

ASTM A 416

ASTM A 722

ASTM C 939

509.1.03 Submittals

A. Coupler Use and Location

The use and location of couplers in bars entering into the prestressing work is subject to the Engineer's approval.

B. Alternate Stressing or Anchorage Block Drawings and Calculations

When using stressing or anchorage blocks not shown on the Plans, submit shop drawings and calculations for the blocks to Bridge and Structural Design when submitting the prestressing system calculations and shop drawings.

C. Design Calculations

Submit design calculations for the proposed post-tensioning system to Bridge and Structural Design for Department review and approval. Design calculations may be on letter size sheets.

Submit calculations for the size and spacing of the reinforcing around the ducts, as shown in Figure 1 (metric), to Bridge and Structural Design. Include the following in the calculations:

- Required jacking force and elongation of tendons during tensioning

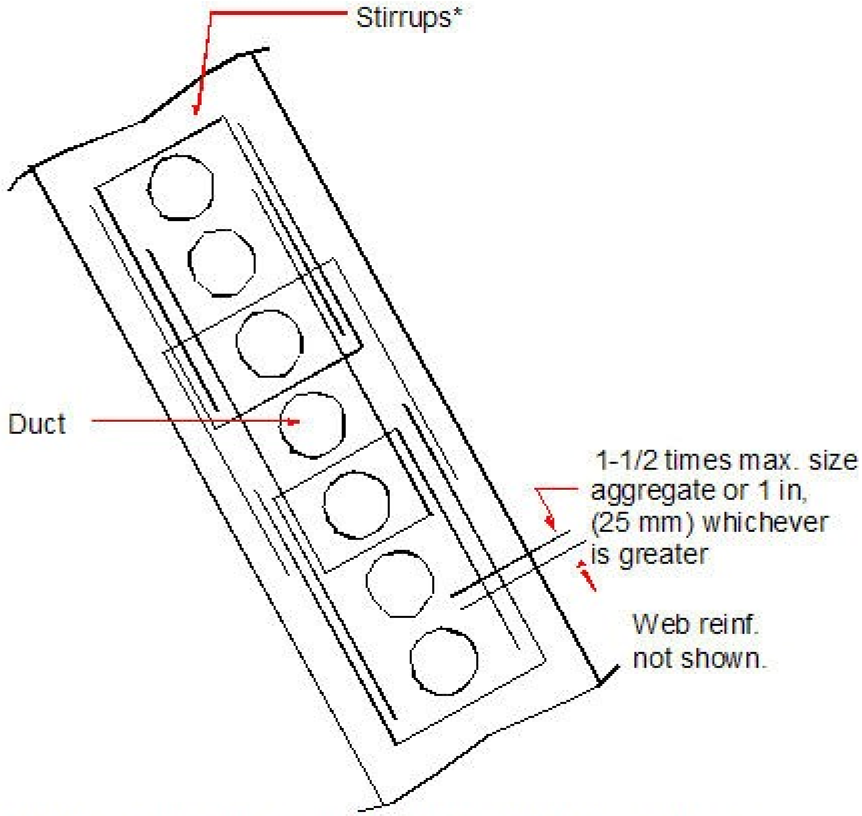
  Using the initial jacking force, design the reinforcing to prevent ducts from pulling out because of the effects of web curvature and slope.

- Stresses in anchorages and distribution plates

  Ensure that the calculations account for reinforcing to prevent the peeling of anchorages from the top and bottom slab. See Figure 2 (metric) for minimum reinforcing requirements for tying ducts to the deck reinforcing.

- Stress-strain curves typical of the prestressing steel to be furnished
- Seating losses
- Temporary overstresses
- Reinforcing in the concrete to resist tensioning loads

Determine bearing offsets and expansion joint gaps and adjust for construction sequence, prestress shortening, and temperature.



* A stirrup group is one pair of overlapping "U" shaped bars.

- Stirrups shall enclose vertical web reinforcement.
- No more than 3 ducts shall be enclosed by a stirrup group.
- Min. bar size: No. 4 (No. 13 M) bar.
- Max. longitudinal bar spacing: 24 in. (600 mm)

Figure 1 (metric)

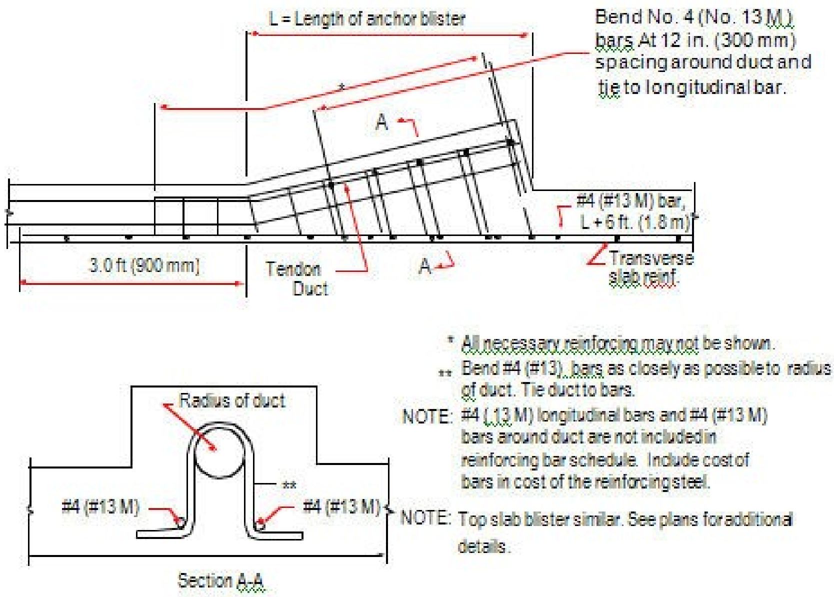


Figure 2 (metric)

D. Certificates of Compliance

The Department will accept certificates of compliance for cements to be used. The Department reserves the right, however, to sample and test the cement before its use and at any time during the progress of the work.

E. Certified Mill Test Reports

Submit certified mill test reports for high tensile prestressing steel to the Project Engineer.

F. Shop Drawings

Submit Shop Drawings for review and approval according to Subsection 501.1.03.B, “Shop Drawings.” Place a title block in the lower right-hand corner of the drawings that includes the following:

- Project number
- Sheet numbering for the Shop Drawings
- Structure name
- Contractor and fabricator names

Submit Shop Drawings on 23 in by 36 in (575 mm by 900 mm) sheets with a 1-1/2 in (38 mm) left margin and a ½ in (13 mm) top, bottom, and right margins.

The Shop Drawings shall include the following:

1. Fully dimensional views showing all projections, recesses, notches, openings, blockouts, and pertinent design details

2. Details of mild steel reinforcing showing size, spacing, and location, including special reinforcing required as determined by the design calculations but not shown on the Plans
3. Details of ducts for post-tensioning tendons showing size, type, and horizontal and vertical profiles
4. Details of duct supports, grout tubes, and vents showing size, type, and location
5. Details of the relative positions of reinforcing steel, ducts, and anchorages
6. Details of the anchorage systems for the proposed post-tensioning system
7. A table giving jacking sequence, jacking forces, and initial elongation of the tendons at each erection stage for post-tensioning
8. Details and a complete description of the post-tensioning system to be used for permanent tendons
9. Details of the prestressing, including:
    - Method, sequence, and procedure for prestressing and securing tendons
    - Procedure for releasing tendons
    - Equipment supplier and type
    - Tendon size and properties
    - Anchorage plates and assemblies
10. Information on grouting, including:
    - Grout mix design
    - Method of mixing and placing the grout
    - Type and capacity of grouting equipment
11. Working drawings and bar schedules for each prestressing system
12. Details of reinforcing or coil ties under anchorage plates
13. Details for usage of high-strength steel bar (furnished by the bar manufacturer)
14. Friction factors used in the prestressing system of deformed bars

As an option, shop drawings may be submitted on plan sheet sizes of 12” x 18” (305 mm x 457 mm) or 11” x 17” (279 mm x 432 mm) for review and approval. Information contained on these sheets must be legible.

After shop drawings have been approved, submit an electronic file that is compatible with Bentley Microstation J (Version 7) Cadd operating system, or an electronic file in Adobe Acrobat Portable Document Format (.pdf) to the Engineer. For bridges carrying railroads only, after shop drawings have been approved, submit one full size set of reproducible drawings to the Department.

G. Ram Calibration Charts

Before using rams in the work, furnish the Engineer with a certified chart from the calibration for each ram.

H. Designs and Details of Distribution Reinforcing Steel

The Department plans for anchorages show only a minimum amount of distribution reinforcing steel.

Design and detail the reinforcement needed to prevent bursting, peeling, and splitting. Submit the designs and details to the Engineer for review and approval.

I. Gauge Readings and Elongations

Keep a record of gauge pressures or readings and elongations at the end of each jacking operation and submit it to the Engineer for review and approval.

January 20, 2006

Section 535—Painting Structures

Delete Section 535 and substitute the following:

535.1 General Description

This work consists of painting new and existing steel structures, steel H-piling and metal shell piling, and steel swaybracing. The work includes applying special protective coatings to piling and swaybracing, complete in place. The work also includes protecting traffic and property.

535.1.01 Definitions

EPA: Environmental Protection Agency

OSHA: Occupational Safety and Health Administration

PCCP: Painting Contractor Certification Program

QP1: SSPC Contractor Certification program evaluates contractors who perform surface preparation and industrial coating application on steel structures in the field.

QP2: SSPC Contractor Certification program evaluates the contractor's ability to perform industrial hazardous paint removal in a field operation. Two QP 2 categories are available based on the type of equipment and containment:

- Category A - Negative Air Containment
- Category B - No Negative Air Containment

SSPC: The Society for Protective Coatings

535.1.02 Related References

A. Standard Specifications

Section 107—Legal Regulations and Responsibility to the Public

Section 501—Steel Structures

Section 520—Piling

Section 647—Traffic Signal Installation

Section 870—Paint

B. Referenced Documents

SSPC-Guide 6, Guide for Containing Debris Generated During Paint Removal Operations

SSPC-Guide 7, Guide for the Disposal of Lead-Contaminated Surface Preparation Debris

SSPC-SP 6/NACE No. 3, Commercial Blast Cleaning

SSPC-SP 7/NACE No. 4, Brush-Off Blast Cleaning

OSHA Standards 29 CFR 1910 and 29 CFR 1926

EPA "Uniform Hazardous Waste Manifest"

EPA Method 1311, "Toxicity Characteristics Leaching Procedure (TCLP)"

535.1.03 Submittals

Provide evidence to the Department prior to beginning The Work that any Contractor or Subcontractor that performs surface preparation or coating application is currently QP1 certified by the Society for Protective Coatings (SSPC).

Provide evidence to the Department prior to beginning The Work that any Contractor or Subcontractor performing cleaning, rehabilitation, and painting work on bridge components coated with lead based paint or paint containing hazardous material is currently QP2, Category "A" certified by the Society for Protective Coatings (SSPC).

At the Preconstruction Conference or at least four (4) weeks before mobilization, make the following submittals to the Engineer for acceptance as appropriate:

A. Health and Safety Responsibilities

Provide effective engineering and work practice controls to protect employee health and safety.

1. Comply with all relevant Environmental Protection Agency (EPA), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Occupational Safety and Health Act (OSHA), and Environmental Protection Division (EPD) Regulations.
2. Certify to the Engineer that personnel involved with lead paint removal operations (including rigging and material handling personnel) have received training and understand the applicable parts of the latest edition of OSHA Standards 29 CFR 1910 and 29 CFR 1926, including any amendments. Have the certification signed by all personnel involved with lead paint removal.
3. Provide test results from an OSHA Certified Laboratory showing blood lead levels of employees that may be exposed to lead during the Project.
4. Provide a medical monitoring schedule to verify acceptable blood lead levels during the Project and after the Project is completed.

B. Blast Cleaning Containment System

1. Before beginning work at each bridge, submit design and drawings of the proposed containment system to the Engineer for review and approval. Include tarpaulin data sheets to verify that the material is airtight, and tightly secured at the seams. Do not use burlap or open weave materials.
2. When the proposed containment system will induce large loads on the existing structure, the Engineer may direct the Contractor to submit an analysis of the load that will be added to the existing structure by the containment system and blast waste. Have a licensed Professional Engineer registered in the State of Georgia with bridge experience perform and stamp the load analysis. Ensure that the analysis shows that the system will not induce a load on the bridge that overstresses it or affects the structural integrity of the bridge.
3. Do not allow the containment system or equipment to violate the minimum bridge clearances shown on the Plans, unless otherwise approved by the Engineer.

C. Emergency Contingency Plan

Submit to the Engineer for review and approval an emergency contingency plan for cleaning up spills from failure of the containment system, spent material recovery system, or storage containers. Define procedures for spills or releases of waste and indicate the training of workers handling the waste as required by RCRA.

D. Spent Material Sampling Plan

Submit in writing to the Engineer for review and approval the proposed method for collecting the spent material. Include a sampling plan that conforms to EPA SW849 or a statement of intent to use the DOT sampling plan (Subsection 535.3.03.B.9). This submittal will also include the name of the company(ies) and responsible person(s) that will sample, treat, and haul the spent material.

E. Material Safety Data Sheets

Submit Material Safety Data Sheets on the abrasive and paint materials that will be used.

F. Hazardous Waste Transporter Information

Provide the name and EPA identification number of each licensed Transporter used for shipping hazardous waste to a treatment, storage, or disposal facility.

G. Permitted Site Information

Provide the name and EPA identification number, phone number, and address for each permitted off-site treatment, storage, or disposal facility to which the waste will be shipped.

H. Accredited Laboratory Information

Provide the name of the Environmental Lead Laboratory Accreditation Program (ELLAP) accredited laboratory that will perform the TCLP tests.

I. Quality Control (QC) Program

Submit a written QC Program that identifies the following:

1. Instrumentation that will be used
2. Schedule of required measurements and observations
3. Procedures for correcting unacceptable work
4. Procedures for improving surface preparation and painting quality as a result of quality control findings
5. Names, qualifications, experience, and training of personnel who will be managing and implementing the QC program and conducting quality control tests.

Include the GA DOT Quality Control Daily Report form as supplied by the Engineer.

Include SSPC Painting Contractor Certification Program (PCCP) certifications.

The Engineer will forward a copy of these submittals to the Office of Materials and Research for review.

535.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Abrasives for Blast Cleaning	Note 1*
Paint	870
Note 1* Use low dusting mineral abrasives which contain a minimum of ten percent (10%) by weight G-80 steel grit blended homogeneously throughout the blasting abrasive or 100% steel grit. Alternate abrasive mixtures proposed by the Contractor require approval by the Office of Materials and Research before use. Abrasives shall contain no more than 100 ppm of any corrosive compound such as sulfate or chloride. Abrasives shall not contain EPA characteristic compounds such as lead, chromium, or arsenic which can be detected by the EPA Toxicity Characteristic Leaching Procedure (TCLP). The mineral abrasive used to blend with steel grit will be listed in the Department's Qualified Products Manual.	

535.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

535.3 Construction Requirements

535.3.01 Personnel

A. Contractor Certification

Provide the Engineer with documentation to ensure that all Contractors or Subcontractors that perform surface preparation or coating application are currently certified by the Society for Protective Coatings (SSPC) to the requirements of SSPC QP-1.

Provide the Engineer with documentation to ensure that all Contractors or Subcontractors that perform removal or disturbance of paint containing lead or other hazardous material are currently certified to the requirements of SSPC QP-2, Category A.

The painting Contractors and painting Subcontractors must remain so certified for the duration of the project. If a Contractor's or Subcontractor's certification expires, the company will not be allowed to perform any work until the certification is reissued. Notify the Engineer of any change in Contractor certification status, including certification expiration or certification renewal. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply.

535.3.02 Equipment

A. Brushes

Preferably, use brushes with round or oval cross sections. If using flat brushes, ensure that the maximum width is 4 in (100 mm).

For surfaces inaccessible to brushes, apply paint with sheepskin daubers made for painting.

Application of inorganic zinc by brush is prohibited except for small areas and touch up work.

B. Spray Equipment

If spraying paint, use air, cold airless, or hot circulating airless equipment. Spray equipment is subject to the Engineer’s approval.

Use spray equipment that can constantly agitate the paint. Also, use equipment with a device that thoroughly mixes paints in their shipping containers before the paints are removed.

Water traps are required as follows:

- When using air spray equipment, ensure that the air lines in the system have suitable water traps.
- For cold airless spray equipment, water traps are not required in the air lines; use them if desired.

C. Rollers

Rollers are subject to the Engineer’s approval.

Use rollers suitable to the type of paint applied and the work areas involved. Provide pans for dipping the rollers into the paint.

Follow these restrictions:

- Do not use worn rollers.
- Do not use rollers to apply special protective coatings or paints to piling and swaybracing.
- If a surface is inaccessible to rollers, apply the paint with sheepskin daubers made for painting.

D. Inspection Equipment

Ensure that the system applicator has the following:

- Wet-film gauge
- Dry-film gauge
- Surface thermometer
- Sling psychrometer
- Abrasive blasting finish gauge

During and after field cleaning and painting, furnish a safety belt and a lift truck, bucket truck, or snooper truck to the Engineer's satisfaction to inspect the cleaning and painting operation.

E. Protection Equipment

Furnish signs, warning lights, barricades, enclosures, and watchmen as required by the Manual on Uniform Traffic Control Devices or by the Engineer.

535.3.03 Preparation

Refer to Subsection 535.3.05B.1, "weather conditions" before performing any cleaning operations.

A. Clean New Steel Structures

Before painting, clean new steel structures as follows:

1. Clean steel H-piling, metal shell piling, and steel swaybracing.
2. Field blast clean steel H-piling, metal shell piling, and steel swaybracing that will receive paints systems or special protective coatings by field blasting. The extent of cleaning shall be SSPC-SP6, "Commercial Blast Cleaning."
3. Thoroughly shop clean the following structural steel metal surfaces to be painted. The extent of cleaning shall be SSPC-SP6, "Commercial Blast Cleaning."
4. Clean field weld or bolted connection surfaces as follows:
    a. Before cleaning the steel, straighten bent metal according to Subsection 501.3.05.A, "Straightening Material."
    b. Before welding or bolting, field clean the surfaces that will touch after the welding or bolting as described in Subsection 535.3.03.A, "Clean New Steel Structures," step 1 and step 2.
    c. Keep the surfaces free of paint and metal spatters.
    d. Field clean the remainder of the structural steel.

    If desired, delay cleaning the rest of the structural steel until concrete work is complete and the main painting operation is ready to begin.
5. Prepare new steel structure surfaces for painting as follows:
    a. Have the Engineer inspect each span or unit of work.
    b. Do not begin painting until the Engineer approves the spans or units of work.

B. Clean Existing Steel Structures

Ensure that no work is performed before a Project Bridge Painting /Repainting Pre-Construction Conference is held.

Clean only as much metal as can be painted before it rusts. If surfaces rust after cleaning, clean them again before painting them.

Blast clean existing steel structures as follows:

1. Construct protection devices. Assume responsibility for damages to vehicles, persons, or property caused by cleaning operations.

    Protect the following from blast-cleaning hazards:

- Portions of the structure (superstructure, substructure, and highway appurtenances) that could be damaged by the blast cleaning
- Existing pedestrian, vehicular, and other traffic on, underneath, or adjacent to the structure.

Construct protection devices as follows:

a. Cover or shield portions of the structure that could be damaged.

b. Construct a system that protects traffic from direct blasting and prevents abrasive materials and debris from spreading and creating a traffic hazard.

c. If blast cleaning disrupts traffic flow, stop cleaning or clean behind screens.

d. If the protection devices are not providing protection, stop the work and correct the problem.

   Do not begin work until effective corrections are made.

e. Before reopening work areas to traffic, remove abrasive material and debris deposited on the pavement, shoulders, or slope paving in the area.

2. Prepare the structures for blast cleaning as follows:

   a. If the Project Inspector requires, remove railings, nameplates, and other interfering parts from surfaces to be cleaned and painted.

   b. Straighten bent metal.

   c. Before blast cleaning a beam or girder, remove dust and debris from the top of the bottom flange.

3. Remove all coats of paint to clean, bare metal by blast cleaning or other approved means.

   The extent of cleaning shall be SSPC-SP6, “Commercial Blast Cleaning,” with an anchor pattern between 1.0 and 2.0 mils (0.025 and 0.051 mm). Anchor patterns greater than 2.0 mils (0.051 mm) will require that the primer be applied at a thickness of at least 1 mil (0.025 mm)over the anchor pattern or that the steel be re-blasted unless otherwise approved by the Engineer.

4. After blast cleaning and before painting, prepare the steel surfaces as follows:

   a. Remove sand, dust, and other foreign matter from the following:

      - Deck
      - Piers
      - Railing
      - Other adjoining parts of the structure
      - Slope paving

   b. Remove any fins, tears, or slivers from the steel.

   c. Remove burred or sharp edges that appear on any steel members.

   d. Have the Engineer inspect each span or unit of work.

   e. Do not begin painting until the Engineer approves the spans or units of work.

5. Contain the paint chips, abrasive particles, and dust or debris (spent material) caused by cleaning and blasting as follows:

   a. Contain spent material according to the SSPC GUIDE 6, Class 1. The containment materials and support structure may be flexible or rigid.

   b. Ensure that tarpaulins are airtight and secure at the seams.

   c. Do not use burlap or open-weave materials.

d. Seal seams and joints by taping or overlapping tarps at least 24 in (600 mm). Overlap the entryway at least 3 ft (1 m).

e. Use negative pressure and verify it as follows:

- Verify pressure through the concave nature of the containment materials, taking into account wind effects.
- Observe air flow using smoke or other visible means inside or outside the containment.

f. Filter the air exhausting from the containment with a properly sized dust collector, bag house, or other approved method.

g. During abrasive blasting operations, ensure that the cross-draft and downdraft air movements within the containment comply with OSHA Standard 29 CFR 1910.94.

6. Additional blast-cleaning requirements for bridges over waterways:

a. Ensure that there is no scum on the surface of the water outside a 200 ft (60 m) limit of the bridge. Stretch a floating boom across the waterway at or before this 200 ft (60 m) limit on the downstream and downwind sides of the bridge to contain floating spent material.

b. If floating residue is found outside this 200 ft (60 m) limit, the Engineer will consider protection inadequate and will require further containment measures.

c. If the wind velocity is high enough to blow the residue outside the 200 ft (60 m) limit, the Engineer will temporarily suspend the blast cleaning.

d. Provide a flotation device in the water underneath the area being blast cleaned to collect the spent material.

e. If the stream is too shallow for a barge, erect a temporary platform or tarp arrangement to collect the spent material.

7. Alternate Containment System

If desired, propose an alternate method for containing the dust and spent materials from blast cleaning the structural steel.

The Department may reject a proposed alternate method that does not satisfy the Department's concerns for the safe removal and containment of lead-based paint from bridge structures.

Submit the proposal for evaluation and approval as follows:

a. Submit a detailed, written proposal describing the alternate containment and blasting method.

b. Include in the description specific information on materials and equipment, noise levels, and worker safety and health.

c. Supply references of other locations where the alternate method has been used.

d. The Department will review the information submitted and may reject the proposal or issue a conditional approval.

e. If the Department grants conditional approval, demonstrate the alternate method for containment and blast cleaning on a trial basis.

1) The Department will evaluate the effectiveness of dust and spent material containment, worker safety and health concerns, and noise levels.

2) If the Department finds the alternate method unacceptable, the Department may reject it and require work according to this Specification.

3) If the Department approves the alternate method, the Contractor will receive no additional payment above the established Contract Unit Price.

8. Handling Spent Materials

Handle spent materials according to the following requirements:

a. Collect the spent material daily and store it in sealed waste disposal containers.

b. Use waste containers that are approved by the Engineer and located where they will not cause a potential hazard.

c. Store waste containers in a temporary, fenced, secured area that is not located in a storm water runoff course, in standing water, nor on Department property. Ensure compliance with the requirements of EPA 40 CFR 264.14 and 40 CFR 264.18.

d. Label waste containers in compliance with hazardous waste laws.

e. Have the Contractor or his/her Consultant sample the spent materials according to the approved sampling plan referenced in Subsection 535.1.03.D.

f. Test the material using certified independent laboratory in accordance with the Toxicity Characteristic Leaching Procedure (TCLP).

g. Collection, storage, sampling, and testing shall be performed in accordance with EPA RCRA Regulations (40 CFR 240-299).

h. Forward a copy of all TCLP results to the Engineer and to OMR.

i. If the TCLP toxicity test results do not classify the spent materials as a hazardous waste, uniformly blend twenty percent Portland cement with the spent materials and solidify the mixture before disposing of it at a licensed solid waste landfill. The cost of treatment and disposal of non-hazardous spent material is considered incidental to the pay item.

j. If the TCLP test results classify the material as a hazardous waste, treat the material to the Land Disposal Restriction standard of 0.75mg/l. The waste shall not be disposed of until authorized by the Engineer.

    1) If the waste is to be treated on-site, submit a waste analysis plan to the regional EPA office in accordance with 40 CFR 264.13 within 30 days of receipt of the TCLP results.

    2) If the waste is to be treated off-site, submit TCLP results to the EPA permitted hazardous waste treatment facility.

k. Forward a copy of all manifests and pertinent documents to the Engineer and to OMR.

9. Sampling for Lead Paint Residue

a. Use the approved detailed sampling plan included in Subsection 535.1.03.D, "Spent Material Sampling Plan" which could either be the sampling plan listed below or a similar plan that conforms to *EPA SW 846, Chapter 9 Test Methods for Evaluating Solid Waste Physical/Chemical Methods*.

   Ensure the plan includes the following:

    1) Who will be responsible for the sampling

    2) How often samples will be taken

    3) How the samples will be obtained

    4) Where the samples will be taken

    5) How the samples will be handled

    6) How the sample results will be tied back to the waste from which it was sampled.

b. Inform the Project Personnel and Independent Assurance Engineer as to when (date and time) the samples will be taken. The Department will monitor the sampling procedure and the Project Personnel will enter all pertinent information in a logbook. Information to be recorded is as follows:

    1) Project and Contract ID numbers

    2) Sampling points

    3) Field contact personnel

4) Producer of waste
5) Type of process producing the waste
6) Type of waste
7) Total number of samples
8) Number of drums each sample will cover
9) Which bridge location and the drum number i.e. 1-10, 11-18 that the sample will cover.
   a) Label all of the drums on the project. Ensure that the labels are weatherproof and include the following:
      - The Date
      - The Project Number
      - The Contract ID Number
      - The Bridge Location
      - Assign drums a series of consecutive numbers, i.e.,1-40.

c. Take one grab sample (using random sampling technique) from a drum for each bridge location. Use a thieving device to secure samples from each of the drums. The minimum sample size is 0.66 lb (300 g) which is about a cupful.

d. Samples may be taken by the paint Contractor or his/her consultant who will treat the waste.

1) Send the samples to a certified private testing lab.
2) Attach a Sampling Analysis Request (sample card) to the samples which includes:
   a) The Date
   b) Project Number
   c) Contract ID number
   d) Bridge Location
   e) Name of collector
   f) Place of collection
   g) Number of drums from Bridge each sample will cover, and
   h) Drum numbers, i.e. 1-10, 11-18 that sample will cover.
3) Include this information on the test report and the manifest so that the waste on the manifest can be keyed to the results on the TCLP report.
4) Ensure that a chain of custody form accompanies the sample and is returned with the test results.

e. Test the samples for EPA Method 1311, Toxicity Characteristic Leaching Procedure (TCLP).

f. Test one (1) sample for each bridge location.

1) If the results are 5 mg/l or greater leachable lead, the waste is to be declared hazardous and no further testing is needed until the waste has been treated. After treatment, the waste shall be re-sampled and re-tested in accordance with an approved sampling plan and shall be below 0.75 mg/l before disposal.
2) If the results are below 5mg/l, the waste is to be declared non-hazardous, then the contractor or his/her consultant shall uniformly blend twenty percent Portland cement with the spent material and solidify the mixture before disposing of it at a licensed solid waste landfill.

g. Additional samples must be acquired according to EPA SW 846 and SSPC-Guide 7 Section 5.6.5.

h. Mail the Test reports and manifests to the Engineer's office, who will review them, take the appropriate action and send them to the lab files at the Office of Materials and Research. Send an extra copy of each to the Office of Materials and Research/Independent Assurance.

   If the TCLP toxicity test results classify the spent materials as a hazardous waste, treat the waste either on-site or off-site to the Land Disposal Restriction Standard of 0.75 mg/l. Do not dispose of the waste until authorized by the Engineer. Hazardous waste material may be treated off-site if the treatment is performed by a licensed hazardous waste treatment facility in accordance with EPA and EPD guidelines. Forward a copy of all manifests and other pertinent documents to the Engineer and to OMR. These documents will be maintained in the project file for three years.

   If after treatment, the spent material is classified as a hazardous waste by the TCLP test, retreat it until the Universal Treatment Standard is met. Hazardous waste disposal shall be paid for as specified under Subsection 535.5 “Payment”, of this Specification.

10. Handle hazardous waste as follows:

   a. Comply with Section 107 of the Specifications. The Contractor is responsible for complying with the hazardous waste laws when performing the Work. Obtain a separate United States Environmental Protection Agency, Generator I.D. Number for each project where the spent material is hazardous waste according to the Toxicity Characteristic Leaching Procedure (TCLP) results.

      Obtain the generator I.D. number from the Georgia Environmental Protection Division, Hazardous Waste Management, (404) 656-2833.

      Obtain the Generator I.D. Number within 30 days of receiving the TCLP results and provide copies of the number to the Project Engineer and the Office of Maintenance, Bridge Inspection Unit, No. 2 Capitol Square, Atlanta, Georgia 30334.

   b. Dispose of hazardous spent material only at a licensed hazardous waste disposal facility.

   c. If the disposal facility requires it, send a sample of spent material for confirmation testing before delivering the shipment.

   d. Transport the waste to the facility using EPA-approved licensed waste haulers.

   e. Document each truckload of hazardous waste using an EPA “Uniform Hazardous Waste Manifest.”

   f. According to EPA and EPD rules, provide GDT and the Georgia EPD notification and certification of treated hazardous spent abrasives. Include the following:

      - Name and address of facility receiving the shipment Description of the waste as initially generated, including the applicable EPA Hazardous Waste Number(s) and treatability group(s)
      - Treatment standards applicable to the waste at the initial generation point
      - Signature of an authorized Contractor representative on the certification

   g. Hazardous waste disposal is paid for as specified under Subsection 535.4.01.A, “Spent Materials.”

C. Clean Structures Under or Over Railroads

When cleaning and painting steel structures involves work on, over, or below the railroad right-of-way or the property of a railroad company (Railroad), comply with the following:

- The additional requirements, including railroad flagging and insurance coverage, listed in the Special Provision for Protection of Railway Interests
- The Railroad’s general rules, regulations, and requirements including those on safety, fall protection, and personal protective equipment

Coordinate the work with the Railroad and ensure that there will be no interference with or delay to Railroad operations, including train, signal, and communication services.

1. Railroad Protection Requirements

The Contractor is responsible for damages to vehicles, persons, or property resulting from cleaning operations.

Ensure that the facilities and property of the Railroad or any tenants remain undamaged.

Comply with the following:

a. Protect the following from the damages of blast-cleaning operations:

- Traffic (pedestrian, vehicular, rail, train, and other kinds of traffic) on, under, or next to the structure
- Portions of the structure (superstructure, substructure, and highway appurtenances) that could be damaged

b. Weight or anchor ground cloths to withstand the suction effects of a passing train.

c. Restrain ropes, hoses, tarps, booms, and other equipment so they do not hang from the bridge or otherwise infringe on the clearances around an active track (see Subsection 535.3.03.C.2, "Railroad Construction Clearance Limits," below). Account for the following:

- Wind billowing of draped tarpaulins
- Sag from the weight of collected spent materials

2. Railroad Construction Clearance Limits

Comply with the Railroad Construction Clearance Limits:

Railroad Construction Clearance Limits		
Track Type	**Horizontal Limits**	**Vertical Limits**
Single Track	25 ft (8 m) from the center line	The existing vertical clearance from the top of the rail to the underside of the bridge
Multiple Tracks	25 ft (8 m) from the center lines of the outermost tracks	The existing vertical clearance from the top of the rail to the underside of the bridge

3. Requirements on Bridges Carrying Roadways Over Railroad Tracks

When work is required within the Railroad Construction Clearance Limits, ensure that the following can be moved outside the clearance limits when the Railroad flagman notifies you to clear the track for rail traffic.

- Working platforms
- Scaffolding
- Containment systems
- Other equipment necessary to complete the Work

While the track is open to rail traffic, do not allow ropes, hoses, tarps, booms, or other equipment or items to hang from the bridge or infringe on the clearance limits.

4. Requirements on Bridges Carrying Railroad Tracks over Roadways

When work is required on the Railroad bridge, ensure that the following can be moved completely off the bridge when the Railroad flagman notifies you to clear the track for rail traffic.

- Working platforms
- Scaffolding
- Containment systems
- Other equipment necessary to complete the Work

- Spent material

Do not attach rigging or other items to the bridge rails or barriers at the sides of the bridge.

While the track is open to rail traffic, do not allow ropes, hoses, tarps, booms, or other equipment or items to remain on the bridge.

D. Prepare Steel Piling, Swaybracing, and Concrete Piling Surfaces for Special Protective Coatings

Prepare surfaces and material for special protective coatings according to the manufacturer's recommendations. For a list of sources, see QPL 18.

535.3.04 Fabrication

General Provisions 101 through 150.

535.3.05 Construction

A. Provide Protection

Protect the structure, adjoining property, and the public from the dangers and damages of cleaning and painting.

Protect the following:

- Pedestrian, vehicular, and marine traffic on or underneath the structures being painted
- Structures
- Slope paving

Clean slope paving stained during painting to the Engineer's satisfaction.

B. Meet General Painting Requirements

Follow these requirements when painting new and existing steel structures:

1. Weather Conditions

   Cleaning or Painting shall not take place during windy or gusty conditions unless the contractor can demonstrate to the satisfaction of the Engineer that containment is sufficient to prevent the escape of paint overspray or spent material. If any paint overspray or spent material is detected outside containment areas, cease all operations until clean up has been completed. Do not recommence cleaning or painting operations until additional measures have been taken to prevent any future escape of spent material and/or paint overspray.

   When the Plans specify System VI (waterborne), ensure that the minimum air and surface temperature is 50 °F (10 ^{o}C). Comply with the other weather requirements listed below.

   When the Plans specify System VII, ensure that the minimum air and surface temperatures are above 35 ^{o}F (2 ^{o}C) and the relative humidity is greater than 50% when applying the inorganic zinc primer. Apply System VII waterborne intermediate and top coats only when the temperatures of both the air and surface are above 50 ^{o}F (10 °C).

   For Systems IV and V (alkyd), apply paint only when the air and surface temperatures are both above 40 ^{o}F (4 °C).

Weather Requirements for Painting All Systems	
Maximum surface temperature	140 °F (60 °C)
Relative humidity	Below 85%
Minimum surface temperature	5 °F (3 °C) above dew point

Follow these weather restrictions:

- Do not apply paint to surfaces that are damp or otherwise unsatisfactory as determined by the Engineer.
- Do not paint in open yards or on erected structures when the metal is hot enough to cause the paint to blister or produce a porous film.
- Do not paint metal hot enough to cause oil separation in the alkyd paint.
- Do not paint metal when freezing weather 32^{o}F (0^{o}C) is forecast or expected before the paint can dry.
- Do not store at temperatures below 32^{o}F (0^{o}C)or above 100^{o}F (38^{o}C). When outdoor temperatures exceed these limits, paint shall be stored in an appropriate indoor location.

2. Oxidation

If a prime coat on structural steel fades or chalks because of oxidation, thoroughly remove the oxidation by brushing or by washing with water until the sound prime coat is visible.

3. Paint Thinning

Do not thin or dilute paints.

4. Application Methods

Thoroughly mix paints in their shipping containers using mechanical devices before removing the paint.

For inorganic zinc primers, add the powder component to the liquid component with thorough stirring, and continue stirring until the powder is well dispersed. Strain the mixture through a 30-60 mesh sieve to remove large particles. Use pressure pots equipped with a mechanical agitator, which will remain in motion throughout the application.

Ensure that the paint formulation matches the application method (brush, roller, airless spray, or air spray).

Apply paint neatly by brushing, spraying, or rolling. Use rollers only as specified in Subsection 535.3.02.C, “Rollers.”

When using brushes or rollers, apply the paint as follows:

a. Produce an even coating covering the metal or the previous coat.

b. Work the paint into corners and crevices.

c. Keep enough paint on rollers and overlap the applications to avoid unsightly or mottled areas.

Use the paint numbers shown in the Table of Application Methods, below.

Table of Application Methods			
Brush	**Roller**	**Airless Spray Hydraulic**	**Air Spray**
Ordinary Exposure Green System IV (Lead Free Alkyd)			
1A	1A	1A	X
1A	1A	1A	X
2A	2A	2A	X
3B	3B	3B	X
X	X	X	X
Heavy Exposure Green System V (Lead Free Alkyd)			
1A	1A	1A	X
1A	1A	1A	X
1A	1A	1A	X
2A	2A	2A	X
3B	3B	3B	X
Ordinary Exposure Green System VI (Waterborne)			
1W	1W	1W	1W
1W	1W	1W	1W
2W	2W	2W	2W
3W	3W	3W	3W
Ordinary exposure Green System VII (Zinc Primer)			
X	X	Inorganic Zinc Primer	X
2W	2W	2W	2W
3W	3W	3W	3W

5. Paint Systems and Dry Film Thickness

Apply the minimum required dry film thickness and the additional coats according to the paint system required on the Plans.

Table of Paint Systems and Minimum Required Dry Film Thickness		
No. of Coats	**Color of Coats**	**Thickness, mils (mm)**
Ordinary Exposure Green System IV (Lead Free Alkyd)		
Primer	Red	2.0 (0.051) to 5.0 (0.127)
Touch-Up	Red	*
2nd Coat	Buff	2.0 (0.051) to 5.0 (0.127)
3rd Coat	Green	1.0 (0.025) to 3.0 (0.076)
4th Coat	None	X
Heavy Exposure Green System V (Lead Free Alkyd)		
Primer	Red(T)	2.0 (0.051) to 5.0 (0.127)
Touch-Up	Red	*
2nd Coat	Red	2.0 (0.051) to 5.0 (0.127)
3rd Coat	Buff	1.5 (0.038) to 5.0 (0.127)
4th Coat	Green	1.0 (0.025) to 3.0 (0.076)
Ordinary Exposure Green System VI (Waterborne)		
Primer	Brown	3.0 (0.076) to 5.0 (0.127)
Touch-Up	Brown	*
2nd Coat	Buff or White	3.0 (0.076) to 5.0 (0.127)
3rd Coat	Green	3.0 (0.076) to 5.0 (0.127)
4th Coat	None	X
Ordinary Exposure Green System VII (Zinc Primer)		
Primer	Gray	3.0 (0.076) to 5.0 (0.127)
2nd Coat	Buff or White	2.0 (.0.051) to 5.0 (0.127)
3rd Coat	Green	2.0 (0.051) to 5.0 (0.127)
4th Coat	None	X
* = 2.0 (0.051) for touch-up coats (T) = Tinted		

6. Proper Drying

Ensure that each coat is thoroughly dry and cured before applying the next coat. Allow at least 24 hours between coats.

If weather conditions and paint type require, allow longer periods between coats.

7. Cracks and Cavities

Before applying the second field coat, fill small cracks and cavities that are not sealed watertight by the first field coat using the following:

Plan-Required Paint System	Fill Mixture
IV or V	Pasty mixture of zinc hydroxy phosphite and linseed oil
VI	Pasty mixture recommended and supplied by the manufacturer
VII	Pasty mixture recommended and supplied by the manufacturer

C. Paint New Steel Structures

Paint new steel structures as follows:

1. Use the correct paint system. The Plans usually specify one of the systems shown in the Table of Paint Systems and Minimum Required Dry Film Thickness. If the Plans do not specify a paint system, use System VI.

   If the structure is located in the 13 county ozone non-attainment region, use only Waterborne coatings for any painting operation conducted between May 1 and September 30. The 13 metro Atlanta counties that comprise the non-attainment region are: Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale. Do not apply Alkyd coatings and the System VII inorganic zinc primer under the above conditions. System VI and the System VII waterborne intermediate and top coats may be applied.

2. Paint new structural metal with one shop prime coat, one field touch-up coat, and two field weather coats. When severe exposure conditions require, apply one additional prime coat. Once painting has commenced, (including shop coat) succeeding coats of paint are to be the same paint system and from the same paint manufacturer.

3. Apply the type and color of paint coats as required by the system number shown on the Plans.

   If succeeding coats are the same type and color, tint one of the underlying coats as required by Subsection 870.2.01.B.1.d and Subsection 870.2.06.A.6.

4. Do not paint advertising on structural steel.

5. Adhere to the following requirements for special surfaces:

   a. Concrete Contact Areas

      If the following surfaces will touch previously poured and hardened concrete, apply two coats of primer to them:

      - Steel surfaces
      - Nongalvanized handrail posts
      - Nonembedded armored joints

      Unless otherwise specified on the Shop Drawings, do not shop paint surfaces that will touch plastic concrete.

   b. Inaccessible Areas

      Before assembly, paint surfaces that will be inaccessible after assembly or installation with two coats of primer.

   c. Connection Areas

      Do not shop paint the following connection areas:

      - Surfaces that will touch after welding or bolting
      - Areas next to field welds

   d. Machine-Finished Surfaces

      Using the materials specified, either shop paint or coat the machine-finished surfaces according to Subsection 501.3.04.D.9, “Coating Machine-Finished Steel Surfaces.”

   e. Plates That Touch Elastomeric Pads

      Apply one coat of the shop primer specified on the Plans to plates that will touch elastomeric bearing pads.

      1) Paint surfaces and edges that will be exposed after components are erected.
      2) Do not apply the primer paint to areas that will be welded.
      3) Do not apply the primer paint to the area that will bear against the elastomeric pad.
      4) Dimension and locate the blocked-out, no-paint areas to within plus or minus 1/2 in (13 mm) of the theoretical location and size of the elastomeric pad.

6. Do not handle or load steel until the shop paint is dry.
7. Field paint steel surfaces according to this time line:
   a. Before Erection

      If the following surfaces will touch previously poured and hardened concrete, touch them up as required with primer (or apply two coats of primer if the item was not shop painted) before installing them:

      - Steel surfaces
      - Nongalvanized handrail posts
      - Nonembedded armored joints

      Do not install until the paint is thoroughly dry.

   b. After Erection

      After completing steel erection, clean unprimed surfaces of connection areas requiring paint as specified in Subsection 535.3.03.A, "Clean New Steel Structures," step 3.

      Connection areas include welded or bolted splices, beam and diaphragm connections, and bracing connections.

      Prime connection areas with the paint specified in the system number shown on the Plans.

      Do not prime welded connections until the following occurs:

      - Weld metal is cleaned according to Subsection 501.3.04.I.2, "Paragraph 3.10.1," and Subsection 501.3.04.I.3, "Paragraph 4.30.1."
      - Radiographic or magnetic particle inspection work, if specified, is complete and the welds are approved.

   c. After Concreting

      After completing concreting work, clean surfaces as specified in Subsection 535.3.03.A, "Clean New Steel Structures," and field paint as follows:

      1) Cover the following with one coat of touch-up primer paint and allow it to dry:
         - Shipping and erection marks
         - Bolt heads
         - Other surfaces with worn off or defective prime coat
      2) During touch up, stripe or paint the following with an additional coat of primer:
         - Exposed edges of flanges on rolled beams and built-up girders
         - Edges of angles and stiffeners
         - Exposed edges of gusset plates, splice plates, and cover plates
      3) Ensure that sharp, exposed edges have two full coats of primer paint, including the shop coat.
      4) If removing oxidation as described in Subsection 535.3.05.B.2, "Oxidation," damages the prime coat so that bare metal is exposed after cleaning, prime the exposed bare metal with an additional coat at no expense to the Department.
      5) If removing oxidation reduces the prime thickness, use two field weather coats, if desired, to obtain the total thickness required for the paint system.

         However, when the two field weather coats are different types of paint, use additional prime paint to obtain the prime thickness.

D. Paint Existing Steel Structures

Paint existing steel structures as follows:

1. Prevent paint overspray by using containments.
2. The weather conditions specified for new steel structures described in Subsection 535.3.05.B also apply to existing steel structures.
3. Apply the correct colors and number of coats as follows:

   Only steel which has undergone complete removal of all coats and which has a surface cleanliness conforming to SSPC SP-6 may be coated with System VI.

   Give this steel one full prime coat and two weather coats, all of the color and type required by the Special Provisions or Plans. If succeeding coats are of the same type and color, tint one of the underlying coats as required by the Specifications.
4. The drying requirements of Subsection 535.3.05.B.6 specified for new steel structures shall apply to existing steel structures.
5. The paint thinning requirements of Subsection 535.3.05.B.3 specified for new steel structures shall apply to existing steel structures.
6. Painting Of Surfaces:
   a. Methods Of Application: The requirements of Subsection 535.3.05.B.4.as specified for new steel structures shall apply to existing steel structures.
   b. Cracks And Cavities: The requirements of Subsection 535.3.05.B.7 as specified for new steel structures shall apply to existing steel structures.
   c. Paint Thickness: The minimum required dry film thickness as specified in Subsection 535.3.05.B.5 and the additional coats specified in Subsection 535.3.05.B.5 for new steel structures shall apply to existing steel structures. However, when new paint is applied over existing sound paint, the required wet film thickness of the new coats shall be that required by the Special Provisions or Plans.
7. Apply the minimum required dry film thickness and the additional coats specified in the Table of Paint Systems and Minimum Required Dry Film Thickness.

   However, when applying new paint over existing sound paint, comply with the required wet film thickness specified by the Special Provisions or Plans for new coats.
8. After completing the painting, replace the railings, name plates, and other interfering parts removed (as described in Subsection 535.3.03.B, “Clean Existing Steel Structures” step 2.a) to the Engineer’s satisfaction.

E. Paint Steel H-Piling, Metal Shell Piling, and Steel Swaybracing

Paint this material as follows:

1. Weather Conditions

   Except as specified below, apply paint in the weather conditions specified in Subsection 535.3.05.B.1, “Weather Conditions.”
   a. Painting in open yards or on erected structures shall not be done when the metal is sufficiently hot to cause the paint to blister or produce a porous film.
   b. Metal shall not be painted when freezing weather [32^{o}F (0^{o}C)] is forecast or expected in the time that would occur before the paint has dried.
2. Thinning Paint

   Do not thin or dilute pile paints.
3. Number of Coats and Color

   Unless the Plans require a No. 1P or 2P system, described in Subsection 870.2.05.A.1, “Paint for Steel Piling and Swaybracing,” paint steel H-piling, metal shell piling, and steel swaybracing with a System VII paint system.

Apply a No. 1P system as follows:

a. When using a No. 1P system formulated as a first application primer and a separate finish coat, ensure that containers are clearly labeled as primer or finish coat.

b. Apply the primer first.

c. Apply successive coats using either primer or finish coat.

d. Ensure that the final coat is a finish coat.

4. Method of Application

Apply the black paints noted in Subsection 535.3.05.E.3, “Number of Coats and Color” using either brushes or sprayers.

When using a brush, apply the paint as follows:

a. Apply a thick application of paint to be plastered or troweled on the steel surfaces.

b. Brush out the paint only as required to obtain uniform thickness; do not attempt to brush it out neatly.

c. Work the paint into corners and crevices.

5. Application Rate

For each coat, apply at least 1 gal of paint type per 60 ft^2. (0.7 L/m2). Ensure that the total dry-film thickness of paint coats is as specified in Subsection 535.3.05.E.6, “Thickness of Paint,” below.

6. Thickness of Paint

Ensure that the final, dry-film thickness of the completed work is at least 25 mils (0.635 mm).

Apply additional coats to achieve the minimum dry-film thickness at no expense to the Department.

7. Extent of Paint

Paint to the following extent:

- Coat exposed piling with a System VII paint system unless a No. 1P or No. 2P system is specified on the Plans.
- Coat piling in the stream bed and within 10 ft (3 m) of the top of the stream bank with the System VII from 5 ft (1.5 m) below the stream bed to the bottom of the concrete cap.
- Coat end bent piles 2 ft (600 mm) below the bottom of the cap or concrete encased as defined in Subsection 520.3.05.O, “Coat and Paint Piling.”
- For piling that will be encased according to Section 547, paint the piling with System VII to the extent specified in Subsection 520.3.05.O, “Coat and Paint Piling.”
- Before driving, coat test piles located in permanent surface water with a System VII according to Subsection 520.3.05.O, “Coat and Paint Piling.”

Paint enough of the test pile to ensure that the coated portion extends 5 ft (1.5 m) below the stream bed or bottom.

8. Drying Requirements

Ensure that each coat is thoroughly dry before the next coat is applied.

F. Apply Special Protective Coatings to Steel Piling, Steel Swaybracing, and Concrete Piling

Unless the Plans require No. 1P or 2P system, apply a System VII coating. Apply the coating to the extent specified in Subsection 520.3.05.O, “Coat and Paint Piling.”

Ensure that coverage, wet- and dry-film thicknesses, temperature considerations, primer use, and drying and curing time comply with the manufacturer’s recommendations.

Apply the special protective coating as follows:

1. When the structure will be welded, do not apply the material until the weld is placed and cleaned.

2. Apply the material in at least two coats by brushing.
3. Apply the second coat at right angles to the first coat.
4. Use the elapsed time between coats recommended by the manufacturer.
5. Ensure that the finished film has no holidays and pinholes and completely covers the underlying surface.
6. After applying the coating material, recoat damaged areas where the protection is ineffective as determined by the Engineer.
7. Where swaybracing members will be welded to piles and painted in advance, burn off the coating at the weld location and proceed as follows:
    a. Thoroughly clean the burned area by scraping and power-operated wire brushing before welding.
    b. After making and cleaning the weld, recoat the area.
8. Do not drive piles painted in advance until the second coat has thoroughly dried and completely cured.

535.3.06 Quality Acceptance

A. Correct Defective Work

If applied paint does not meet the requirements of this Specification, remove the paint or correct it using SSPC-approved means.

Remove paint that is applied to improperly cleaned surfaces. Clean the surfaces and repaint them to the Engineer’s satisfaction.

B. Meet the Required Total Dry-Film Thickness

If the minimum required total dry-film thickness specified for the paint system is not reached after applying the required number of coats and colors, apply additional coats at no expense to the Department until the required thickness is obtained.

The Department considers the applied zinc primer deficient in thickness for measured dry thickness values less than 3 mils (0.076 mm). If more than four deficient thickness values (one measurement per 25 ft^2 (2.32 m^2) of surface area) are found in any 200 ft^2 (18.6 m^2)of continuous metal section, blast clean the entire section to a SSPC-SP6, Commercial Blast condition. Repaint the section with inorganic primer to achieve a dry film coating thickness of 3.0 to 5.0 mils (0.076 to 0.127 mm).

Repair primed areas having excessive dry film coating thickness, coating "dry spray", visible coating "mudcracking", visible surface hackles, handling abrasions, and missed paint in bolt holes. Repair in accordance with the written recommendations of the paint manufacturer. Obtain the Engineer's approval for all repair recommendations. Include current product data and application instruction sheets with the repair recommendations.

535.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

535.4 Measurement

The cost of painting new steel structures shall be included in the Contract Price for structural steel. No separate payment will be made.

Cleaning and painting existing steel bridge structures will be measured and paid for at the Contract Unit Price for “Painting Existing Steel Structure Station or Bridge I.D. No. _____.” This includes payment for the following:

- Equipment (including a “flotation device” or temporary platform on waterway bridges)
- Work platform
- Bucket truck or snooper truck with safety belt

- TCLP testing
- Materials and work necessary to remove lead-based paint and contain the spent materials
- Collection and storage of spent materials, water, and slurry generated by abrasive blasting

535.4.01 Limits

A. Spent Materials

Treatment of hazardous waste and subsequent disposal shall be paid for under a force account basis. The Engineer will reimburse the Contractor based upon invoices from the licensed hauler and disposal facility. An additional amount equal to 3% of the total invoices will be paid as administrative costs incurred by the Contractor.

The costs of collecting spent material, furnishing the containers, loading the material into containers, treating the material onsite, and loading the containers into the licensed hauling unit will not be paid for separately. These costs are considered incidental to the pay item.

The disposal of other spent materials collected is incidental to the Pay Item “Painting Existing Steel Structures.”

B. Piling and Steel Swaybracing

The cost of applying special protective coatings or paint to piling shall be included in the Contract Price for piling. No separate payment will be made.

The cost of applying special protective coatings or paint to steel swaybracing shall be included in the Contract Price for structural steel. No separate payment will be made.

535.5 Payment

Payment is full compensation for the costs, direct and indirect, of complying with the requirements of this Specification.

Payment will be made under:

Item No. 535	Painting existing steel structure, Station No. ____	Per lump sum
Item No. 535	Painting existing steel structure, Bridge I.D. No. ____	Per lump sum
Item No. 535	Painting existing steel structures, Railroad Special, Station No. _______	Per lump sum
Item No. 535	Painting existing steel structures, Railroad Special, Bridge I.D. No. _______	Per lump sum

535.5.01 Adjustments

General Provisions 101 through 150.

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July 21, 2006

Section 540—Removal of Existing Bridge

Delete Subsection 540.5 and Substitute the following:

540.5 Payment

This work will be paid for at the Contract Price per Lump Sum, which will be full compensation for all things necessary to complete the Work.

The cost of excavation needed only to remove or dispose of all or parts of an existing structure, and which is not within the limits of an excavation required as part of another Pay Item, shall be included in the Contract Price for this work. This price shall also include the cost of backfilling excavation performed for these purposes.

Payment will be made under:

Item No. 540	Removal of Existing Br, Sta No -	Per lump sum
Item No. 540	Removal of Existing Br, Br No -	Per lump sum
Item No. 540	Removal of Parts of Existing Bridge, Sta No -	Per lump sum
Item No. 540	Removal of Parts of Existing Bridge, Br No -	Per lump sum

540.5.01 Adjustments

General Provisions 101 through 150.

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July 21, 2006

Section 561—Renovating Existing Pipe

Delete Section 561 and substitute the following:

561.1 General Description

This work includes furnishing and inserting helically corrugated metal pipe, smooth-lined corrugated polyethylene pipe, high density polyethylene profile wall pipe, and high density polyethylene solid wall pipe or a polyvinyl chloride pipe inside an existing metal pipe and pressure grouting the space between the two pipes.

561.1.01 Definitions

General Provisions 101 through 150.

561.1.02 Related References

A. Standard Specifications

Section 801—Fine Aggregate

Section 830—Portland Cement

Section 831—Admixtures

Section 844—Steel Pipe

Section 845—Smooth Lined Corrugated Polyethylene (PE) Culvert Pipe

Section 880—Water

Section 882—Lime

Section 883—Mineral Filler

B. Referenced Documents

GDT 84

561.1.03 Submittals

General Provisions 101 through 150.

561.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Corrugated Steel Pipe (Helically Corrugated)	844.2.01*
Smooth-Lined Corrugated Polyethylene (PE) Culvert Pipe	845
Portland Cement, Types I or II	830
Mineral Filler (Limestone Dust)	883
Fly Ash, Type A	831
Water	880
Fine Aggregate, Size No. 20	801.2.02
Agricultural Lime	882.2.02**
*Use Georgia Standard 1030D to determine the metal thickness of the insert pipe.	
**For this Work, use agricultural lime that has 90 percent minimum passing the No. 30 (600 μm) sieve and 30 percent minimum passing the No. 200 (75 μm) sieve.	

A. High Density Polyethylene (HDPE) Profile Wall Pipe

Use pipe liner that consists of a HDPE profile wall pipe that conforms to the requirements of ASTM F 894. Polyethylene material shall have polyethylene pipe liners material designation of PE 3408 and shall have a material cell classification per ASTM D 3350 of 334433C or higher.

Join HDPE profile wall pipe liner by thermal fusion (extrusion welding) per manufacturer specifications, or provide a positive mechanical joint that meets the requirements of ASTM D 3212. The joint shall be able to be pulled or pushed into the host pipe without joint separation.

B. High Density Polyethylene (HDPE) Solid Wall Pipe

Pipe liner shall consist of a HDPE solid wall pipe that conforms to the requirements of ASTM F 714 with an SDR of 21. Polyethylene material shall have polyethylene pipe liners material designation of PE 3408 and shall have a material cell classification per ASTM D 3350 of 345434C.

Join HDPE solid wall pipe liner by butt fusion per ASTM D 2657 and the manufacturer specifications, or provide a positive mechanical joint that meets the requirements of ASTM D 3212. The joint shall be able to be pulled or pushed into the host pipe without joint separation.

C. Polyvinyl Chloride (PVC) Pipe

Pipe liner shall consist of PVC corrugated pipe with a smooth interior that conforms to the requirements of ASTM F 949. PVC pipe shall have a minimum pipe stiffness of 46 psi (317 kPa) when tested according to ASTM D 2412. Use pipe made of PVC compound with a cell classification per ASTM D 1784 of 1245B.

Join the PVC pipe liner with a PVC coupling that uses elastomeric sealing gaskets. The assembled joint shall meet the performance requirements of ASTM D 3212. The joint shall be able to be pulled or pushed into the host pipe without joint separation. Ensure that elastomeric seals meet the requirements of ASTM F 477.

D. Grout Mixtures

Mix water with the dry ingredients to produce a grout with an efflux time from the flow cone of at least 16 seconds and no more than 22 seconds when tested according to GDT 84.

Add cement, cement and limestone dust, or cement and fine aggregate to the batch proportions to produce the required consistency.

Table of Grout Mixtures					
Mix Proportions, Percent by Weight of Dry Materials					
Dry Materials	**Grout Types**				
	1	2	3	4	5
Cement	25	25	25	25	100
Limestone dust		25	75	50	
Fly ash	25			25	
Fine aggregate	50	50			

561.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

561.3 Construction Requirements

561.3.01 Personnel

General Provisions 101 through 150.

561.3.02 Equipment

A. Batching

Use weight hoppers and scales for each dry material or calibrated volumetric batch hopper. Calibrate volumetric batch hoppers in increments equivalent to one 94 lb (42.6 kg) bag of cement.

B. Mixing

Use a watertight batch-type mixer capable of blending the various materials into a homogenous mixture.

C. Grout Pumping

Use a positive-displacement, piston-type pump or a screw-type worm pump equipped with the following:

- Discharge line with a positive cut-off valve at the nozzle end and a by-pass return line to recirculate the grout back into a holding tank or mixer
- A nozzle or device at the end of the discharge line that will remain secure in the 1 in (25 mm) grout pipe and free of leaks

D. Pulling

Provide equipment capable of pulling the new helically corrugated metal pipe.

561.3.03 Preparation

General Provisions 101 through 150.

561.3.04 Fabrication

General Provisions 101 through 150.

561.3.05 Construction

A. Grout Mixtures

Use the Table of Grout Mixtures in Subsection 561.2.D, "Grout Mixtures."

B. Installation

Install pipe liner according to the manufacturer's guidelines and as specified in the plans, with the following requirements:

1. Clean and inspect the existing pipe before pulling or pushing the new pipe through.
2. Use a nose cone on all on all pipe liners. The nose cone shall have enough strength to withstand pulling or pushing of the new pipe liner. Weld or bolt the nose cone to the end of the liner. Use a nose cone that includes a ring for attaching the pulling cable.
3. After pulling or pushing the new pipe through the old one, plug the space between the pipes at both ends with concrete or mortar. Insert a 1 in (25 mm) grout pipe with threaded ends on the outside into the tops of the plugs at both ends of the pipes, and screw on a threaded cap.
4. After the pipe plugs have been in place long enough to develop strength to withstand pressure grouting, remove the grout pipe caps. Connect the grout pump to the downstream grout pipe and pump grout into the void until it flows freely from the upstream grout pipe.
5. After pumping is complete, replace the grout pipe caps.

561.3.06 Quality Acceptance

General Provisions 101 through 150.

561.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

561.4 Measurement

Renovating existing pipe is measured by the linear foot (meter) of the specified diameter of new pipe installed.

561.4.01 Limits

General Provisions 101 through 150.

561.5 Payment

Renovating existing pipe will be paid for at the Contract Unit Price bid per each diameter and metal thickness of new pipe. This payment will be full compensation for completing all work described in this Section, including cleaning and restoring damaged areas.

Payment will be made under:

Item No. 561	Renovating existing pipe____ in (mm) diameter	Per linear foot (meter)

561.5.01 Adjustments

General Provisions 101 through 150.

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

January 20, 2006

Section 600—Controlled Low Strength Flowable Fill

Delete Section 600 and substitute the following:

600.1 General Description

This work consists of furnishing and placing ready-mixed or volumetric mixed Flowable Fill as an alternate to compacted soil as approved by the Engineer. Applications for this material include beddings, encasements, and closures for tanks and pipe, and general backfill for trenches and abutments.

600.1.01 Definitions

General Provisions 101 through 150.

600.1.02 Related References

A. Standard Specifications

Section 500—Concrete Structures

Section 801—Fine Aggregate

Section 830—Portland Cement

Section 831—Admixtures

Section 880—Water

B. Referenced Documents

SOP-10

General Provisions 101 through 150.

600.1.03 Submittals

Mix designs for flowable fill and other documentation listed in Subsection 500.1.03.

600.2 Materials

All materials shall meet the requirements of the following Specifications:

Material	Section
*Fine Aggregate	Subsection 801.2.02
Portland Cement	Subsection 830.2.01
**Fly Ash	Subsection 831.2.03
***Air-Entraining Admixtures	Subsection 831.2.01
Water	Subsection 880.2.01

*Note—Gradation requirement is waived.

**Note—The requirements of Subsection 831.2.03 will be waived for fly ash.

***Note—High air generators or foaming agents may be used in lieu of conventional air entraining admixtures and may be added at the job site and mixed according to the manufacturer’s recommendation.

600.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

600.3 Construction Requirements

600.3.01 Personnel

General Provisions 101 through 150.

600.3.02 Equipment

General Provisions 101 through 150.

600.3.03 Preparation

A. Mix Design

Flowable fill can be batched by ready-mix or volumetrically mixed on site.

Ready-mixed flowable fill is a mixture of Portland cement, fly ash, fine aggregate, air entraining admixture, and water. Ready-mixed flowable fill contains a low cement content for reduced strength development.

Volumetric mixed flowable fill is a mixture of Class C fly ash or Portland cement, Class F fly ash, and water mixed on site.

1. Submit mix designs for flowable fill to the Engineer for approval by the Office of Materials and Research. The following table lists mix design proportion ranges for excavatable and non-excavatable flowable fill:

***Table 1—Mix Designs for Flowable Fill**

	Ready-Mixed		**Volumetric Mixed**	
	Excavatable	**Non-Excavatable**	**Excavatable**	**Non-Excavatable**
Cement, Type I	75-100 lbs/yd^3 (45-60 kg/m^3)	75-150 lbs/yd^3 (45-90 kg/m^3)	90 lbs/yd^3 (53 kg/m^3)	150 lbs/yd^3 (90 kg/m^3)
Class C Fly Ash	-	-	735-840 lbs/yd^3 (333-381 kg/m^3)	841-1045 lbs/yd^3 (381-474 kg/m^3)
Class F Fly Ash	-	150-600 lbs/yd^3 (90-355 kg/m^3)	1250-2000 lbs/yd^3 (567-1186 kg/m^3)	1045-1940 lbs/yd^3 (474-1150 kg/m^3)
Water	**	**	**	**
***Air	15 to 35%	5-15%	NA	NA
***28-Day Compressive Strength	Maximum 100 psi (690 kPa)	Minimum 125 psi (860 kPa)	Maximum 100 psi (690 kPa)	Minimum 125 psi (860 kPa)
***Unit Weight (Wet)	90-100 lbs/ft^3 (1440-1600 kg/m^3)	100-125 lbs/ft^3 (1600-2000 kg/m^3)	90-100 lbs/ft^3 (1440-1600 kg/m^3)	100-125 lbs/ft^3 (1600-2000 kg/m^3)

*Amounts singly or in combination to make the mix yield one cubic yard (meter).

**Mix designs shall produce a consistency that will result in a flowable self-leveling product at time of placement.

***The requirements for percent air, compressive strength, and unit weight are for laboratory designs only and are not intended for jobsite acceptance requirements.

600.3.04 Fabrication

A. Ready-Mixed

Ensure ready-mixed flowable fill is manufactured at plants that qualify as approved sources according to the Standard Operating Procedure for Quality Assurance for Ready-Mix Concrete Plants in Georgia (SOP-10). Mix and deliver according to Subsection 500.2.01 of the Specifications or other methods approved by the Engineer. Revolution counter requirements are waived.

B. Volumetric Mixed

Ensure volumetric mixed flowable fill is manufactured through the use of volumetric mixers according to Subsection 500.3.02 of the Specifications or other methods approved by the Engineer.

600.3.05 Construction

When using as backfill for pipe, where flotation or misalignment may occur, assure correct alignment of the pipe by using straps, soil anchors, or other approved means of restraint.

Protect flowable fill from freezing for 36 hours after placement.

600.3.06 Quality Acceptance

A. Jobsite Acceptance

Acceptance of flowable fill is based on documentation as outlined in Subsection 500.1.03 of the Specifications and a minimum temperature of flowable fill at the point of delivery of 50 °F (10 °C).

600.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

600.4 Measurement

Flowable fill will be measured for payment in cubic yards (meters) in place and accepted when shown as a pay item in the Contract. When flowable fill is not shown as a pay item, include the cost of the work in the bid price for the appropriate item.

600.4.01 Limits

General Provisions 101 through 150.

600.5 Payment

When shown as a pay item in the Contract, flowable fill complete, in place and accepted will be paid for per cubic yard (meter).

Payment will be made under:

Item No. 600	Flowable fill	Per cubic yard (meter)

600.5.01 Adjustments

General Provisions 101 through 150.

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May 19, 2006

Section 610—Removal of Miscellaneous Roadway Items

Delete Section 610 and Substitute the following:

610.1 General Description

This work includes removing, salvaging, or disposing of items listed in the Proposal as Pay Items to be removed, and backfilling the excavations made during removal.

Remove structures not separately listed as Pay Items in the Contract as specified in Sections 201, 202, or 205.

610.1.01 Definitions

General Provisions 101 through 150.

610.1.02 Related References

A. Standard Specifications

Section 201—Clearing and Grubbing Right-of-Way

Section 202—Random Clearing and Grubbing

Section 205—Roadway Excavation

Section 208—Embankments

Section 540—Removal of Existing Bridge

Section 611—Relaying, Reconstructing, or Adjusting to Grade of Miscellaneous Roadway Structures

B. Referenced Documents

General Provisions 101 through 150.

610.1.03 Submittals

General Provisions 101 through 150.

610.2 Materials

610.2.01 Delivery, Storage, and Handling

A. Materials Retained by the Department

Unless removed under Sections 201, 202, or 205, or unless otherwise provided for in the Plans or Proposal, carefully remove materials with a salvage value.

1. Neatly stack or stockpile the materials along the right-of-way near the removal point and above high water.
2. Store highway signs standing on edge and protected from the elements.
3. Replace materials damaged, defaced, or destroyed by removing them carelessly at no cost to the Department.
4. Notify the Engineer when the materials have been stockpiled and are ready to be transported.
5. Keep materials secure and replace (at the Contractor's expense) materials lost, stolen, or missing within a maximum of 10 days after the Engineer has been notified that the materials are ready to be transported.

B. Materials Reused in the Work

Maintain structures, portions of structures, and other materials to be salvaged and reused in reconstruction work.

Assume responsibility for the material until Project Final Acceptance.

Repair or replace materials lost or stolen before reuse at the Contractor's expense.

Spread suitable surplus excavation material on the slopes of the roadway embankments. Otherwise, dispose of the waste materials off the right-of-way at the Contractor's expense.

C. Bridge Components

Dispose of bridge components according to Section 540. Replace or repair at the Contractor's expense structures, portions of structures, or materials to be salvaged, retained, or used in the reconstructed work but that were carelessly damaged or destroyed by the Contractor.

610.3 Construction Requirements

610.3.01 Personnel

General Provisions 101 through 150.

610.3.02 Equipment

General Provisions 101 through 150.

610.3.03 Preparation

If removing a structure may endanger a new construction, finish that part of the work before beginning the new construction.

610.3.04 Fabrication

General Provisions 101 through 150.

610.3.05 Construction

A. Protection of Remaining Structures

Do not use explosives, equipment, or devices that may endanger structures, facilities, or other property to remain in place. If parts of structures are to remain in place, protect them from damage during construction. Protect and preserve the salvage value of materials to be salvaged.

B. Extent of Removal

Separate and remove existing structures, with their attached parts and connections, as shown on the Plans or designated to be removed.

1. When a part of an existing structure is to remain in place, ensure that the part to be removed extends to a construction joint or is cut off to the lines shown on the Plans, leaving reasonably smooth faces.

   Remove walls and other masonry construction to the bottoms of the foundations unless otherwise specified.

2. Remove walls and their foundations within the roadbed area to an elevation at least 3 ft (900 mm) below the top of the finished subgrade, unless otherwise specified.

3. See Subsection 201.3.05.C.1.c, "Abandoned Obstructions," for guidelines for rigid surfaces.

C. Railway Tracks

Removing railway tracks includes removing rails, ties, switches, towers, concrete structures, sign posts, and other related railway structures. Leave ballast in place, unless otherwise specified.

D. Inlets, Catch Basins, Manholes, and Culverts

1. Remove gratings, traps, and other metal castings of inlets, catch basins, and manholes without damaging them. Reuse them on new structures or salvage them, whichever the Engineer directs.

2. Remove old culverts down to the ground level or to the adjacent water level, unless otherwise shown on Plans.

3. Remove the bottom slabs of inlets, catch basins, manholes, and culverts. If the Engineer permits them to remain in place, break them up so that water will readily pass through them.

E. Removing Pipe

Uncover the pipe to remove it without damage. Exercise care in removing the pipe. Replace pipe sections damaged by negligence at the Contractor's expense.

After removing the pipe, clean it and neatly stack it at points directed by the Engineer along the line of the work. Unless otherwise specified, the pipe is the property of the Department.

F. Septic Tanks

When encountering septic tanks, completely remove the contents of each tank.

1. Remove and dispose of the tank's contents as required by the State Department of Health and local health authorities.

2. Before backfilling the remaining portion of the septic tank, drill holes in the bottom of the tank or break it up as the Engineer directs, to permit drainage.

G. Backfilling

Backfill trenches and other excavations dug for removing miscellaneous structures.

1. Use approved materials in the backfill.

2. Compact the backfill in layers no more than 6 in (150 mm) thick and with the proper moisture content. Use pneumatic tampers or other approved equipment.

3. Under the roadway, ensure that the degree of compaction conforms to Section 208.

   Elsewhere, compact the backfill equal to the soil surrounding it.

H. Structures to Remain

Preserve unharmed the miscellaneous structures, including fences, buildings, pipe lines, pole lines, water and sewer lines, and other improvements that owners or the Department will retain or that others will remove.

I. Culverts to be Extended

Where concrete culverts are to be extended, remove a minimum amount of concrete in parapets, wing walls, and wing wall footings to clear the new construction. Make the joint or connection as shown on the Plans or as directed by the Engineer.

J. Fences

When removing fences, do not allow livestock to escape. If fences are to be reset according to Section 611, protect the spelter coating of fence fabric, steel fence posts, and braces.

The Engineer will require that reusable posts removed be clean and free of concrete. If desired, furnish new posts instead of cleaning the old ones at no additional cost to the Department.

K. Raised Edge Curb

Remove raised edge curb to a reasonably true line at the elevation of normal finished pavement.

If the average of the plus and minus deviations approximate the original normal edge of pavement, a tolerance of approximately 1 in (25 mm) above or below this elevation will be accepted.

Do not shatter pavement that will be retained.

L. Highway Signs

Remove the entire sign from the supports, and remove the supports from the concrete foundation.

M. Lighting Standards and Appurtenances

Disassemble the lighting standard, and separate each component part including the transformer base. Cut the underground duct before removing these items.

N. Removal of Existing Building Structures

Demolish, remove, and dispose of all building structures within the right of way and easement areas including concrete slabs, footings, foundations, etc. as shown on the plans. Grade all disturbed ground to a reasonably smooth and pleasing appearance, free from loose boulders and other debris that would interfere with the use of power mowers. Grass all disturbed areas.

Prior to demolition or removal:

1. Inspect all building structures for the presence of asbestos. The inspection shall be done by an EPA Asbestos Hazard Emergency Response Act (AHERA) accredited inspector whose certification is current.
2. Provide a copy of all inspection reports including the inspector’s credentials to the Engineer.
3. Provide written notice of intent to demolish to the Georgia Environmental Protection Division (EPD) of the Georgia Department of Natural Resources in accordance with EPD regulations with a copy to the engineer. This notice is required even if there is no asbestos present.

If there is asbestos present, its removal shall be done by a contractor licensed with the EPD in accordance with the Rules of Georgia Department of Natural Resource Environmental Protection Division chapter 391-3-14-04. All asbestos removal and disposal shall be done in accordance with EPD regulations. All asbestos removal shall be considered as Extra Work and payment will be made in accordance with Subsection 109.05.

610.3.06 Quality Acceptance

General Provisions 101 through 150.

610.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

610.4 Measurement

Removing miscellaneous roadway items is measured to determine the Unit or Units of each type specified in the Proposal and on the Plans. Only when listed as a Pay Item in the Contract will a removed item be measured for separate payment.

610.4.01 Limits

General Provisions 101 through 150.

610.5 Payment

Removing miscellaneous roadway items will be paid for at the Contract Unit Price. Payment is full compensation for removing and disposing of the structures according to these Specifications.

Payment will be made under:

Item No. 610	Remove______	Per unit shown in Proposal

610.5.01 Adjustments

General Provisions 101 through 150.

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October 19, 2007

Section 624—Sound Barriers

Delete Section 624 and substitute the following:

624.1 General Description

This work includes furnishing and installing a sound barrier according to this Specification and conforming to the locations, dimensions, lines, and grades shown on the Plans.

Unless a specific type is required by the Contract documents, select one of the following barrier types

Type B	Interlock steel panels
Type C	Precast concrete panels
Type D	Treated timber panels
Type F	Glass reinforced thermoset composite structural panels
Type G	Precast autoclaved aerated concrete (PAAC) panels

624.1.01 Definitions

General Provisions 101 through 150.

624.1.02 Related References

A. Specifications

Section 106—Control of Materials

Section 201—Clearing and Grubbing Right-of-Way

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 208—Embankments

Section 210—Grading Complete

Section 500—Concrete Structures

Section 520—Piling

Section 700—Grassing

Section 702—Vine, Shrub, and Tree Planting

Section 865—Manufacturing of Prestressed Concrete Bridge Members

Section 885—Elastomeric Bearing Pads

B. Referenced Documents

GDT 7

GDT 20

GDT 21

GDT 24a

GDT 24b

GDT 59

GDT 67

QPL 42

QPL 53

Federal Specification QQ-S-763-C

AASHTO		ASTM	
M 31/M 31M M 32/M 32M M 111/M 111M M 270/M 270M	A 153/153M A 653/653M A 792/792M B 695 B 766	C 1386 D 638 D 695 D 790 D 792	D 2092 D 2583 E 90 G 154

624.1.03 Submittals

Submit Shop Drawings to the Engineer for review and approval.

Prepare Shop Drawings for each Sound Barrier.

Show all details necessary for field erection. The minimum requirements are:

Complete elevation view showing the top and bottom elevations, the required wall envelope, the roadway grade and ground line at the wall.

Diameter and depth of caissons at each post

Post size

Complete plan view with dimensions, stations and offset

Have the manufacturer certify to the Department that a specimen of the proposed barrier meets or exceeds a minimum weighted sound transmission loss of 20 dBA. Furnish test results for barrier material types (except Type C). The transmission or loss results must be based on the generalized truck spectrum when tested according to ASTM E 90.

624.2 Materials

Ensure that other materials not listed herein meet the requirements of the appropriate Specification to which they pertain.

A. Type B

1. Interlocking Steel Panels

   Use cold formed configured steel panels that meet these requirements:

   - Use steel sheet conforming to ASTM A 653/653M or ASTM A 792/792M Structural Steel (SS) Grade 50 Class 2 with a minimum thickness of 0.029 inches (0.74 mm)
   - Provides friction interlocking with adjacent panels
   - Has a male-female rib that provides a friction interlock connection with adjacent panels or is joined adequately according to the manufacturer's specifications
   - Provides sufficient friction interlock connection strength to support its own weight without using fasteners when connected to another panel and held in a vertical or horizontal position

   Use a panel size and shape shown on the Plans or an alternate approved by the Engineer.

   Coat (galvanize) the panels with either a G90 (Z275) weight of zinc according to ASTM A 653/653M or an AZ50 (AZM150) weight of 55% aluminum-zinc alloy according to ASTM A 792/792M.

2. Protective Color Coating

   Use one of the following coatings:

   a. System A—The coating is polyvinylidene fluoride (70 percent resin, minimum enamel, PVF2).

      1) Apply the coating system (including primer) at a total minimum film thickness of 1 mil (0.03 mm) per coated side.

      2) Cure the polyvinylidene fluoride film to at least 0.8 mil (0.02 mm) film thickness.

   b. System B—The coating is polyvinyl fluoride plastic film (PVF1) and has a thickness of at least 1.5 mils (0.04 mm) coated on both sides.

      1) Have the coating applied at the factory to thoroughly cleaned and pretreated galvanized steel according to ASTM D 2092, Method F.

      2) Laminate the coating to the galvanized steel using heat and adhesive to form a uniform and durable coating pigmented to obtain optimum color performance.

      3) Use a color from the Federal Standard Color Number indicated on the Plans. Ensure that caulking is color pigmented to match the wall color specified.

3. Post

   Use a post for steel walls with these features:

   - Hot rolled shape conforming to AASHTO M 270/M 270M GR 36/GR 250
   - Hot-dip galvanized by an approved galvanizer as listed on QPL-53 and in accordance with AASHTO M 111/M 111M
   - Coating that weighs at least 2 ounces/ft2 (610 g/m²) on all sides
   - Each post requires pre-inspection by the Office of Materials & Research as evidenced by a GDT stamp affixed near one end of each post

4. Steel Flashing and Caps

   Use flashing and caps for steel walls that are the same material and color coating as the panels. Fasten steel flashing and caps with self-tapping screws. Ensure that A-1 screws are Class #410 Stainless Steel and conform to Federal Specification QQ-S-763-C, or are cadmium coated according to ASTM B 766.

5. Fasteners

   Attach panels to posts using a powder-actuated fastening system. Fasteners shall be stainless steel or shall be hot-dip galvanized as per ASTM A 153 Class C or shall have a mechanically deposited zinc coating as per ASTM B 695 Class 50.

B. Type C

Use precast concrete panels that meet these requirements:

Class AA Concrete	Section 500
Reinforcing	AASHTO M 31/M 31M and M 32/M 32M
Piling-Weathering Steel	AASHTO M 270/M 270M, GR 50W/345W
Piling-Galvanized Steel	Section 520 and AASHTO M 111/M 111M
Elastomeric Bearing Pads	Section 885

Use piling, bolts, and fittings that are hot-dip galvanized when the barrier rests on another concrete structure.

C. Type D

Use treated timber panels that meet these requirements:

Type D.1	See Plan Detail D-1
Type D.2	See Plan Detail D-2
Class A Concrete	Section 500
Bolts and Washers	Plan Details
Pile	Plan Details

D. Type F

1. Structural Plank. Use continuous glass fiber reinforced structural planks that meet these requirements:
   - Are constructed of a durable, UV resistant, flame retardant, thermosetting composite material
   - Are resistant to degradation from ozone, hydrocarbons, and freeze/thaw cycling
   - Match the Federal Standard Color Number indicated on the Plans
   - Meet the following minimum mechanical properties:

PROPERTY	MINIMUM VALUE	TEST METHOD
Flexural Modulus	2,200,000 psi (15 200 MPa)	ASTM D 790
Flexural Strength	70,000 psi (480 MPa)	ASTM D 790
Tensile Strength	65,000 psi (450 MPa)	ASTM D 638
Tensile Modulus	4,500,000 psi (31 000 MPa)	ASTM D 638
Elongation	1.5 %	ASTM D 638
Compressive Strength	60,000 psi (410 MPa)	ASTM D 695
Barcol Hardness	50	ASTM D 2583
Specific Gravity	1.86	ASTM D 792

2. Filler. Use either hollow structural planks or planks filled with a recycled tire rubber compound comprised of sorted and graded ground tire rubber (0.25 + 0.025 inch (6.4 + 0.6mm)).
3. Flashing and Caps. Use flashing and caps of the same material and color as the panels.
4. Caulking. Use caulking that is color pigmented to match the wall color specified.
5. Posts. Use posts fabricated from hot rolled shapes conforming to AASHTO M 270/M 270M, GR 36/GR 250, and hot dip galvanized in accordance with AASHTO M 111/M 111M, except coating weight shall be a minimum of 2.0 oz/ft2 (600 g/m2) on all sides.
6. Other Materials. Use materials that meet the requirements of the appropriate Section in the Standard Specifications to which they pertain.

E. Type G

1. Precast Autoclaved Aerated Concrete (PAAC) Wall Units. Use PAAC wall units cast from a mixture of Portland cement, fine aggregate, water, gypsum, lime, and an expansion agent. After setting, and before hardening, the PAAC is machine cut to the required size, then steam-cured under pressure in an autoclave. Use PAAC that meets the following physical requirements:
   - Has a minimum average compressive strength of 725 psi (5000 kPa) when three specimens are tested in accordance with ASTM C 1386, with no single specimen having a compressive strength of less than 580 psi (4000 kPa).
   - Has a maximum shrinkage of 0.02% when tested in accordance with ASTM C 1386.
   - Has a dry bulk density between 34 lb/ft3 (544 kg/m3) and 41 lb/ft3 (656 kg/m3)when tested in accordance with ASTM C 1386.
2. Reinforcing. Use reinforcing that conforms to AASHTO M 31/M 31M or M 32/M 32M.
3. Galvanized Steel Supports. Use supports that conform to Drawing No. H2 as shown on the Plans.
4. Welds. Use welds conforming to Drawing No. H2.1 as shown on the Plans.
5. Coatings. Use only approved coating systems on all exposed surfaces, including steel supports. Use the same topcoat color on both the PAAC panels and the steel supports. Submit independent laboratory test results for 1500 hours of accelerated weathering in accordance with ASTM G 154. Submit results that show ratings of at least 9 in the following categories: color change, chalking, checking, cracking, blistering, flaking and rusting. Submit a certification stating that the PAAC topcoat is graffiti resistant.

624.3 Construction Requirements

624.3.01 Construction

Perform the following work according to the Specifications:

A. Clearing and Grubbing

When necessary, clear and grub according to Section 201 as applicable.

B. Excavation, Borrow, Embankment

Perform excavation, borrow, and embankment according to Section 205, Section 206, Section 208, or Section 210. The scope and dimensions of the work are shown on the Plans.

C. Grassing

Perform grassing according to Section 700, as specified on the Plans.

D. Vine, Shrub, and Tree Planting

Plant vine, shrub, and trees according to Section 702 as specified on the Plans.

E. Miscellaneous Construction Items

When items are shown on the Plans but are not covered in this Specification, the Plans and Standard Specifications govern the work.

F. Walls

Follow these requirements to construct each type of wall:

1. Type B Wall

   Install steel sound barrier walls according to the manufacturer's recommendations and Plan details.

   Repair cut, scratched, or marred surfaces according to the manufacturer's recommendations.

2. Type C Wall

   When using precast concrete panels:

   a. Cast them in a precast facility approved by the Engineer.

   b. Have the Engineer determine panel acceptability from the compressive strength of cylinders made and cured the same as the panels, and from inspection during manufacture.

      Have the panel manufacturer furnish facilities and assistance to sample and test quickly and satisfactorily.

   c. Cast the panels on a steel surface with steel side forms.

   d. Place concrete in each panel without interruption. Consolidate the concrete using vibrators supplemented by hand tamping and rodding to force the concrete into the corners of the forms to eliminate stone pockets, cleavage planes, and air bubbles.

   e. Give the panels a Type III—Rubbed Finish on the upper surface (as cast) according to Subsection 500.3.05.AB, "Finish Concrete."

   f. Cure the panels as specified in Subsection 500.3.05.Z.1, "General Curing—Supplying Additional Moisture," (wet cure) long enough for the concrete to develop the specified compressive strength.

      1) Ensure that the curing period is at least 72 hours under normal summer temperature conditions. In colder weather extend the curing period, as directed by the Engineer

      2) Protect the panels from freezing from the time the concrete is placed until curing is complete.

      3) Instead of the wet cure method, steam cure the panels as specified in Subsection 865.2.01.B.2.g.(2) if desired.

   g. Mark each panel with the date cast and the Inspector's approval stamp.

   NOTE: Even with the Inspector's acceptance at the precast yard, panels can still be rejected at the erection point if they are damaged.

   h. Erect the panels according to Plan details and dimensions.

      Place bearing pads as shown in the Plans, and tighten the restraining bolts.

   i. After erection is complete and before Final Acceptance of the Project, clean the sound barrier to remove dirt or stains.

3. Type D Wall

   The Plans shall designate the correct type of D wall (Type D.1 or Type D.2.).

   a. Type D.1 Wall

      Construct this wall of tongue and groove panels placed in a horizontal configuration supported by vertical posts set on concrete piers. Follow the Plan details for information on sizes, timber treatment, and erection.

b. Type D.2 Wall

Construct this wall of double wood panels staggered to provide a 1/2–width overlap. The supports are posts set in a concrete footing. Follow the Plans for full details of materials and erection, sizes and timber treatment.

4. Type F Wall

Install in accordance with manufacturer's recommendations and Plan details. Do not install walls with burns, discolorations, cracks, or other objectionable marks that would adversely affect the performance of the system.

5. Type G Wall

a. Cast the PAAC panels in a precast facility approved by the Engineer.

b. Have the Engineer determine panel acceptability from the compressive strength of cylinders made and cured the same as the panels, and from inspection during manufacture.

Have the panel manufacturer furnish facilities and assistance to sample and test quickly and satisfactorily.

c. Cast the panels on a steel surface with steel side forms.

d. Place concrete in each panel without interruption. Consolidate the concrete using vibrators supplemented by hand tamping and rodding to force the concrete into the corners of the forms to eliminate stone pockets, cleavage planes, and air bubbles.

e. After machine cutting to the required size, cure the PAAC units by high-pressure steam autoclaving so that the units meet the physical requirements of Subsection 624.2.E.1.

f. Mark each panel with the date cast and the Inspector's approval stamp.

NOTE: Even with the Inspector's acceptance at the precast yard, panels can still be rejected at the erection point if they are damaged.

g. Erect the panels according to Plan details and dimensions.

h. After erection is complete and before Final Acceptance of the Project, clean the sound barrier to remove dirt or stains.

i. Use coatings that are approved by the Laboratory.

1) PAAC panels. Apply the coating with a sponge-textured roller in accordance with the manufacturer's recommendations. Cover all exposed galvanized steel surfaces for protection from splattering. Apply the coating at a minimum thickness of 60 dry mils (1.5 mm). Apply the coating only when the ambient temperature is greater than 40 oF (4 oC) and rising. Do not apply any coating during rainfall or when rainfall is forecast overnight.

2) Galvanized Steel Supports. Apply a corrosion resistant coating by brush, roller, or airless spray in accordance with the manufacturer's recommendations. Protect the adjacent PAAC surfaces from overspray. Apply the coating at a minimum thickness of 2 dry mils (0.5 mm). Use a color that matches the PAAC final topcoat color. Apply the coating only when the ambient temperature and relative humidity fall within the limits stated by the manufacturer.

6. All Walls

Before beginning earthwork on the Project, stake the sound barriers in the field and establish the final groundline elevations at the barrier walls.

Furnish these elevations to the supplier who will develop the shop plans, including a complete elevation view of each barrier indicating top and bottom elevations and the roadway grade.

a. Protect the final ground elevations established in the field for the duration of the Project. Do not adjust them without the Engineer's approval.

b. Install sound barriers according to the Plans and Shop Drawings approved by the Engineer.

c. Secure joints and connections to be structurally sound with no visible openings for sound transmission. Ensure that vibration from metal barriers is not a secondary source of sound transmission.

d. Repair marred, chipped, scratched, or spalled barrier areas according to the manufacturer’s recommendations and as directed by the Engineer at the Contractor’s expense.

e. To substitute welded for fixed-bolt connections or vice versa on metal barriers, meet these conditions:

- Submit load calculations for the specific connection to be modified.
- Use a safety factor of at least 3.0.

f. Place trench backfill for sound barrier construction according to Section 207. Use select material to backfill.

If the Engineer believes the trench is too narrow for compaction, backfill the trench excavation with concrete grout to the Engineer’s satisfaction. No additional compensation will be made for the concrete grout.

g. Dispose of excess excavation to the Engineer’s satisfaction.

h. Keep right-of-way fence in place that is scheduled to be salvaged until the barrier is constructed, or as long as the Engineer deems practical.

i. After erecting the barrier, leave the disturbed area in a finished condition at the Engineer’s direction and plant grass or sod.

j. Payment for establishing grass is described in Subsection 624.4.C, “Grassing.”

k. Ensure that the barrier meets these tolerances:

1) Vertical alignment for barriers and posts is:

- 0.5 in (15 mm) for barrier heights to 10 ft (3 m)
- 1 in (25 mm) for barrier heights to 20 ft (6 m)
- 1.5 in (40 mm) for barrier heights to 30 ft (9 m)

2) Horizontal alignment for barriers is close to that shown on roadway Plans.

3) Post spacings are within 0.5 in (15 mm) of their intended location.

l. For sound barriers built on top of earth berms, construct the berms of earthwork fill material and compact to 95% of the maximum density as determined by GDT 7, GDT 24a, GDT 24b or GDT 67, as applicable. Determine in-place density according to GDT 20, GDT 21, or GDT 59, as applicable.

G. Graffiti-Proof Coating

This work includes providing graffiti-proof coating on both faces of concrete and masonry barriers from the ground line to the top of the wall.

1. Materials. Use materials as noted on QPL 42.

2. Delivery and Storage. Ensure that the materials are delivered in manufacturer’s original containers with labels intact.

   Store the materials out of the weather, in a single location, and as specified by the manufacturer.

3. Job Conditions. Protect the coating from the weather and work conditions as follows:

   a. Apply the graffiti-proof coating in weather recommended by the manufacturer.

   b. Mask, cover, or otherwise protect finished adjacent surfaces from damage that work in this Section could cause.

   c. Protect finished coatings from staining, marring, and damages from other trades.

4. Quality Criteria. Use materials that are products of one manufacturer.

   Use application equipment recommended or approved by the coating manufacturer for use on this Project. Use equipment in good operating condition.

5. Application. Ensure that the moisture content of surfaces to receive coating are within the limits recommended by the coating manufacturer.
   a. Apply coating after applying a Type III finish of concrete, or after thoroughly cleaning the concrete block.
   b. Apply coating at rate of 1 gal per 250 to 300 ft^2 (1 L per 6 to 7 m^2). Apply three coats using a low-pressure spray.
   c. Begin the coating application at the uppermost surfaces and work down.
   d. Remove loose particles, dirt, grease, oil, and other foreign materials following application.

624.3.02 Quality Acceptance

The panels are subject to rejection if they fail to meet the requirements specified above. The following defects are also cause for rejection:

- Defects from imperfect mixing and casting
- Honeycombed or open texture
- Exposed reinforcement
- Failure to meet the required 3,500 psi (25 MPa) compressive strength at 28 days.

624.4 Measurement

A. Clearing and Grubbing

Clearing and grubbing will not be measured separately for payment.

B. Excavation, Borrow, and Embankment

Excavation, borrow, and embankment will not be measured for payment unless an earthwork pay item is included in the contract.

The scope and dimensions of the work are as shown on the Plans.

C. Grassing

Grassing is not measured separately for payment unless shown on the Plans as a pay item.

D. Vine, Shrub, and Tree Planting

Vine, shrub, and tree planting shown on the Plans is measured according to Section 702.

E. Items Not Covered in This Specification

Items shown on the Plans but not covered in this Specification are measured for payment according to the applicable portions of the Specifications.

F. Walls

1. Type B Wall

   Steel wall is measured in square feet (meters) of wall surface installed before backfilling complete in place according to Subsection 109.01, “Measurement and Quantities.” There will be no separate measurement for posts, flashing, caps, concrete post embedment, or other incidental items required for construction.

2. Type C Wall

   Precast concrete sound barriers are measured in square feet (meters) of wall surface before backfilling, including pile flanges, complete in place and accepted.

   There will be no separate measurement for pile, anchor bolts, plates, connections, neoprene bearing pads, connecting bolts, or other components of the Sound Barrier.

3. Type D Wall

   Treated timber walls are measured in square feet (meters) of wall surface installed before backfilling.

   No separate measurement is made for posts, caps, foundations, footings, hardware, timber treatment, pile or cover boards.

4. Type F Wall

   Glass reinforced thermoset composite structural panel walls are measured in square feet (meters) of wall surface installed before backfilling complete in place in accordance with Section 109.

   There will be no separate measurement for posts, top caps, bottom caps, side caps, flashing, strip seals, mounting brackets and hardware, concrete post embedment, or other incidental items required for construction.

5. Type G Wall

   Precast Autoclaved Aerated Concrete walls are measured in square feet (meters) of wall surface installed before backfilling, complete in place and accepted.

   There will be no separate measurement for steel supports or any other components of the Sound Barrier.

6. All Walls

   Only authorized changes required to adjust plan ground line elevations and other authorized changes will be measured. Payment will be made based on plan quantity unless changes are authorized.

624.5 Payment

A. Clearing and Grubbing

The cost of clearing and grubbing is included in the Lump Sum Clearing and Grubbing Item for the Project. When Clearing and Grubbing is not shown as a separate Pay Item, the cost is included in the overall Contract Price for the work covered in this Specification.

B. Unclassified Excavation, Borrow and Embankment

No separate payment will be made for Excavation, Borrow and Embankment unless shown on the Plans as a separate Pay Item.

C. Grassing

No separate payment will be made for Grassing unless shown on the Plans as a separate pay item.

D. Vine, Shrub, and Tree Planting

When the Plans state that this Item will be paid for, payment will be made under Section 702.

E. Items Not Covered by This Specification

Items shown on the Plans to be paid for but are not covered by this Specification will be paid for according to the applicable portions of the Specifications.

F. Walls

Unless a specific wall type is specified in the Contract, the contractor shall construct one of the following wall types.

1. Type B Wall

   Steel wall will be paid for at the Contract Unit Price bid per square foot (meter). Payment is full compensation for furnishing and installing materials, providing post and post embedment, and providing labor, equipment, and incidentals to complete the Work.

2. Type C Wall

   Precast concrete sound barrier will be paid for at the Contract Unit Price bid per square foot (meter). Payment is full compensation for furnishing materials, including piling and attachments and for erecting the sound barrier, including graffiti-proof coating.

3. Type D Wall

   Treated timber wall will be paid for at the Contract Unit Price bid per square foot (meter). Payment is full compensation for furnishing materials including concrete and steel and for erecting the sound barrier.

4. Type F Wall

   Glass reinforced thermoset panel walls will be paid for at the Contract Unit Price bid per square foot (meter). Payment is full compensation for furnishing and installing materials, including post and post embedment, and for labor, equipment, and incidentals to complete the Work.

5. Type G Wall

   Precast autoclaved aerated concrete sound barrier will be paid for at the Contract Unit Price bid per square foot (meter). Payment is full compensation for furnishing materials, including steel supports, and for erecting the sound barrier, including graffiti-proof coating.

Additional wall payment criteria:

Walls will be paid at plan quantity plus or minus any authorized changes, or adjustments due to the ground line elevation varying from plan.

Payment will be made under:

Item No. 624	Sound barrier, type ___,	Per square foot (meter)
Item No. 624	Sound barrier	Per square foot (meter).

624.5.01 Adjustments

General Provisions 101 through 150.

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November 18, 2005

Section 638—Structural Supports for Overhead Signs

Delete Subsection 638.1.01 and substitute the following:

638.1.01 Definitions

Structural supports for overhead signs are defined generally as follows:

Type	Description
I	A SIGN BRIDGE type structure that spans the roadway with more than two horizontal chords supported by two columns, one at each end. Each column shall have at least two braced vertical members.
II	A CANTILEVER type structure with two or more horizontal chords supported by a single column at one end.
III	A BUTTERFLY type structure with two or more horizontal chords extending an equal distance in opposite directions from a single column.
IV	A COMBINATION (Bridge-Cantilever) type structure with more than two horizontal chords supported by two columns, only one at one end and one at an intermediate point. Each column shall have at least two braced vertical members.
V	A CANTILEVER type structure with a maximum of two horizontal chords supported by a single column at one end.
VI	A SIGN BRIDGE type structure that spans the roadway with a maximum of two horizontal chords supported by two columns, one at each end.
VII	A BRIDGE MOUNTED (attached to a highway bridge) structural frame.
VIII	A BUTTERFLY type structure with a maximum of two horizontal chords extending an equal distance in opposite directions from a single column.

Type II and V structures' maximum horizontal dimension shall be 32 ft (9.75 m). The horizontal dimension is measured from the column's centerline to the furthest point of the structure or sign.

Type III and VIII structures' maximum horizontal dimension shall be 25 ft (7.6 m). The horizontal dimension is measured from the furthest point of the structure or sign on one side to the furthest point of the structure or sign on the other side. Place the sign(s) on the structure to create a slightly unbalanced condition about the column’s centerline during wind loads.

Types V, VI, and VIII structural supports shall be used with flat sheet aluminum signs. If the vertical dimension of the largest sign is 42 in (1050 mm) or less, one horizontal chord may be used.

A walkway is required only when called for on the signing plans.

Delete the introductory paragraphs under Subsection 638.1.03, Submittals, and substitute the following:

638.1.03 Submittals

Submit to the Engineer 6 sets of shop drawings [(12 in x 18 in (305 x 457 mm)] half size plan sheets) and 2 sets of design calculations [8.5 in x 11 in (216 x 297 mm)] sheets, neatly bound and indexed] for the Structural Supports, anchor bolt assemblies, and foundations for review and approval. Also send a copy of your transmittal letter to the State Traffic Safety & Design Engineer.

Detail the shop drawings to permit replacement of all members and include all dimensions, construction tolerances, elevations at top and bottom of foundations, and sizes of members. The shop drawings shall include the material designations of the structure and of the hardware for attaching the sign, the lane delineation of the roadway under the structure, and the walkway (when required by the signing plans). See Figure 1, Figure 2, and Figure 3.

Delete Subsection 638.1.03.B and substitute the following:

B. Walkways

When walkways are required by the signing plans, place walkways in front of the signs and extend them at least 1 ft (300 mm) outside of the edge of all overhead signs and at least 2 ft (600 mm) outside of the right edge of paving, or as directed by the Engineer. Provide walkways in front of the lower front chord, and do not locate a portion higher than the lowest part of any sign. Make the walkway continuous from end to end with a railing along the front side that can be folded down flush with the walkway when not in use.

Delete Subsection 638.2.D and substitute the following:

D. Concrete Foundations

Class A concrete shall comply with Section 500.

Reinforcement steel shall comply with Section 853, Grade 60 (420).

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August 15, 2006

Section 647—Traffic Signal Installation

Delete Section 647 and substitute the following:

647.1 General Description

This work consists of furnishing materials and erecting a traffic signal installation including all traffic signal equipment, poles, bases, wires and miscellaneous materials required for completion of the installation. Ramp Meters are defined as a form of traffic signalization and all general provisions for traffic signalization are applicable unless otherwise noted in the Plans and Specifications.

It also includes all test periods, warranties and guarantees as designated in subsequent sections, and response to maintenance and operational issues as described in subsequent sections.

Apply for, obtain and pay for all utility services, communications services to, and pole attachment permits required by all utility owners that are necessary for the signal installation and operation required in the Plans. The Contractor will be responsible for establishing utility services and ongoing monthly costs related to utility services until final acceptance of the signal project.

Upon completion of a successful “burn in” or operational testing period for the signal installation, the Contractor will be responsible for an orderly and uninterrupted transfer of these services and permits to the local government or other jurisdiction that will be responsible for subsequent maintenance and operation.

647.1.02 Definitions

General Provisions 101 through 150.

647.1.02 Related References

A. Standard Specifications

Section 106—Control of Materials

Section 107—Legal Regulations and Responsibility to the Public

Section 108 —Prosecution and Progress

Section 150 —Traffic Control

Section 500—Concrete Structures

Section 501—Steel Structures

Section 535—Painting Structures

Section 615—Jacking or Boring Pipe

Section 631—Changeable Message Signs

Section 636 – Highway Signs

Section 639—Strain Poles for Overhead Sign and Signal Assemblies

Section 645—Repair of Galvanized Coatings

Section 680—Highway Lighting

Section 681—Lighting Standards and Luminaires

Section 682—Electrical Wire, Cable, and Conduit

Section 700—Grassing

Section 755—Electrical Work

Section 800—Coarse Aggregate

Section 801—Fine Aggregate

Section 832—Curing Agents

Section 833—Joint Fillers and Sealers

Section 850—Aluminum Alloy Materials

Section 852—Miscellaneous Steel Materials

Section 853—Reinforcement and Tensioning Steel

Section 854—Castings and Forgings

Section 861—Piling and Round Timber

Section 870—Paint

Section 886—Epoxy Resin Adhesives

Section 910—Sign Fabrication

Section 911—Steel Sign Posts

Section 912—Sign Blanks and Panels

Section 913—Reflectorizing Materials

Section 915—Mast Arm Assemblies

Section 922—Electrical Wire and Cable

Section 923—Electrical Conduit

Section 924—Miscellaneous Electrical Materials

Section 925—Traffic Signal Equipment

Section 935—Fiber Optic System

Section 936—CCTV System

Section 937—Video Detection System

Section 938—Detection

Section 939—Communications & Electronic Equipment

Section 940—Navigator Integration

B. Referenced Documents

National Electrical Manufacturers Association (NEMA) Traffic Control Systems Standards No. TS 1

NEMA Traffic Control Systems Standards No. TS 2

AASHTO Roadside Design Guide

The Manual on Uniform Traffic Control Devices (MUTCD), current edition

National Electrical Code

National Electrical Safety Code (NESC)

GDT 7 Determining Maximum Density of Soils

GDT 24a Determining the Theoretical Minimum Dry Density of Soils or Soil Aggregates containing > 45% Retained on the No. 10 Sieve

GDT 24b Determining the Theoretical Minimum Dry Density of Soils or Soil Aggregates containing > 5% Retained on 2-Inch Sieve using a 5.5 Pound Rammer and a 12 Inch Drop

GDT 67 Family of Curves Method for Determining Maximum Density of Soils

647.1.03 Submittals

The Contractor will submit to the Engineer, signal material specifications and technical data information on all materials proposed for use on the project.

Written approval is required from the State Traffic Safety and Design Engineer prior to beginning any work on the traffic signal installation and /or installing the proposed on the work site.

A. Review

For all traffic signal, and Intersection Video Detection System (IVDS) material submittals, the State Traffic Safety and Design Engineer's review of the material should be completed within thirty (30) days from the date of receipt of the submission unless otherwise specified. The State Traffic Safety and Design Engineer will advise in writing, as to the acceptability of the material submitted.

The State Traffic Safety and Design Engineer may determine that submitted equipment is approved, in which no further action is required. Or the item(s) may be partially or totally rejected due to specification compliance. In the event materials submitted for use are rejected the Contractor is required to re-submit materials, within fifteen (15) days of notification of material failure or rejection. Resubmittal of subsequent materials for review will be considered the start point of a new approval cycle as described.

All material submittals for fiber optic communications equipment system components; CCTV, VDS cameras, LED Changeable Message Signs (CMS) and other materials and equipment proposed for use on the project will be reviewed by the Department's Traffic Signal Electrical Facility (TSEF). The material review for ITS items will be completed as defined in Section 935—Fiber Optic System, Section 936—CCTV System, Section 937—Video Detection System, Section 938—Detection and Section 939—Communications & Electronic Equipment) unless otherwise specified. The State Traffic Safety and Design Engineer will advise in writing as to acceptability of materials to be used on the project.

The Department reserves the right to be reimbursed by the Contractor for reviewing any equipment and/or component submittals after a second submittal of equipment proposed for use on the project.

B. Submittal Costs

No separate measurement or payment will be made for submittal costs. All costs associated with reproduction of submittal material documents, samples and mailing expensed will be the responsibility of the Contractor and are not subject to reimbursement by the Department. All material, including equipment data sheets, samples or related equipment information become the property of the Department and will not be returned to the Contractor.

C. Steel Strain Pole, Concrete Strain Pole or Steel Pole Certification

Instruct the supplier or manufacturer of the strain poles or steel poles with traffic signal mast arms to submit a certification, including mill certificates to:

Department of Transportation
Office of Materials and Research
15 Kennedy Drive
Forest Park, Georgia 30297

Include the following in the certification:

- A statement that the items were manufactured according to the Specifications, including the Specification Subsection number
- Project number and P.I. number

Instruct the supplier or manufacturer to send copies of the transmittal letter to the Engineer.

Prepare Shop Drawings and related signal strain pole design calculations. Provide “bending moment at yield” to determine the foundation size according to the signal strain pole foundation drawings. Submit all Shop Drawings and related signal strain pole design calculations to the Engineer to be forwarded to the State Bridge and Structural Design Engineer for review and approval. Obtain written approval prior to pole fabrication and installation. Upon acceptance of the pole certification provide one copy of the design calculations and shop drawings to the agency responsible for maintaining the traffic signal installation.

Show all dimensions and material designations of the designs on the Drawings. See Section 501.1.03 for the certification procedure for poles and anchor bolts.

D. Signal Item Certification

Submit eight (8) copies of material catalog product numbers and descriptions to the Engineer. One copy of all submittals is to be provided to the maintaining agency. Reference the project number, P.I. number and Specification Subsection number for the following traffic signal items:

- Signal heads
- LED Signal Modules
- Mounting hardware
- Controllers
- Cabinet assemblies
- Battery Backup System (BBS)
- Detectors
- Monitors
- Cable
- Load switches
- Blank-out signs
- Lane use signals
- Preformed cabinet bases
- Other related signal equipment (including but not limited to Conduit, Pull boxes, Ground Rods, Enforcement Indications, etc.)

Submit the material organized in a three ring binder with sections labeled as bulleted above. Provide eight separate binders each one identical.

- For ITS items (including but not limited to Dialup Modems Fiber Cable, Fiber Optic Modems, Ethernet switches, Intersection Video Detection System) provide a separate binder organized by sections that includes all ITS items. Refer to the submittal requirements in the appropriate GDOT Specification (including but not limited to Section 935—Fiber Optic System, Section 936—CCTV System, Section 937—Video Detection System, Section 938—Detection and Section 939—Communications & Electronic Equipment).

E. Test Results Submittal

Submit the results of the testing of the following items to the Engineer. A copy of the test result submittals shall be provided to the maintaining agency.

- Loop Detector Testing
- Signal Cable Testing
- Interconnect Cable Testing
- Pre-emption Testing
- Controller and Cabinet Testing
- Any other operational testing required by the Engineer

F. Mast Arm Pole Chart

For locations with mast arm pole installations, submit a “Mast Arm Pole Chart” for review and approval by the State Bridge and Structural Design Engineer. The “Mast Arm Pole Chart” shall also include a sketch on an 8 ½ inch x 11 inch (216 mm x 279 mm) sheet of paper showing the following:

- Curb lines
- Location of mast arm pole based on utility information and field location verified by Contractor. (Final location of mast arm pole must meet the criteria for setback from the road as specified in the Roadside Design Guide by AASHTO and in the Standard Detail Drawings.
- Distance from both adjacent curbs to mast arm pole
- Distance along mast arm from pole to curb and from curb to each proposed signal head
- Directional arrow
- Street names
- Position of Luminaries

Label the sketched distances. Once this pole chart is approved, the Contractor shall use the distances measured to the proposed signal head locations when ordering the mast arm to ensure that the mast arm is fabricated with holes for signal head wiring in the correct locations.

647.2 Materials

647.2.01 Delivery, Storage, and Handling

A. State-supplied Equipment

For projects where traffic signal equipment is to be supplied by the Georgia Department of Transportation, obtain State-supplied traffic signal equipment from the Traffic Signal Electrical Facility (TSEF):

1. Contact the Engineer by phone or correspondence within one week after receiving the Notice to Proceed and arrange for a date, time and location to pick up the signal equipment and materials from the Traffic Signal and Electrical Facilities (TSEF) .

2. Sign GDOT's Warehouse Issue Request Form 592 to accept delivery of the State-supplied equipment from GDOT's Traffic Signal Equipment Warehouse. Initial Form 592 if equipment is received from a GDOT District Field Office.
3. Inspect the equipment to ensure that it is operating properly and perform any operational tests within ten (10) calendar days after receiving the equipment.
4. Before installation, and within ten (10) calendar days, certify to the Engineer in writing that the State-supplied equipment was received in good condition.
5. Notify the Engineer in writing if the State-supplied equipment is defective. The State Signal Engineer will replace the defective State-supplied equipment.
6. If no written dissent is received after ten (10) calendar days or if equipment is installed in the field, the Engineer will consider this equipment to be satisfactory and accepted.
7. The Contractor shall supply new equipment to replace State-supplied equipment that is damaged by the Contractor.

B. Signal Equipment

See Section 925 for signal equipment specifications.

The signal equipment, components, supplies, or materials used in traffic signal installation may be sampled and tested if not previously approved by the Department.

Test according to the Specifications and the Sampling, Testing, and Inspection Manual using one or more of the following methods:

- Have the Department use their own facilities.
- Have the supplier or manufacturer use their facilities with an authorized Department representative to witness the testing.
- Provide independent laboratory test results indicating compliance with Department Specifications referenced in Subsection 647.1.02, "Related References", of this document.
- When testing by the Department is required, supply the item to the Department. Acceptance of materials tested does not exclude further testing or waive warranties and guarantees required by the Specifications.

C. Cable

Use cable conforming to Section 680, Section 922, and Section 925 and the appropriate IMSA, NEMA, or UL Specifications for the wire or cable.

Obtain pole attachment permits required by local utility companies or pole owners to allow joint use for signal cable, hardware, or other auxiliary devices.

D. Interconnect Communications Cable

The interconnect cable (communication cable) links the master controller, the field controllers, and sensors. Communications cable (fiber communications cable) may also connect multiple devices such as CCTV's, CMS signs and other devices specified by the project. Interconnect communications cable may also consist of multiple strand fiber optic communication cable and /or "drop" cable assemblies used to provide continuous communications between system components. Follow these guidelines:

1. Use fiber optic interconnect cable for all new interconnected signal systems. See Section 935 for fiber optic cable information, specifications, marking and installation and testing techniques.
2. Use copper cable only as directed by the Engineer or where specifically shown in the Plans. Refer to Section 647.3.05, "Construction", of this document for installation.

E. Messenger Cable

Use cable conforming to ASTM A 475 Siemens-Martin grade or better with Class A coating. The messenger is used to support signal cable indicated in the Plans as overhead cable. Use devices such as wire ties or lashings to attach the cable.

- Before erecting the messenger strand, determine the suspension strand length to span the distance between the poles.
- Run the messenger strand from structure to structure without splicing.
- The maximum allowable sag is two and one-half percent (2.5%) of the longest diagonal distance between the signal poles.
- Calculate attachment points for the messenger strand at the signal pole according to the Plan Detail Sheet.

F. Conduit on Structures

Use rigid metallic materials for all exposed conduit for cabling. Use metallic conduit on the exterior of signal poles and other structures and to house signal conductors for the entire length from the weather head on the pole to the interior of the cabinet or to the pull box (see Subsection 647.3.05W).

647.3 Construction Requirements

Refer to Subsection 107.07 of the Specifications regarding proper conduct of The Work.

647.3.01 Personnel

For the definition of a qualified electrician, see Subsection 755.1.01.

647.3.02 Equipment

Use machinery such as trucks, derricks, bucket vehicles, saws, trenchers, and other equipment necessary for the work and approved by the Engineer prior to installation operations.

647.3.03 Preparation

Utility Permits

A. Application

Apply for, obtain, and pay for utility services and pole attachment permits for signal operation, traffic signal communications including standard telephone service and DSL communications as required in the Plans.

B. Maintenance

The Contractor will be responsible for establishing utility services and ongoing monthly costs related to utility services until Final Acceptance of the signal(s) installation, or in the event of multiple installations, the Contractor will be responsible for utility costs until overall project acceptance. After Final Acceptance, the Contractor will provide an orderly transfer these services and permits to the local government or jurisdiction responsible for maintenance and operation. Ensure that the transfer does not interrupt service.

C. Utility Location

1. Adjustment

   Prior to ordering signal poles, locate utilities and adjust the location of poles, where necessary, to minimize utility conflicts. Obtain approval from the District Traffic Engineer for any deviation from the Plans.

   Determine the final length of mast arms based on any field adjusted pole locations. Final location shall be approved by the District Traffic Engineer.

2. Clearance

   When installing aerial cable of any type, it is the Contractor’s responsibility to ensure that overhead clearance and separation requirements conform to local utility company standards, the NEC and the NESC. Refer to the Standard Details Drawings for further information on utility clearances.

3. Pre-emption

   When traffic signal pre-emption is used, coordinate with the railroad, fire department or any other agency that uses pre-emption to obtain pre-emption output and route output cable to the signal controller operating the intersection to be pre-empted. It is the Contractor's responsibility to obtain all permits and approval for crossing at grade or grade separated railroad facilities.

647.3.04 Fabrication

General Provisions 101 through 150.

647.3.05 Construction

A. Acquiring and Disposing of Equipment

Do not modify the signal equipment, design, and operation without the District Traffic Operations Engineer's written approval.

All traffic signal equipment removed or replaced shall be returned to District Traffic Signal Shops unless otherwise noted in the Plans or as directed by the Engineer or District Signal Engineer. All materials not returned to the District Signal shop shall be the responsibility of the Contractor to remove and dispose.

B. Traffic Signal Equipment Modification and Removal

Upon the Department issuance of Notice to Proceed any existing traffic signal equipment, responsibilities for maintenance, operations and response to traffic signal malfunction become the responsibility of the Contractor and provisions of Section 647.3.07, "Contractor Warranty and Maintenance", apply.

1. Remove existing signal equipment that is not used in the final installation when the new signal equipment is operational.

   Carefully remove equipment to minimize damage and retain it in its original form. This equipment may include:

   - Strain poles including the foundation down to 2 feet (600 mm) below ground level finished grade
   - Timber poles
   - Traffic signal cabinets including contents, cabinet base and work pads
   - Original signal heads including span wire support
   - Other equipment not retained in the final installation

   Ensure that unused equipment is disposed of in accordance with all Environmental Protection Agency regulations.

2. If the Plans specify delivery of salvaged equipment to a Department facility, provide an inventory list and arrange a mutually agreeable delivery time with the District Signal Engineer twenty-four (24) hours in advance.

3. Replace traffic signal equipment that the District Signal Engineer determines has been damaged or destroyed during installation or modification of the traffic signal, at no expense to the Department. Replace with new material.

4. If the Engineer finds that the existing material shown in the Plans to be relocated is unsatisfactory, replace with new material. The costs will be paid for as Extra Work. Include the removal costs of all equipment, including salvaged equipment, in the cost of the overall bid price submitted.

5. Remove old signal heads by the end of the day that the new signal equipment is placed in operation. Remove all other signal equipment within seven (7) days after operations of the newly installed equipment.

C. Auxiliary Cabinet Equipment

Provide auxiliary cabinet equipment or special purpose equipment with connecting harnesses, if necessary, or as shown in the Plans or Standard Detail Drawings.

1. Install the equipment in its associated cabinet. Extraneous wiring may be necessary to install the equipment. Additional cabling shall be enclosed in rigid, galvanized conduit and neatly secured.

2. Connect the auxiliary equipment to its cable harness, or insert it in premounted racks or sockets.

D. Signal Controllers

Furnish and install approved microprocessor controllers at the locations shown in the Plans or as directed by the Engineer. All equipment furnished shall comply with Section 925,"Traffic Signal Equipment".

1. Identify the controller and other auxiliary equipment by serial number and model. These numbers shall agree with previously approved catalog submittals.
2. Assemble the controller, cabinet, and auxiliary equipment to provide the operational sequence shown in the Plans and future operations specified. Ensure the controller functions as a unit with the cabinet assembly.
3. Ensure controller and auxiliary equipment are provided AC power from receptacles marked for controller power.
4. The Department will provide controller firmware. The Contractor shall provide the controller to the Department. The Department will load the firmware into the controller and notify the Contractor that the controller is ready to be picked up. If the controller is purchased with applications firmware, ensure that the firmware provided is the current Department licensed version of firmware including "boot code". Current firmware version shall be at the date of application " turn on" .
5. Unless otherwise specified in the Plans or directed by the Engineer, the Contractor shall deliver the controllers to and pick up the controller from the District Signal Engineer. The Department shall have 10 work days to load the controller firmware starting from the date the Contractor delivered the controllers to the Department.
6. For 2070 signal controllers used for Ramp Metering ensure the Watchdog Timer "Muzzle Jumper" is selected on the field input/output module. This is required for operating with a 208 monitor.

E. Cabinet Assembly

1. Location

   The cabinet should be located in accordance with the Plan location, however if the cabinet location needs to be moved, choose a location that:

   a. Protects maintenance personnel from vehicles when servicing the equipment
   b. Allows the front panel door of the controller to open away from the intersection for view of signal indications while servicing or performing cabinet work.
   c. Does not block a sidewalk or passageway and complies with Federal regulations for Americans with Disabilities Act (ADA) clearance requirements.
   d. Is located away from the roadway or curb line to prevent vehicular damage to the cabinet.
   e. Is not located within drainage areas or installed in areas likely to collect and hold surface water.

   Relocate the cabinet to avoid conflicts from proposed reconstruction projects, commercial driveways, etc. within the right-of-way at the Engineer's discretion.

2. Erection

   Install and level traffic signal controller cabinets at locations shown in the Plans and/or as directed by the Engineer.

   a. Install cabinets to conform to the Standard Detail Drawings. Install pole or base-mounted as indicated in the Plans.
   b. Seal base-mounted cabinets to their base using silicone based sealer. Pliable sealant used shall not melt or run at temperatures as high as 212 ºF (100 ºC).
   c. Use prefabricated bases and work pads
   d. Install technician pad in front and rear of the controller cabinet door. See Standard Details for pad information.

e. Close all unused conduit in the controller base with a PVC cap sized appropriately. Do not permanently affix the conduit cap to the conduit. Seal those conduits used for signal cable with a pliable sealant to prevent moisture and insects from entering the cabinet via the conduit.

3. Field Cabinet Wiring

All wiring shall be neat and secured and comply with NEC, NEMA, and Table 647-1, Table 647-2, Table 647-3 Table 647-4, Table 647-5 and Table 647-6 of this Specification.

a. Cut field cabinet wiring to the proper length and organize it in the cabinet. Wire lengths should be slack allowing for future modifications.

- Use at least No. 6 AWG wire on conductors between service terminals and the “AC+” terminals to signal light relays, and buss terminals.
- Use at least No. 6 AWG wire on terminal connections to light neutral.

b. Do not mount electrical meter to the cabinet. Submit ”power pedestal” or other method of providing location for mounting to the Engineer.

c. Label all field terminals and conductors so as to identify the specific field input.

d. Crimp terminal connections to conductors with a ratchet-type crimping tool that will not release until the crimping operation is completed.

e. Do not use splices inside the controller cabinet, base, or conduit.

f. Do not use solid wire, except grounding wire.

g. Supply the cabinets with cabinet wiring diagrams, schematic drawings, pin assignment charts, and manuals for circuits and components. Store these documents in the cabinet in a resealable, weatherproof container.

h. Ramp Metering requirements. The typical Ramp Meter layout is shown below:

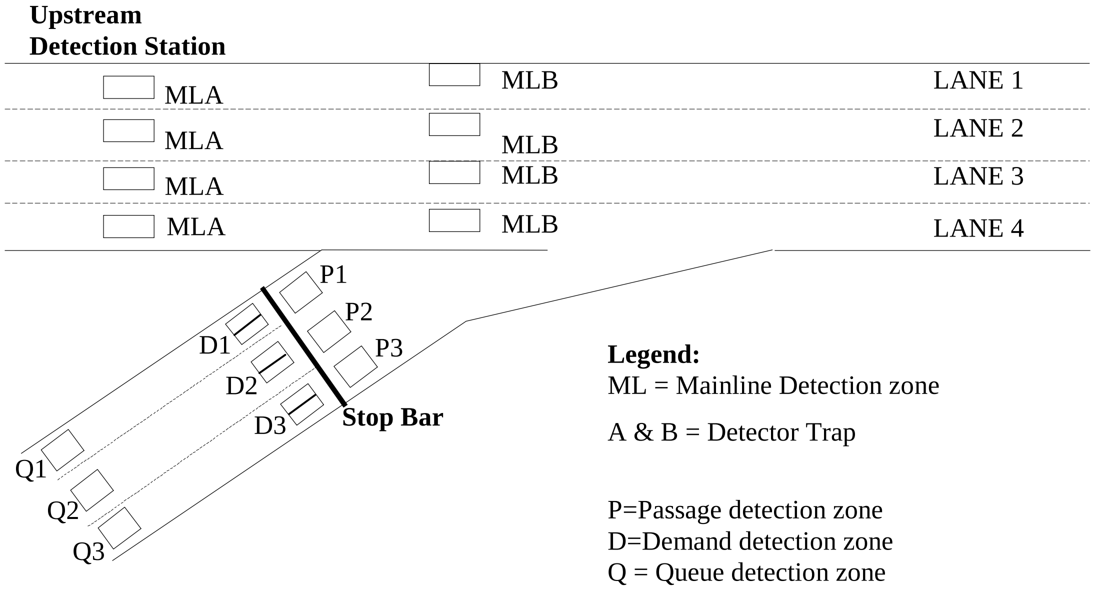

Figure 647-1 Typical Ramp Metering Layout

F. Signal Monitors

Furnish signal monitor equipment as follows,

1. Mount signal monitors in a rack with appropriate connectors to attach to the wiring harness.
2. Program the monitor according to the signal operation indicated in the Signal Plans before placing the installation in flash or stop-and-go operation. Provide any signal monitoring programming tools required to program the monitor to the maintaining agency.
3. Configure and equip the signal monitor to monitor all red signal indications. Ensure that the red output for unused or vacant load bays or output slots is jumpered to 120 V AC+.
4. For ITS Cabinets configure the CMU and AMU.
5. For Ramp Metering Cabinets mount model 208 monitor in rack and provide the necessary programming required for the Ramp Meter operation as shown in the Plans.

G. Power Disconnect

Install a power disconnect box at each intersection as shown in the Standard Detail Sheets. Ensure the power disconnect is installed at the top of the cabinet pole. Install service cables from disconnect box and terminate as specified on the controller cabinet-wiring diagram.

H. Flashing Beacon

Furnish and install the flashing beacon controller at the locations shown in the Plans and/or as directed by the Engineer. Install it as a complete unit (solid state flasher and cabinet with time clock, if applicable) and ensure that it conforms to this Specification.

I. Loop Detector Systems

Install and test loop detector systems according to NEMA Standards Publication TS 1-1983, Section 15, Inductive Loop Detectors, subsequent revisions (except as shown in the Plans), Details, notes, and this Specification.

Ensure that loop detectors are complete and fully operational before placing the signal in stop-and-go operation.

1. General Installation Requirements

   Each loop must consist of at least two turns of conductor, unless otherwise shown in the Plans or this Specification. Do not place a portion of the loop within 3 feet (1 m) of a conductive material in the pavement such as manhole covers, water valves, grates, etc.

   a. Install pull boxes, condulets, and conduits before beginning loop installation.

   b. Ensure that the ambient pavement surface temperature in the shade is at least 40 ºF (5 ºC) before placing sealant into saw cuts.

2. Loop Saw Cuts

   a. Outline the loop on the pavement to conform to the specified configuration.

   b. Ensure each loop has a separate saw cut with a minimum distance between saw cuts of 12 inches.

   c. Install the detector loop in a sawed slot in the roadway surface deep enough to provide at least 3 inches (76 mm) of sealant cover.

   d. Ensure that the slot is at least 0.25 inches (6 mm) wide for stranded No. 14 AWG loop wire, THHN, THWN, XHHN, or XLPE, and at least 0.31 inches (7 mm) wide for polyethylene or PVC encased No. 14 AWG loop wire.

      1) At the intersection of the slots, drill a 1.25 inch (31 mm) diameter hole or make miter saw cuts in the pavement. Overlap miter saw cuts at the intersection of saw cuts so that the slots have a full-depth and smooth bottom.

      2) Prevent the wire from bending sharply.

      3) Do not install detector loop wire unless sawed slots are completely dry and free of debris. Pressure wash the slot to guarantee adhesion of the loop sealant. Use compressed air to thoroughly dry the sawed slot.

      4) Install the loop wire starting at the nearest pull box or condulet, around the loop for the specified number of turns, and back to the pull box or condulet.

      5) Refer to table 647-9 for the number of turns for Quadrupole loops. Refer to table 647-8 for the number of turns for) Bipole loops. Bipole loops require at least three (3) turns.

      NOTE: Loop wire from the street is to be spliced in doublets or pull boxes only.

   e. Press the wire in the slot without using sharp objects that may damage the jacket.

   f. Hold the loop in place every 5 feet (1.5 m) with 1 inch (25 mm) strips of rubber, neoprene, flexible tubing, or foam backer rod as approved by the Engineer.

   g. Leave the hold down strips in place when filling the slot with loop sealant.

   h. Where encased loop wire is used, apply a waterproof seal to the ends of the polyethylene tubing that encase the wire to prevent moisture from entering the tube.

   i. Where the loop wires cross pavement joints and cracks, protect the loop wires using the method specified in “Miscellaneous Details” in the Plans.

   j. Twist Loop Lead-in 3 turns per foot.

3. Loop Sealing

   After successfully testing each loop, fill the slots with sealant to fully encase the conductors.

   a. Seal the slot within one hour of cutting slot.
   b. Ensure that the sealant is at least 3 inches (75 mm) thick above the top conductor in the saw cut.
   c. Apply the sealant so that subsequent expansion does not extend the sealant material above the pavement surface.
   d. Before the sealant sets, remove surplus sealant from the adjacent road surfaces without using solvents or epoxy sealants.
   e. Obtain approval from the Office of Materials and Research to use polyurethane sealants. They shall conform to Subsection 833.2.09.
   f. When the Engineer determines that the loop sealant can accommodate traffic but the surface is tacky, dust the sealer on the pavement surface with cement dust before opening the roadway to traffic.
   g. Dispose of the solvents used to clean loop installation equipment according to the manufacturer's specifications and local, State, and Federal regulations.

4. Loop Connections

   Connect loop conductors to a shielded lead-in cable that runs from the pull box adjacent the pavement edge or condulet to the detector hook-up panel in the controller cabinet, unless otherwise specified in the Plans.

   a. Use continuous (no splices) shielded lead-in cable from the pull box or condulet to the cabinet input file terminal. Do not ground the shield in the loop lead-in cable at the cabinet.
   b. Connect each loop to an individual detector channel as specified in the Plans.
   c. If the Plans specify that two or more loops will be operated on the same detector channel or detector amplifier unit, wire them in series to their loop lead-in at the pull box or condulet.
   d. Use series-parallel connections when series connections do not meet the manufacturer's specified operating range for the detector amplifier unit.
   e. Make weather-tight and waterproof splices as detailed on the Plan Standard Detail Sheets. Make loop splices to loop lead-in cable only after the detector system has been tested and demonstrated under traffic conditions to the Engineer's satisfaction.

5. Loop Maintenance

   Locate all existing loops, determine the operational status of all loop assemblies, and notify the Engineer prior to commencing loop construction activities at the intersection.

   Maintain all existing, operational loops, unless otherwise notified by the Engineer. Repair of an existing loop that is non-operational prior to beginning work will be considered as extra work.

   Locate points of conflict between new loops and existing loops, and install all new loops and saw cuts so as not to cut existing loop lead-ins and loop wires that are to be retained.

   If an existing operational loop that is not scheduled for replacement fails during the construction time frame, notify the Engineer and complete the replacement of the damaged loops immediately.

   The Engineer may grant a twenty-four (24) hour period to repair the loops if their operation is not critical. All costs associated with the replacement of the loops damaged during construction shall be charged and paid for by the Contractor.

J. Pedestrian Push Button

Install the push button with a pedestrian instruction sign as illustrated on the Department's Standard Detail Sheets and according to the Plans.

1. Place the pedestrian buttons as shown on the Signal Plan Sheet and within easy access of the pedestrian crosswalk.

   Position the pedestrian button to correspond to the appropriate signal phase. Locate pedestrian buttons perpendicular to the appropriate signal indication and signal phase, and as field conditions require.

2. Place the center of the buttons between 38 inches (0.965 m) and 42 inches (1.05 m) above the sidewalk or ground level.

3. Seal all openings to prevent moisture from entering the pushbutton.

K. Cable

Install and connect electrical cable to the proper equipment to produce an operating traffic signal system. Use stranded copper cable conforming to Section 925.

Install wiring in accordance with ISMA, NEMA, UL, and the Department's Traffic Signal Wiring Standards, shown in Tables 647-1, 647-2, 647-3, 647-4, 647-5 and 647-6 of this Specification.

In addition to the information provided below, see Section 682, Section 922, and Section 925 for cable equipment and installation specifications.

Table 647-1 Vehicular Signals Georgia DOT Wiring Standards

Signal Indications	**3-Section Signal Heads Seven Conductor Cable**		**5-Section Signal Heads Seven Conductor Cable**
	Phases 2, 4, 6, and 8	**Phases 1, 3, 5, and 7**	**Phases 1/6, 2/5, 3/8 & 4/7**
Red	Red Wire		Red Wire
Yellow	Orange Wire		Orange Wire
Green	Green Wire		Green Wire
Red Arrow		White Wire with Black Tracker	
Yellow Arrow		Black Wire	Black Wire
Green Arrow		Blue Wire	Blue Wire
Neutral	White Wire	White Wire	White Wire

Table 647-2 Vehicular Loop Detectors Georgia DOT Wiring Standards				
Detectors	**Phases 3, 4, 7, and 8 Presence Loops**		**Phases 2 and 6 Setback Pulse Loops and Phases 1 and 5 Presence Loops**	
	Loop Wires	**Shielded Loop Lead-in Cable, 3 Pair**	**Loop Wires**	**Shielded Loop Lead-in Cable, 3 Pair**
Right Curb Lane	Red Wire	Red/Black Pair (1)	Red Wire	Red/Black Pair (1)
Second Lane	Green Wire	Green Black Pair (1)	Green Wire	Green Black Pair (1)
Third Lane	White Wire	White/Black Pair (1)	White Wire	White/Black Pair (1)
Fourth Lane	Red Wire	Red/Black Pair (2)	Red Wire	Red/Black Pair (2)
Fifth Lane	Green Wire	Green/Black Pair (2)	Green Wire	Green/Black Pair (2)
Sixth Lane	White Wire	White/Black Pair (2)		
First Left-Turn Lane			Red Wire	Red/Black Pair (3)
Second Left-Turn Lane			Green Wire	Green/Black Pair (3)

Table 647-3 Pedestrian Signals Georgia DOT Wiring Standards		
Signal Indications	**2-Section Signal Heads Seven Conductor Cable**	
	Phases 2 and 6	**Phases 4 and 8**
Don’t Walk	Red Wire	White Wire with Black Tracker
Walk	Green Wire	Blue Wire
Neutral	White Wire	White Wire

Table 647-4 Pedestrian Detectors Georgia DOT Wiring Standards		
Push Buttons	**3 Pair Shielded Cable**	
	Phase 2 and 6	**Phase 4 and 8**
Call	Green and Black Pair	Red and Black Pair

NOTE: Do not use aluminum cable.

Table 647-5 Ramp Meter Signals Georgia DOT Wiring Standards	
Signal Indications	**3-Section Signal Heads Seven Conductor Cable L1,L2,L3**
Red	Red Wire
Yellow	Orange Wire
Green	Blue Wire
Neutral	White Wire

Table 647-6 Ramp Meter Loop Detectors Georgia DOT Wiring Standards				
	Demand Detector Loops		**Queue Detector Loops**	
	Loop Wires	**Shielded Loop Lead-in Cable, 3 Pair**	**Loop Wires**	**Shielded Loop Lead-in Cable, 3 Pair**
Lane 1	Red Wire	Red/Black Pair (2)	Red Wire	Red/Black Pair (1)
Lane 2	Green/Wire	Green Black Pair (2)	Green Wire	Green/Black Pair (1)
Lane 3	White Wire	White/Black Pair (2)	White Wire	White/Black Pair (1)
	Passage Detector Loops		**Mainline Detector Loops (if used)**	
	Loop Wires	**Shielded Loop Lead-in Cable, 3 Pair**	**Loop Wires**	**Shielded Loop Lead-in Cable, 3 Pair**
Lane 1	Red Wire	Red/Black Pair (3)	Red Wire	Red/Black Pair (4)
Lane 2	Green Wire	Green/Black Pair (3)	Green Wire	Green/Black Pair (4)
Lane 3	White Wire	White/Black Pair (3)	White Wire	White/Black Pair (4)

L. Signal Cable for Vehicular Signal Heads and Pedestrian Heads

Install cable for signal heads and pedestrian heads as follows:

1. For vehicle signal heads, install one 7-conductor signal cable for each intersection approach from the controller cabinet to the furthermost through-signal head on each approach. From this furthermost signal head, install a 7-conductor signal cable to each of the other signal heads on the same approach in sequence.
2. For pedestrian signal heads, install one 7-conductor signal cable from the controller cabinet to each pedestrian head installation location to operate either one or two pedestrian heads.
3. Make a minimum 1 foot (300 mm) diameter weather drip loop as shown in the Standard Detail Drawings in the Plans at the entrance to each pole, overhead conduit, and weatherhead.
4. Neatly tie signal cables leaving a structure or weatherhead to enter a signal fixture. Tie the cables to the messenger cable as illustrated in the Standard Detail Drawings.
5. Provide a 12 inch 3 turn diameter service loop at each signal head.
6. For Ramp Meter signal heads install one 7-conductor signal cable for each lane of the Ramp Meter operation from the controller cabinet .

M. Interconnect Communications Cable

Use fiber optic interconnect cable as specified in the Plans for all new interconnected signal systems. See Section 935 for fiber optic cable information, specifications and installation and testing techniques. Install interconnect communications cable as follows:

1. Provide support for the interconnect cable on new or existing utility poles or signal poles; install underground in conduit.
2. Use fiber optic standoff brackets as needed to prevent damage from poles, trees and other structures.
3. Pull cables with a cable grip that firmly holds the exterior covering of the cable.
4. Pull the cables without dragging them on the ground, pavement or over or around obstructions. The Engineer will inspect and approve the cable prior to installation. Use powdered soapstone, talc, or other approved inert lubricants to pull the cable through the conduit.
5. When using a separate messenger cable, spirally wrap the communications cable with a lashing machine according to the IMSA-20-2 Specifications.
6. Do not splice outside the signal cabinet except at the end of full reels of 5,000 feet (1500 m).
7. Ensure that splice points are near support poles and accessible without closing traffic lanes.
8. Unless drop cable assemblies for communications are used, loop the cable in and out of the control cabinets. Coil and tie 10 feet (3 m) of cable in the controller cabinet foundation. Tape the cable ends to keep moisture out until the terminals are attached.
9. Prevent damage to the cable during storage and installation.

NOTE: Do not allow anyone to step on or run over any cable with vehicles or equipment.

N. Loop Detector Lead-in Cable

Use 3-pair shielded lead-in cable in compliance with Section 925 and manufacturer’s recommendations for Detector loop lead-in installed for loop detectors. Ensure the three pair has 3 separate distinguishing colors. Use a shielded lead-in cable connecting the loop to the detector hook-up panel in the controller cabinet, unless otherwise specified in the Plans. Provide a separate 3- pair for each phase or future phase.

1. Splice the loop detector wire to a shielded loop detector lead-in cable in a pull box adjacent to the loop detector installation.
2. Use continuous (no splices) shielded lead-in cable from the pull box or condulet to the cabinet input file terminal. Do not ground the shield in the loop lead-in cable at the cabinet.
3. Connect each loop to an individual detector channel as specified in the Plans.
4. Each detection loop shall be connected to the control cabinet via separate lead-in pair.
5. Set back loops with aerial loop leads to the control cabinet shall be supported by ¼ inch messenger cable with no splices between the control cabinet and the initial point of aerial attachment.
6. Make weather tight and waterproof splices between lead-in and loop wire. Loop installation may be approved only after the detector system has been tested and demonstrated under traffic conditions to the Engineer’s satisfaction, during the Operational Test Period.

O. Pedestrian Push Button Lead-in

Use 3-pair shielded lead-in cable compliant with Subsection 925 for pedestrian push buttons. Install one 3-pair shielded lead-in cable to each pedestrian push button station(s) location to operate either one or two push buttons. Do not ground the shield for the push button lead-in cable at the controller cabinet. Do not use the same 3 pair cable for loop and pedestrian detectors.

P. Messenger Cable, Stranded-Steel

Set messenger strands so that the height of the installed traffic signal heads conforms to the clearances on the Standard Detail Drawings. Lash cables to messenger cable or use lashing rods (Subsection 925.2.43). If lashing rods are used use lashing rods sized for the cables and messenger strand. Only use lashing rods that are of the same material as the messenger strand.

1. Drill wood poles to receive the eye bolts so that the span wire and eyebolt at each connection form a straight angle.
2. Never pull or strain the messenger on the eye bolt to an angle of variance greater than ten degrees (10º).
3. Attach down guy wires to guy hooks. Never attach them directly to the eyebolt.
4. Ensure that messenger strand clearances conform with local utility company Standards.
5. Make stranded messenger cable attachment points with the appropriate size strand vises or 3 bolt clamps. Stranded steel messenger cable is not paid for separately under this Specification.
6. Use minimum ¼ inch messenger cable.
7. Use standoff brackets as needed to prevent damage from poles, trees or other structures.

NOTE: Never splice messenger cable between structures or stand off brackets.

Q. Underground Cable for Signal Circuits

Underground cable for signal circuits includes cable, with conduit, as shown in the Plans. Install cable under existing pavement or surfaced shoulder, according to Subsection 680.3.05.

1. Cable in Conduit

   Pull cable into conduits as follows:

   a. Pull cables into conduits without electrical or mechanical damage. Pull cables by hand only. The use of trucks or other equipment is not permitted, unless approved by the Engineer. If mechanical pulling is approved, do not exceed the manufacturer’s tension rating for the cable.

   b. Pull cables with a cable grip that firmly holds the exterior covering of the cable.

   c. Use powdered soapstone, talc, or other inert lubricants to place conductors in conduit according to manufacturer’s recommendations.

   d. Handle and install the conductors to prevent kinks, bends, or other distortion that may damage the conductor or outer covering.

   e. Pull all cables in a single conduit at the same time. When pulling cables through hand holes, pole shafts, etc., use a pad of firm rubber or other material between the cable and the opening edges to prevent cable damage.

   f. When installing cable in conduit with existing signal cable circuits remove all existing cables and pull them back into the conduit with the new cables.

   g. The distance between pull boxes in a run of conduit shall not be greater than 100 feet (30 m), unless otherwise shown in the Plans or approved by the Engineer or District Signal Engineer, with the exception of fiber optic cable.

   h. The distance between pull boxes in a run of conduit for fiber optic cable shall not exceed 750 feet (225 m), unless otherwise shown in the Plans or approved by the Engineer. Identification tape and tone detection wire shall be used for fiber optic cable in conduit. All unused conduit shall have a continuous pull cable installed between pull boxes. All buried conduit shall be marked using sentinel marker posts identifying buried conduit at every pull box, approved by the Engineer. See Section 682 for additional requirements.

2. Splices

   Required splicing shall be performed according to the National Electric Code; use materials compatible with the sheath and insulation of the cable.

   Insulate required splices with plastic, pressure sensitive, all-weather 1.5 mil (0.038 mm) electrical tape.

   a. Apply the tape half-lap to a thickness 1.5 times thicker than the factory-applied insulation and sheath. Taper it off over the sheath neatly to approximately 3 inches (75 mm) from the conductor splice.

   b. For cable splicing in junction boxes, use a heat-shrinkable, self-sealing splice instead of the above.

c. Pad the sharp points and edges of the connector and fill voids with extra wraps of plastic tape. Do not stretch the tape excessively or cause creeping.

d. Make the spliced joints watertight.

NOTE: Splice detector wires to shielded loop detector lead-in at pull boxes located immediately after the loop wire leaves the roadway. No splices will be permitted in shielded loop detector lead-in cable from this point to the controller cabinet.

R. Aerial Cable for Signal Circuits

Aerial cable for signal circuits consists of one or all of the following cables:

- Loop lead-in (sensor and detector)
- Signal wiring (controller)
- Interconnect cable (communications)

Support these cables on existing or newly installed signal or utility poles as detailed in Subsection 647.2.01.E .

S. Conduit and Fittings

Install conduit by type (rigid, HDPE, PVC) as shown in the Plans and the Standard Detail Drawings. Refer to the NEC, for conduit full percentages.

Separate signal conductors from vehicle detector and communications interconnect cables, except inside of poles. Separate the power cable to the controller cabinet from all other cables in its own 1in (25 mm) galvanized rigid steel conduit except inside poles. Ensure that conduit conforms to Section 682, Section 923 and Section 925 with the following addition:

- Use flexible conduit only where shown in the Details or as directed to do so in writing by the District Signal Engineer.

Use the conduit size specified in the Plans, unless otherwise directed by the Engineer. Obtain written approval from the Engineer prior to installing conduit other than the size specified in the Plans.

All 2 inch (50 mm) conduit elbows shall be “sweep” type. The minimum radius for the elbow is 18 inches (450 mm), unless otherwise approved by the Engineer.

NOTE: Do not use multi-cell conduit.

Install conduit and fittings as follows:

1. Ensure that exposed conduit on poles are rigid, galvanized metal conduit.
2. Ream the ends of metallic conduit after cutting the threads. Ream other conduit as necessary.
3. Cut the ends square, and butt them solidly in the joints to form a smooth raceway for cables.
4. Make conduit joints to form a watertight seal.
5. Coat metallic conduit threads with red- or white-lead pipe compound, thermoplastic or Teflon seal. Ensure that they are securely connected.
6. Make plastic conduit joints with materials recommended by the conduit manufacturer.
7. Install bushings in the conduit to protect the conductors. When conduit is installed for future use, properly thread and cap the ends of the metallic conduit runs.

    a. Plug the ends of nonmetallic conduit runs to prevent water or other foreign matter from entering the conduit system.

b. Seal the exposed conduit ends with a permanently malleable material.

c. Ensure that empty conduit installed for future wire or cable has a nylon pull string or cord inside that is impervious to moisture and rot and can withstand a load of 50 pounds (23 kg) without breaking. Secure this pull cord at each open end and at each pull box.

8. Ensure that conduit on pole exteriors are mounted with galvanized, two-hole straps or clamps. Place the clamps not more than 3 feet (1 m) from junction boxes, condulets, or weatherheads. Place it at 3 foot (0.9 m) intervals elsewhere.

   a. Fasten the clamps to wood poles with galvanized screws or lag bolts.

   b. Do not install conduit risers on concrete, steel, or mast arm poles unless approved by the Engineer.

9. Install a weatherhead at the end of exterior conduit runs on a pole or other structure to prevent moisture of other matter from entering the conduit.

10. After installation, ensure that the conduit or fitting placement has not warped or distorted any condulet, terminal, or control or junction box.

11. Ensure Conduit that is terminated at poles is grounded at the pull box.

T. Underground Conduit

Underground conduit includes encased or direct burial conduit.

1. Install the conduit in a trench excavated to the dimensions and lines specified in the Plans.

   a. Provide at least 18 inches (450 mm) finished cover, unless otherwise specified.

   b. Under pavement, excavate at least 36 inches (900 mm) below the bottom of the pavement.

2. Before excavation, the Contractor is responsible for determining the location of electrical lines, drainage, or utility facilities in the area to prevent damage.

   a. Place the conduit where it will not conflict with proposed guardrail, sign posts, etc.

   b. Change locations of conduit runs, pull boxes, etc., if obstructions are encountered during excavation. Changes are subject to the Engineer’s approval.

   c. Where possible, provide at least 12 inches (300 mm) between the finished lines of the conduit runs and utility facilities such as gas lines, water mains, and other underground facilities not associated with the electrical system.

3. When the conduit run is adjacent to concrete walls, piers, footings, etc. maintain at least 4 inches (100 mm) of undisturbed earth or firmly compacted soil between the conduit and adjacent concrete or, when the conduit is encased, between the encasement and the adjacent concrete. Unless specified in the Plans, do not excavate trenches in existing pavement or surfaced shoulders to install conduit.

4. When placing conduit under an existing pavement, install the conduit by jacking and boring, or other approved means. See Section 615 for jacking and boring pipe specifications. Obtain the Engineer’s approval prior to installing conduit by means of boring-method.

5. When the Plans allow trench excavation through an existing pavement or surfaced shoulder, restore the pavement shoulder surface, base, and subgrade according to the Specification.

6. Cut trenches for conduit on a slight grade (0.25 percent minimum) for drainage, unless otherwise specified. When the grade can not be maintained all one way, grade the duct lines from the center, both directions, down to the ends.

7. Avoid moisture pockets or traps. Excavate vertical trench walls.

8. Tamp the bottom of the trench to produce a firm foundation for the conduit.

9. When necessary to prevent damage, sheet and brace the trenches and support pipe and other structures exposed in the trenches.

10. Conduit installed for fiber optic cable installation shall have identification tape and detectable tone wire installed for detection as specified and detailed in the Project Standard Detail Sheets.
11. Install direct burial conduit as shown in the Plans. Use rigid galvanized steel, polyvinyl chloride, or polyethylene conduit. Excavate at least 36 inches (900 mm) below the top of the finished ground or 36 inches (900 mm) below the bottom of the pavement.
12. When rock is in the bottom of the trench, install the conduit on a bed of compacted, fine-grain soil at least 4 inches (100 mm) thick.
13. Conduit installed for fiber optic cable installation shall have detectable tone wire installed for detection as specified in Section 935 and detailed in Standard Detail Sheets.

U. Encased Conduit

Place encased conduit in the locations shown in the Plans unless otherwise specified. Construct as follows:

1. Construct the encasement using Class A concrete that meets requirements in Section 500 .
2. Extend the encasement or conduit under roadway pavements or surfaces 6 inches (150 mm) past the outer edge of paved shoulders or sidewalks, or past curbs if no shoulder or sidewalk is present.
3. Extend the conduit at least 3 inches (75 mm) beyond the encasement.
4. Place 3 inches (75 mm) of concrete in the bottom of the trench and place the conduit on top of it.
5. Temporarily plug the ends of the conduit to prevent concrete or foreign materials from entering.
6. Cover the conduit with at least 3 inches (75 mm) of concrete. Wait to encase the conduit with concrete until the Engineer inspects and approves the conduit.
7. Cure the concrete encasement according to Subsection 500.3.05.Z, except curing may be reduced to twenty-four (24) hours. Use a precast encasement if approved by the Engineer.

V. Backfilling

Immediately backfill the conduit after the Engineer's inspection and approval, except for encased conduit, which must complete a twenty-four (24) hour cure period.

1. Backfill with approved material free of rocks or other foreign matter.
2. Backfill in layers no greater than 6 inches (150 mm) loose depth, up to the original ground level.
3. Compact each layer to one hundred percent (100%) of the maximum laboratory dry density as determined by GDT 7, GDT 24a, GDT 24b, or GDT 67 whichever applies..

W. Conduit on Structures

Install conduits, condulets, hangers, expansion fittings, and accessories on structures according to the Plans and, unless otherwise specified, the following:

1. Run the conduit parallel to beams, trusses, supports, pier caps, etc.
2. Install horizontal runs on a slight grade without forming low spots so they may drain properly.
3. Run conduits with smooth, easy bends. Hold the conduit ends in boxes with locknuts and bushings to protect the conductors.
4. When not specified in the Plans or Special Provisions, submit the type and method for attachment to structures to the Engineer for submission to the District Traffic Operations Engineer for approval.
5. Ground galvanized rigid steel conduit in pull boxes.

All exposed conduit shall be galvanized, rigid conduit unless otherwise specified.

X. Testing Conduit

After installing the conduit, test it in the presence of the Engineer.

1. Test conduit using a mandrel 2 inches (50 mm) long and 0.25 inches (6 mm) smaller in diameter than the conduit.
2. Repair conduit to the Engineer's satisfaction if the mandrel can not pass through. If repairs are ineffective, remove and replace the conduit at no additional cost to the Department.
3. Thoroughly clean the conduits. When installing conduit but wiring at a later date:
   a. Perform the mandrel test.
   b. Ream the duct opening to remove burrs or foreign matter.
   c. Thoroughly clean the duct.
   d. Provide and install a weatherproof cap at each open end.
   e. All installed conduit not used or containing cable shall have a continuous nylon pull string installed between junction boxes.

Y. Grounding

Ground the cabinets, controller, poles, pull boxes, and conduit to reduce extraneous voltage to protect personnel or equipment. See Section 639 and Section 924 for grounding requirements.

NOTE: Grounding shall meet the minimum requirements of the NEC.

Provide permanent and continuous grounding circuits with a current-carrying capacity high enough and an impedance low enough to limit the potential above the ground to a safe level.

Perform grounding as follows:

1. Bond the grounding circuits to nonferrous metal driven electrodes. Use electrodes that are at least 0.625 inches (15 mm) in diameter, 8 feet (2.4 m) long, and are driven straight into the ground.
2. Use the shortest possible ground lead that leads directly to a grounding source.
3. Ensure that the maximum resistance between the ground electrode and the cabinet ground buss or other point in the grounding system is no greater than twenty five (25) ohms.
4. Connect the ground electrodes and the ground wire with an exothermic weld.
5. Connect neutral conductors to the cabinet buss-bar and ground them at each terminal point.
6. Ground the cabinet with a No. 6 AWG solid copper wire between the buss-bar to the ground electrode. Bends shall not exceed 4 inch (100 mm) radius bends.
7. Permanently ground the poles by bonding the No. 6 AWG solid copper wire to a separate ground rod.
8. Ground pole-mounted accessories to the pole.
9. Underground metallic conduit or down guys are not acceptable ground electrodes. Do not use Snap-On connections.
10. For extended distances between Ramp Meter and IVDS additional grounding may be required by the manufacturer.

Z. Ground Rod

Install copper clad ground rods in or adjacent to the traffic signal pole bases, controller cabinet bases, and pull boxes to shield and protect the grounding system.

When ground rods are not protected, bury them at least 2 inches (50 mm) below the finished ground level. See Section 924 for information pertaining to ground rod composition.

1. Use 0.625 inch (15 mm) diameter ground rods at least 8 feet (2.4 m) long. Use copper clad ground rods.
2. Drive single ground rods vertically until the top of the rod is no more than 2 inches (50 mm) above the finished ground.
3. Attach a length of No. 6 AWG solid copper wire to the top of the ground rod using an exothermic weld.

4. When controller cabinets are mounted on timber poles, ground them with No. 6 AWG solid copper wire attached to the ground rod. Run the wire inside a minimum 0.75 inch (19 mm) rigid conduit attached to the timber pole and to the chassis ground in the controller cabinet.
5. When ground penetration is not obtained:
   a. Place a horizontal ground rod system of three (3) or more parallel ground rods at least 6 feet (1.8 m) center-to-center and no more than 2 inches (50 mm) above the finished ground.
   b. Ensure that this grounding system produces a resistance of 5 ohms or less.
   c. Join the ground rods and connect them to the grounding nut of the traffic signal base with No. 6 AWG solid copper wire.
6. Install a ground wire on wood poles.
   a. Use at least No. 6 AWG solid copper wire bonded to the grounding electrode and extending upward to a point perpendicular to the uppermost span.
   b. Place wire staples no greater than 2 feet (0.6 m) apart to secure the ground wire to the pole.
   c. Connect the span wire to the pole ground using copper split bolt connectors. Provide a separate ground rod for pole mount cabinets. Do not use the pole ground. Bond the pole ground to the pole cabinet ground rod.
7. Ensure that grounding for signal strain poles conforms to the grounding assembly typical erection Detail Sheet in the Plans.
8. Permanently ground cabinet and cabinet conduits to a multi-terminal main ground buss.
   a. Use a No. 6 AWG solid copper wire bonded between the buss and grounding electrode.
   b. Connect the power company neutral, conduit ground, and grounds of equipment housed in the cabinet to the buss-bar.
   c. Do not ground to a permanent water system instead of the driven ground rod. Ensure that grounding devices conform to the requirements of the NEC and NEMA.
9. When testing for resistance ensure the ground is dry. The Contractor is responsible for submitting the ground test results.

AA. Signal Poles

See Section 501 for signal pole materials certification and Subsection 925.2.27, Subsection 925.2.28, Subsection 925.2.29, Subsection 925.2.30and Subsection 925.2.31 for traffic signal equipment. Refer to the Plans for pole locations.

Where necessary, adjust pole location to avoid utility conflicts. Provide minimum clearance distances between the signal pole and the roadway as specified in the Plans and on the Standard Detail Drawings.

1. Strain Poles

   Provide signal strain poles that conform to Section 639.

   Provide caissons or foundations that conform to the “Construction Detail for Strain Pole and Mast Arm Pole Foundations” in the Plans.

   Determine the required foundation size based on the manufacturer’s specified “bending moment at yield” for each pole.

   Provide strain poles with manufacturer-installed holes for pedestrian heads and push buttons. Seal unused holes with water tight plugs that match the pole finish provided by the manufacturer of the pole. All holes that are used shall have a rubber grommet or weather head.

   Rake the poles during installation to provide a pole that is plumb once the load is applied.

2. Metal Poles

   Install metal poles as follows:

a. Ensure that anchor bolts, reinforcing bars, and ground rods conform to Section 639 and Section 852 and are placed in the excavation.

b. Support the anchor bolts with a template to provide the proper bolt circle for the pedestal or pole to be installed.

c. Wire the reinforcing bars together or to the anchor bolts.

d. Wire the conduits in the base to the reinforcing bars for support. Ensure that they are accessible above and beyond the foundation.

e. Before pouring the foundation concrete, determine that the anchor bolt orientation is correct so that the tensile load is divided between at least two anchor bolts. Pour and vibrate the concrete with the Engineer present.

f. Ensure that the pole foundations and pedestals with the anchor-type base conform to Section 500 and Section 639. Do not install or locate poles without the Engineer's approval. Ensure the foundation extends at least 2 inches above finished grade.

   The Engineer may take a concrete test cylinder as it is being poured.

   1) Cure the cylinder and submit it for testing to the Office of Materials and Research.

   2) If the concrete foundation fails to meet the requirements of the Specifications and is not accepted, replace the foundation upon notification of failure.

g. After installing poles and applying the load of the signal span, inspect them for plumb and for the proper horizontal position of the mast arm, when applicable. Make sure all threads of the nut are threaded onto the anchor bolt.

   Correct deficiencies by using the leveling nuts on the anchor bolts or by adjusting the mast arm.

h. The Engineer will examine the pedestals and poles for damaged paint or galvanizing. Restore the finish coating where necessary.

i. After the Engineer approves the pole installation, provide an acceptable method of protecting the area between the pole base and the top of the foundation to prevent the accumulation of debris.

   If the finish or galvanized steel materials is scratched, chipped, or damaged, the material will be rejected. The finish may be replaced as specified under Section 645, with the Engineer's approval.

NOTE: Never add holes or openings to the metal pole or mast arm without approval fro the Office of Bridge and Structural Design.

j. For poles or arms that need galvanization, thoroughly clean the steel poles and arms and touch up non-galvanized parts with i-d red or original-type primer.

   Apply the remaining coats according to the System V (Heavy Exposure) Section 535, unless otherwise indicated in the Plans. The entire pole shall be the same color.

k. Install a service bracket and insulator on one pole at each intersection to attach power service wire as specified in the Plan Details. Install a disconnect box on the cabinet pole at each intersection to attach power service where the power service is provided overhead.

l. Install poles to which controller cabinets are attached with mounting plates, bolts, nipples, and at least two, 2 inch (50 mm) threaded openings at the top and bottom of the pole.

m. Attach the fittings to the poles as specified by the manufacturer in the Plans or as the Engineer directs. The fittings may include:

   - Cast aluminum cap
   - Pole clamp hardware for span wire attachment
   - Weatherhead with chase nipples and couplings

- Galvanized elbow with bushing installed by cutting the pole and welding in place around the entire circumference

n. The Office of Materials and Research will inspect the anchor bolts. If approved, the Office of Materials and Research will display the inspector's hammer stamp mark on the top of the bolt.

3. Concrete Strain Poles

a. Ensure that concrete strain poles meet the requirements of Section 639. Use concrete poles that have threaded couplings to accept weatherheads, pedestrian head mounting hardware, or utility service points shown in the construction Details.

b. Install concrete strain poles so that the angle of variance between the eye bolt on the pole and the span wire is less than ten degrees (10º).

c. Verify pole hole orientations for pedestrian heads, pedestrian push button stations, luminaries arms, etc., with the Engineer prior to proceeding with traffic signal installation. For poles at cabinet location provide at least three 2 inch (50 mm) threaded openings.

d. Plug all unused holes. Use Grout or threaded fitting. Match the finish of the pole.

4. Mast Arms

Install mast arms that can accommodate traffic signal mounting hardware and that adhere to the manufacturer's recommended procedures and Section 925 and Section 915. Do not add holes.

a. Seal the openings in the mast arms to prevent pests from entering.

b. Align the mast arm to allow the signal heads to hang plumb at the correct height without using extensions.

c. All Mast arms are to be galvanized unless indicated otherwise in the Plans.

NOTE: The Contractor shall submit a "Mast Arm Pole Chart" to the Engineer and the Office of Bridge and Structural Design for review and approval as described in Subsection 647.1.03.F of this Specification.

Verify pole hole orientations for pedestrian heads, pedestrian push button stations, luminaries arms, etc., with the Engineer prior to proceeding with traffic signal installation.

5. Aluminum Pedestrian Pedestals Poles

Install aluminum pedestal poles, which adhere to Section 850 on breakaway aluminum bases that meet the requirements for breakaway construction. See Section 925 for breakaway base requirements. See the Standard Detail Drawings for Pole and Foundation Details.

a. Secure at least four anchor bolts in a concrete foundation as shown in the construction Detail.

b. As an alternate to a concrete foundation install a Pedestal Foundation Anchor Assembly (Subsection 925.2.29). Install the foundation until the top of the base plate is level with the ground. Slide bolt heads through the keyhole and under the base plate against the bolt head keepers with threads up. Bolt the pole base to the foundation. Adhere to the manufacturers instructions for installation.

1) Use a Universal Driving Tool with the correct kelly bar adaptor and bolts supplied with the tool.

2) Attach driving tool assembly to the foundation base plate using the bolts provided with each foundation. Be sure to align the tool soothe holes in the tool line up with the proper bolt circle on the foundation.

3) Stand the foundation, with the attached drive tool assembly, upright and attach the drive-tool-foundation to the kelly bar.

4) Raise the kelly bar until the foundation swings free of the ground. Maneuver the kelly bar until the point of the foundation is over the marked installation location.

5) Lower the kelly bar until the point of the foundation is forced into the ground and the helix is flush with the ground surface.

6) Ensure the shaft of the foundation is plumb by checking the shaft with a level on tow sides that are at least 90 degrees from each other. Recheck the shaft to be sure it is plumb when the foundation has penetrated 1 foot into the ground.

7) When the base plate of the foundation is 1(25 mm) to 2 (50 mm) inches above the g round line remove driving tool.

c. Contain the wiring inside the pole. Do not allow conduit outside the pole except to wire the pedestrian push button.

d. Position the pedestal pole plumb and high enough to clear the pedestrian's head as shown in the Plans. Ensure that the bottom of the signal housing including brackets is not less than 9 feet or greater than 10 feet from the ground line.

e. Instruct the supplier to furnish a mill certificate that shows the alloy and physical properties of the steel used in fabricating the anchor bolts. The bolts may be subjected to a tensile and shear strength test.

6. Timber Poles

Timber poles do not require the use of concrete for filling the cavity around the pole base.

Use timber poles that meet the requirements of Section 861. Use Class II for all signal support poles. Use Class IV for aerial loop lead-in or communication cable if approved by the Engineer. Poles shall be inspected and include AWW stamp.

Drill wood poles to receive the eye bolt so that the angle of variance between the eye bolt and span wire at each connection is less than ten degrees (10º). See the Standard Detail Drawings for additional information.

Guy timber poles use single or double guy wires as shown in the Plans and as directed by the Engineer. Guy helper cables with separate guy wires when helper signal span cables are indicated in the Plans.

NOTE: Never attach down guy wires to eye bolts. Attach down guy wires to angle guy attachment only and install insulating rods on all down guy installations as detailed on Standard Detail sheets.

BB. Pull Boxes

Ensure that pull boxes conform to the Standard Detail Drawings or Plan Detail Sheet. Install pull boxes as required by the Specifications and Plans.

1. Include provisions for drains in pull box excavations as specified.

2. Do not place the aggregate for the drain until the Engineer approves the excavation.

3. Do not set the pull box until the aggregate is in place.

4. Set the pull boxes in place, level, and install conduits as required. Conduit entrance shall be through the open bottom in Types 1, 2, 3, 4S and 5S. Conduit entrance shall be through directly through cored holes in the side walls in Types 4 and 5. Conduit entrance shall be through the conduit terminators in Types 6 and 7.

   Adjust the location of the pull box if necessary to avoid obstacles.

   Where conduit entrance will be through the side wall in Types 4 and 5, or for conduit other than the terminator size provided in Types 6 and 7, use field cored conduit entrance holes in the side wall of the box. All field coring shall be made with a diamond-tipped masonry hole saw and according to the pull box manufacturer's recommendations.

   Use an underground-type conduit adhesive where joining conduit or conduit bodies of dissimilar materials, such as HDPE-to-PVC sweeps into pull boxes or installing into pull box conduit terminators.

   - Do not locate pull boxes on the curb side of the signal pole in the intersection radius return
   - Install pull boxes so that the long dimension is parallel to the adjacent roadway

- Install the pull box at a location that is level with the surrounding ground or pavement. Do not place a pull box in a ditch or depression. Unless otherwise shown in the Plans, when installed either in a sidewalk or in the ground, the top of the pull box shall be level with the sidewalk or ground surface

5. Obtain the Engineer's approval, and begin backfilling and installing the frame and cover. Ground metal lids or covers.

CC. Span Wire and Span Wire Assemblies

Use span wire to support signal heads, cable, and other hardware only. Use messenger cable to support the aerial cable plant. Install span wire and messenger wire where specified in the Plans and in accodance with the Standard Detail Drawings. See Section 925 for information on span wire and messenger cable.

1. Install signal span wire not to exceed the sag specified in the Standard Detail Drawings.
2. Use helper cables where specified in the Plans and on the Standard Detail Drawings.
3. See Subsection 639.3.05.F except, when erecting cable on a timber pole, in which case locate the attachment point a minimum of 18 inches (450 mm) from the top of the pole, to determine the required attachment point.
4. For construction of a box or modified box span, use bullrings. Be consistent throughout the intersection in use of bull rings or strandvises.
5. Install 12 inch (300 mm) diameter drip loop wrapped three times at the cable entrance to signal heads. Arrange cable so that it enters the structure from the bottom of the drip loop. Use a 24 inch (600 mm) diameter drip loop where cables enter a weatherhead and use 24 inch (600 mm) sag at corners of a span.
6. Lash cables to span wire or use aluminum wrap with at least three turns of wrap spaced at 6 inch (150 mm) increments.
7. Ground all span wire and down guy assemblies as shown on Standard Detail Sheets. Bond all span wire together and bond to ground at every pole.

DD. Traffic Signal Heads

Place traffic signal heads according to the signal design and Plan Detail Drawings. Deviation from the Plans must be according to the MUTCD, current edition and at the Engineer's approval. Ensure all Traffic Signal Heads at an installation have the same appearance for the signal heads and the LED Modules. The Ramp Metering enforcement device shall be mounted on the back of one signal per lane and wired to the red display. The enforcement device shall be able to be viewed from downstream on the ramp.

1. Install traffic signal heads at least 17 feet (5.1 m), but no greater than 19 feet (5.7 m) over the roadway. All vertically attached signal head assemblies shall have a metal support plate installed within the top section (RED) indication of the signal head for additional support and stability. Install Ramp Metering traffic signal heads as shown on the Plans Detail Drawings.
2. Adjust signal heads on the same approach to have the same vertical clearance.
   a. Measure the clearance from the pavement to the lowest part of the assembly, including brackets and back plates.
   b. Mount traffic signals on the side of wood or metallic poles with a clearance of at least 12 feet (3.6 m) above the sidewalk or pavement grade of the center of the highway, whichever grade is higher.
   c. Mount and adjust Ramp Metering traffic signals as per the Plan Detail Drawings.
   d. Mount and adjust Ramp Meter enforcement device (head) as per the Plan Detail Drawings.
3. Connect the signal cable to the wire in each signal head to provide the correct signal indication when the cables are connected to the controller cabinet back panels. Do not splice cables. Use wire nuts to make the connections to the LED signal modules leadin. Make all connections in the top section.
4. Install optically programmable (OP) signal heads as shown in the Plans and Standard Detail Sheet and as directed by the manufacturer.
5. Mount OP heads securely or tether them to limit movement.

6. Mask the OP lamp for directing visibility under the Engineer's supervision.
7. Tether signal heads that have tunnel visors longer than 12 inches (300 mm), at the discretion of the Engineer.
8. Attach signal heads to mast arms using rigid mounting brackets. See Section 925 for equipment information. Adjust signal heads on mast arms so that all red indications on the same mast arm are at the same elevation.
9. Install lane control heads for reversible lane systems and Ramp Metering heads as shown in the Plans and the Standard Detail Drawings. Center each signal over the lane or lanes under signal control.
10. Leave a vertical clearance for blank-out signs as shown on the Standard Detail Drawings. Use a spirit level to ensure that the bottom edge of each sign is horizontal.

EE. Pedestrian Signal Heads

Install pedestrian signal heads on wood, concrete, steel strain poles, wood or steel auxiliary poles, or metal pedestal poles. Do not mix pole mount methods at the same intersection installation.

Install the pedestrian signal heads as shown on the Standard Detail Drawings and the intersection Plan Sheets and Drawings.

Leave a vertical clearance from the bottom of the head to the ground level of least 10 feet (3 m) unless specified by the Engineer.

1. Pedestal Mounts

   Make pedestal mounts with a lower supporting assembly consisting of:

   a. A 4 inch (100 mm) slip-fitter bracket
   b. Hollow aluminum arms with a minimum inside cross-sectional area equal to a 1.5 inch (38 mm) pipe

   Use serrated locking devices that firmly hold the signal heads in the required alignment.

2. Pole Mounts (Side of Pole)

   For Metal poles, use side hinge "clamshell" mounting hardware or hardware as described in Wood Pole or Metal Pole alternate.

   a. Side Hinge "Clamshell"

      See the Standard Detail Drawings.

   b. Wood Pole or Metal Pole alternate:

      Make pole mounts with the upper and lower assembly consisting of:

      - A post arm with a minimum cross-sectional area equal to a 1.5 inch (38 mm) pipe
      - A post hub plate that matches the outside pole contour
      - Secure the hubs to metal or concrete poles using 0.75 inch (19 mm) wide and 0.030 inch (0.75mm) thick stainless steel bands. Secure the hubs to wood poles using lag bolts

   Space the junctions so that each pedestrian signal head can be directed toward approaching traffic as needed.

   Use serrated locking devices that hold the pedestrian signal heads in alignment.

FF. Blank-out Signs

Install blank-out signs as shown on Plans or as follows:

1. Securely fasten the signs to a stationary structure or to a messenger strand support system.
2. Center each sign over the lane or lanes under sign control, where applicable.
3. Leave a vertical clearance for blank-out signs as shown in the Plans or in Subsection 647.3.05.DD, "Traffic Signal Heads." Use a spirit level to ensure that the bottom edge of each sign is horizontal.

4. Use terminal strips to connect each sign electrically to the external control box or cabinet.
5. Install Ramp Meter Advance Warning Flasher Blank-out signs as shown on the Plans Detail Drawings.

GG. Battery Backup System (BBS)

Install Battery Backup System (BBS) if indicated on the Plans. Only install Battery Backup Systems at locations using LED Signal Heads. Install in accordance with the option as indicated on the Plans.

With the Battery Backup submittal provide calculations for determining the size of the inverter and batteries based on the actual power requirements for the intersection installation. Ensure that all auxiliary items are included in the calculations. Ensure the submittal specifies the model number and the firmware revision that is being supplied.

Ensure that the external cabinet supplied meets the Section 925 Specifications and is base mounted next to the 332A cabinet as specified. Do not attach the battery external cabinet to the 332A cabinet unless otherwise specified. The external cabinet option allows for 2 separate configurations. Ensure that the correct configuration is installed in accordance with the Plans. Make all connections to the 332A cabinet through the base of the cabinets.

Provide date of manufacture of all batteries provided.

Ensure the BBS functions as required by the specifications. Ensure the "ON BATTERY" relay provides an input into the controller Alarm 2.

Provide copy of all documentation (Operation and Maintenance Manual) for items supplied. Include with documentation any communications firmware and cable required interrogate the unit for status, setup or logs.

HH. Wireless Communications

Install, and integrate the spread spectrum wireless radio system with all necessary hardware in accordance with Special Provision: Section 926 – Wireless Communications Equipment: and Section 927 Wireless Communications Installation. Prior to installing any equipment perform a radio path Site Survey test. Ensure the test evaluates the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio, Data Integrity (poll test), and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. During the initial radio path signal strength test it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. Final locations of antennas and any necessary repeater stations are to be approved by the Engineer.

Install the antenna in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the National Electrical Safety Code) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole and route the coaxial cable such that no strain is placed on the coaxial connectors. On wood pole installations run a separate ground from the antenna to the base of the pole. Bond the antenna mounting hardware to the pole ground using # 6 AWG bare copper wire using split bolt or compression type fitting.

Do not exceed the 1inch (25.4 mm) bend radius of the coaxial cable as it transverses from the cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the equipment cabinet. Properly ground and secure the arrestor in the cabinet. Permanently label all cables entering the cabinet. Ensure that the power supply for the radio system is NOT connected to the GFCI receptacle circuitry located in the cabinet. Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

At certain locations it may be necessary to integrate the radio system with an existing communications system. Follow the Details shown in Plans.

647.3.06 Quality Acceptance

A. Testing Loop Detector Installation

Test each loop after installing the conductors in the slots cut in the pavement and before sealing.

- Perform a test where the loop wire is spliced to the shielded lead-in wire and where the shielded lead-in wire enters the controller cabinet

- If there are no splice points, such as in direct entry to the controller cabinet, only perform the tests at the controller
- Record the test results on the Loop Installation Data Sheet in Table 647-10, as shown in this section. Make copies of the data sheet as needed
- Include the data sheets in the records, and place a copy in the controller cabinet

Conduct the following five (5) tests to evaluate each loop installation for acceptance before sealing the loop in the pavement:

1. Induced AC Voltage Test

   Read 0.05 V AC or less on a digital voltmeter or no deflection on the pointer of an analog meter.

2. Inductance

   Inductance (I) is measured in microhenries (mH), and the total inductance is equal to the inductance of loop plus inductance of the loop lead-in.

   Acceptable inductance is within 10 percent (10%) of the calculated value for a single loop with the design criteria listed in Table 647-8 and Table 647-9:

Table 647-8 Standard (Bi-Pole) Loops

6 ft x 6 ft (3 turns) [1.8 m x 1.8 m (3 turns)]	I = 76 mH per 100 feet of loop lead-in cable I = 76 mH per 30 m of loop lead-in cable
6 ft x 30 ft (2 turns) [1.8 m x 9 m (2 turns)]	I = 126 mH per 100 feet of loop lead-in cable I = 126 mH per 30 m of loop lead-in cable
6 ft x 40 ft (2 turns) [1.8 m x 12 m (2 turns)]	I = 165 mH per 100 feet of loop lead-in cable I = 165 mH per 30 m of loop lead-in cable
6 ft x 50 ft (2 turns) [1.8 m x 15 m (2 turns)]	I = 205 mH per 100 feet of loop lead-in cable I = 205 mH per 30 m of loop lead-in cable
6 ft x 70 ft (2 turns) [1.8 m x 21 m (2 turns)]	I = 285 mH per 100 feet of loop lead-in cable I = 285 mH per 30 m of loop lead-in cable

Table 647-9 Quadrupole (QP) Loops

6 ft x 30 ft (2, 4, 2 turns) [1.8 m x 9 m (2, 4, 2, turns)]	I = 269 mH + 23 mH per 100 feet of loop lead-in cable I = 269 mH + 23 mH per 30 m of loop lead-in cable
6 ft x 40 ft (2, 4, 2 turns) [1.8 m x 12 m (2, 4, 2 turns)]	I = 349 mH + 23 mH per 100 feet of loop lead-in cable I = 349 mH + 23 mH per 30 m of loop lead-in cable
6 ft x 50 ft (2, 4, 2 turns) [1.8 m x 15 m (2, 4, 2, turns)]	I = 429 mH + 23 mH per 100 feet of loop lead-in cable I = 429 mH + 23 mH per 30 m of loop lead-in cable
6 ft x 60 ft (2, 4, 2 turns) [1.8 m x 18 m (2, 4, 2, turns)]	I = 509 mH + 23 mH per 100 feet of loop lead-in cable I = 509 mH + 23 mH per 30 m of loop lead-in cable
6 ft x 70 ft (2, 4, 2 turns) [1.8 m x 21 m (2, 4, 2, turns)]	I = 589 mH + 23 mH per 100 feet of loop lead-in cable I = 589 mH + 23 mH per 30 m of loop lead-in cable

3. Leakage Resistance to Ground

   The resistance to ground shall be 5 Mohm or more.

4. Loop Resistance

   The resistance reading on an ohmmeter is approximately within ten percent (10%) of the calculated value:

- Acceptable Resistance @ (dc @ 68 ºF [20 ºC]):ohms(μ)
- No. 18 AWG wire: R = 29.4μ/mile (or) R = 5.5 x 10^{-3}μ/ft. Approximately 5.5 ohms per 1,000 feet of No. 18 AWG wire)[R = 18.3μ/km (or) R=18.3 x 10^{-3}μ/m]
- No. 14 AWG wire: R = 13.32μ/mile (or) R = 2.523 x 10^{-3}μ/ft. Approximately 2.52 ohms per 1,000 feet of No. 14 AWG wire)[R = 8.3μ/km (or) R=8.3 x 10^{-3}μ/m]
- No. 12 AWG wire: R = 5.2μ/mile (or) R = 9.85 x 10^{-4}μ/ft. Approximately 0.98 ohms per 1,000 feet of No. 12 AWG wire [R = 3.24μ/km (or) R = 3.24 x 10^{-3}μ/m]

5. Loop Q

Q at 50 kHz is greater than 5.

Report to the Engineer an out-of-range reading on any of the above tests. If a test is found unacceptable, remove the loop, install new wire, and repeat the test procedure.

Include in the test results:

- Type and model number of the equipment used (must be ohmmeter having a high resistance scale of R x 10 KW or greater)
- The last calibration date of the equipment and the scale used

Check the loop using an impedance tester to determine the natural operating frequency and impedance. Ensure that the completed units detect all motor vehicles. If the loop detection system does not meet the above test requirements, payment will not be made for work on the signal installation until corrections are completed.

Table 647-10 Loop Installation Data Sheet	
Conditions	
Project Number:	
Date:	
Contractor:	
Weather:	
Temperature:	
Pavement Condition - Wet ( ) or Dry ( )	
Location	
City or County:	Phase:
Intersection Name or Number:	Function:
Route Number(s) or Name (s):	Lane Location:
Installation or Plan Sheet Number:	No. of Turns:
Size and Type of Loop:	Downstream/Upstream: Down ( ) Up ( )
Distance from Stop Bar:	Distance E.O.P/Curb to Lead-in:
Distance Lead-in Cable:	
Material	
Loop Wire Color/Insulation Type/Gauge:	
Loop Lead-In Wire Color/Insulation Type/Gauge:	
Splice Point:	
Conduit Length from Curb/E.O.P. to Splice Point:	
Conduit Length from Splice Point to Cabinet:	
Sealant Type and Part Number:	
Sealant Manufacturer and Lot No.:	
Interconnect Wire Type and Length:	
Loop Tests	
1. Induced Voltage _____2. Inductance _____ microhenries 3. Leakage Resistance to Ground _____ megohoms 4. Loop Resistance _____ ohms 5. Loop Q (Quality) _____ Q	
Comments	
Inspector's Name, and Title	

B. Field Tests

In addition to performing tests during installation and before turning on the equipment, perform the following tests on traffic signal circuits in the presence of the Engineer:

- Test each circuit for continuity

Test each circuit for grounds. If a test fails, repair the circuit immediately. New signals shall operate in the flash mode for three (3) days prior to beginning stop-and-go operation unless otherwise directed by the Engineer.

For Ramp Metering:

The Contractor shall submit to and obtain approval from the Engineer for Ramp Metering testing procedures for each specific Ramp Meter location. The testing procedure shall demonstrate that all components: hardware, cable, and connections furnished and installed by the Contractor operates correctly and that all functions are in conformance with the specifications.

At a minimum, the Contractor shall demonstrate to the Engineer:

- The IVDS and loop detectors at each location are functioning properly with expected accuracy as specified. IVDS burn-in period shall only be in conjunction with the Ramp Meter signal burn-in periodof 30 days.
- The Ramp Meter signals function properly at all stages, including non-metering, startup, metering, and shutdown.
- In multi-lane configurations, the Ramp Meter can operate a simultaneous release of vehicles from all lanes and as wellas an alternating or staggered release of vehicles from the two (or three) lanes..
- Queue detectors are functioning as specified, including both queue detection and queue override.
- The Ramp Meter functions properly for both local traffic responsive and time of day operations.
- The advance warning sign can be clearly seen and can be activated and deactivated properly.
- The Ramp Meter can communicate properly with the hub/TMC.
- The traffic enforcement heads are operating as per the Plans and can be seen by enforcement personnel.

The Contractor shall coordinate closely with Engineer for conducting Ramp Meter field operational tests. Note: Pretest should be performed prior to calling the Engineer for formal field tests inspection. Pretest shall be defined as conducting all field tests in accordance with the Ramp Metering field testing procecucres submitted and approved. Results of pretests shall be recorded and submitted to the Engineer. The Engineer may require the Contractor to address particular items noted in the pretest before beginning the actual field tests.

Operational test shall not begin until the field tests are accepted by the engineer.that will be performed during the Engineer’s inspection. Begin operational tests after the Engineer is satisfied that all work has been completed. After the Ramp Meter has been placed in operation, the Contractor, in coordination with the system integrator, shall demonstrate that all equipment furnished and installed by the Contractor operates with all software and firmware as specified.

After successful completion of the test procedure, each Ramp Meter assembly shall go through a burn-in period for 30 consecutive days of normal Ramp Metering operations. During the burn-in period, the Contractor shall ensure that all Contractor-supplied equipment operates without failures of any type. If any equipment component malfunctions or fails to provide the specified functionality during the 30-day burn-in period, the Contractor shall replace or repair the defective equipment within 48 hours of notification by the Engineer.

After the malfunctioning component(s) have been repaired or replaced to the satisfaction of the Engineer, the Contractor shall begin a new 30-day burn-in period. The new 30-day burn-in period shall apply only to equipment components supplied by the Contractor. In the event of a failure or malfunctioning of equipment furnished by others which prevents the 30-day burn-in test from continuing, the Engineer will suspend the burn-in test and resume when the other equipment failures are corrected.

C. Operational Tests and Equipment Activation

After the equipment is installed and the field tests are completed successfully the Contractor shall request an initial equipment inspection. The Engineer shall notify in writing the District Signal Engineer a minimum of 10 working days prior to the inspection. The District Signal Engineer shall provide an in depth inspetion and provide a written punch list of items for the Contractor to correct. Within ten days of the notification the Contractor shall correct the items noted.

Prior to activating new equipment and before removal of any existing intersection control or equipment, test and ensure any communications equipment is functional.

In the event that programming of the controller application is not a pay item for the contract the Engineer will notify the District Signal Engineer a minimum of 10 working days prior to activating the equipment.

Prior to activating equipment all Inductance loop, video detection equipment and detection zones shall be functional and operational.

When defects are resolved, the District Signal Engineer will begin the Contractor's operational test period to demonstrate that every part of the system functions as specified. The operational test shall be concurrent for the entire project.

1. The operational test for the traffic signal and Ramp Metering projects shall be at least thirty (30) days of continuous, satisfactory operation.
2. If a component or system fails or shows unsatisfactory performance, the condition must be corrected and the test repeated until thirty (30) days of continuous satisfactory operation is obtained.
3. The District Traffic Engineer will send the Engineer and Construction Office a letter showing the start, termination, suspension, or successful completion of the operational test period.
4. The District Engineer may recommend payment only after the successful completion of the test period.
5. The Contractor shall obtain written acceptance of the signal installation from the District Traffic Operations Engineer before Final Acceptance.

Costs incurred during operational tests, including power consumption, shall be at the Contractor's expense and included in the price bid for Contract Items.

647.3.07 Contractor Warranty and Maintenance

A. Traffic Signal Equipment Maintenance

Perform an inspection with the Engineer to determine the operational status of existing field equipment and finalize materials and equipment that is to be removed due to the project.

Prepare written directions identifying what equipment was operational and non-operational and responsibility for repair.

Functional responsibility for new traffic signal equipment installed will become the responsibility of the Contractor until acceptance of the project. Contractor responsibility for operation, maintenance and response to reports of operational or equipment malfunction for existing or newly installed signal material at the intersection begins from the issuance of the Notice to Proceed (NTP) until Final Acceptance of the project.

Measure and document existing vertical signal head clearance during the inspection. Maintain existing vertical clearances until Final Acceptance.

Failure to measure and document vertical clearances as part of the inspection will require that all signals be maintained with a vertical clearance of 17 feet (5.1 m) until Final Acceptance. Maintain newly installed signals continuously as detailed in following sections, until Final Acceptance.

Provide a telephone number where the Worksite Traffic Control Supervisor (WTCS) responsible representative of the Contractor can be reached twenty four (24) hours a day seven (7) days a week in the event of an emergency.

If a signal is not functioning properly:

1. Non-Emergency

   Commence work on this signal within three (3) days of the written notice from the Engineer. Failure to respond shall result in a per calendar day charged against monies due or that may become due until the maintenance work is started.

   Liquidated damages are in addition to those specified in Subsection 108.08, "Failure or Delay in Completing Work on Time," for delay or failure in completing the Work within the specified time and to the satisfaction of the Engineer.

   The Contractor shall be responsible for all materials, equipment and expertise necessary to correct signal malfunction or repair.

2. Emergency

If the Engineer determines that the signal malfunction or failure is an operational hazard, the Contractor is to take corrective action within three (3) hours of the first attempt of notification. Response shall be considered only when qualified personnel and equipment are provided.

Failure to respond within three (3) hours will result in a non-refundable deduction of money of $1,000.00 with an additional charge of $500.00 per hour after the first three (3) hours until qualified personnel and equipment arrives on site and begins corrective action.

In addition, the cost of labor and material will be charged by the Department if the Department takes corrective action using its own forces or local municipality forces.

Total charges will not exceed $5,000.00 (per emergency call) in addition to the material cost and labor incurred to make repairs by the Department or local municipality forces respond to the malfunction.

The Department will not be held responsible or liable for any alleged damage to the signal or as a result of the signal malfunction due to problems that may occur after Department or local municipality forces make emergency repairs.

The Contractor shall be responsible for all materials and equipment necessary to correct signal malfunction or repair.

Final Acceptance will not be given until payment for such work is received.

B. Warranties

Provide manufacturer’s warranties or guarantees on electrical, electronic, or mechanical equipment furnished, except state-supplied equipment.

Ensure that warranties and/or guarantees are consistent with those provided as customary trade and industry standard practices; or as otherwise specified in the Plans, Standard Specifications, or Special Provisions.

Upon Final Acceptance, transfer the manufacturer and Contractor warranties or guarantees to the Engineer. Ensure that warranties are continuous and state that they are subject to transfer.

Acceptance or approval of the Work does not waiver warranties or guarantees where required by the Specifications. Final Acceptance will not be granted until all warranties and guarantees are received.

C. Guaranties

Repair and/or replace all equipment and material supplied under these Contract Documents which has been determined by the Engineer to not meet Specifications.

The Engineer reserves the sole right to determine suitability or unsuitability of the supplied equipment and material. The Contractor shall bear the total cost of delivery and transportation related to the repair and replacement of equipment and material throughout the duration of the Contract unless otherwise approved by the Engineer.

Transfer to the Engineer any warranties and guaranties remaining on all items after Final Acceptance. Perform transfer at 12:01 AM of the day following Final Acceptance.

647.4 Measurement

647.4.01 General

Traffic signal items complete, in place, and accepted of the kind, size, and type specified are measured as follows:

A. Traffic Signal Installation

Signal installation will be paid for by lump sum, including furnishing labor, materials, tools, equipment, and incidentals required to complete the work unless otherwise specified in this Subsection.

B. Communications Wire, Fiber Optic Cable

The number of feet (meters) of communications cable, wire or fiber optic cable, is the actual number of linear feet (meters) of the size installed and accepted. Communications cable shall be paid for under Section 935.

C. Strain Poles, Traffic Signs

Highway signs are measured and paid for under Section 636. Strain poles are measured and paid for under Section 639.

D. Type 4, 4S, 5, 5S, 6 and 7 Pull Boxes

The number of pull boxes will be the actual number of pull boxes installed and accepted.

E. Loop Detector – Maintenance Milling and Resurfacing Projects

The number of loop detectors will be the actual number of loop detectors installed as specified in the Plans or as directed by the Engineer and accepted. Loop detector lead-in cable will not be measured separately for payment but will be included in the price submitted for Loop Detectors.

647.4.02 Limits

General Provisions 101 through 150.

647.5 Payment

647.5.01 General

The lump price bid for Traffic Signal and/or Ramp Meter Installation covers all Items of work in this Specification including furnishing labor, materials, tools, equipment, and incidentals required to complete the work.

Costs for installation, operation, maintenance, and removal of the traffic signal equipment are included under this Item.

Include payment for removal; disposal of existing pavement, shoulder surface, base and sub-grade; and restoration to original condition in the Contract Price for the items to which they pertain. They will not be paid for separately.

Furnishing, installing, and removing sheeting, bracing, and supports will not be paid for separately, but is included in the Contract Prices for other items.

No additional payment will be made for testing and storing State-supplied or Contractor-furnished traffic signal equipment.

No payment will be made for individual items unless a pay item is included in the Plans for the specific item.

Type 4, 4S, 5 and 5S pull boxes will be paid for per each. Loop Detector will be paid for per each.

Payment will be made under:

Item No. 647-Traffic signal installation no-	Per lump sum
Item No. 647- Pull Box PB4	Per each
Item No. 647- Pull Box PB4S	Per each
Item No. 647-Pull Box PB5	Per each
Item No. 647-Pull Box PB5S	Per each
Item No. 647-Pull Box PB6	Per each
Item No. 647-Pull Box PB7	Per each
Loop Detector	Per each

Payment for various elements of traffic signals will be as shown on the Plans.

A. Partial Payment

The Contractor may initiate a partial payment process for the lump sum traffic signal Items by submitting a written request to the Engineer. If the Engineer approves this request, payment will be made as follows:

Underground (loops, pull boxes, and conduits)	20%
Overhead (span, heads, poles, push buttons)	30%
Cabinet, contents, and base	20%
Successful completion of operational test	10%

B. Additional Items

Payment Items related to Section 647 are described in the following sections:

Strain Poles	Section 639
Highway Lighting	Section 680
Lighting Standards and Luminaries	Section 681
Electrical Wire, Cable, and Conduit*	Section 682
Grassing	Section 700
Timber Poles	Section 639 and Subsection 861.2.02
Sign Blanks	Section 912
Reflectorization Materials	Section 913
Traffic Signal Equipment/Ramp Metering Equip.	Section 925
* Payment for conduit installation shall be as described in Section 682 unless conduit installation is performed as part of a traffic signal installation, in which case measurement and payment is a part of the complete traffic signal installation. Payment is Lump Sum, unless listed as a separate pay item.	

647.5.02 Adjustments

General Provisions 101 through 150.

March 17, 2006

Section 710—Permanent Soil Reinforcing Mat

Delete Section 710 and substitute the following:

710.1 General Description

This work includes furnishing and placing a permanent mat over prepared areas according to the Plans or as directed by the Engineer.

710.1.01 Definitions

General Provisions 101 through 150.

710.02 Related References

A. Specifications

Section 700—Grassing

Section 881—Fabrics

B. Referenced Documents

QPL 49

710.1.03 Submittals

General Provisions 101 through 150.

710.2 Materials

Use materials listed in the QPL 49 .

Ensure that materials meet the following requirements.

A. Preformed Mat

Use mat with a web of mechanical or melt-bonded polymer nettings, monofilaments, or fibers entangled to form a dimensionally stable matrix. Bond the mat with one of the following:

- Polymer welding
- Thermal fusion
- Polymer fusion
- Fibers placed between two high-strength, biaxially oriented nets bound by parallel-lock stitching with polyolefin, nylon, or polyester threads.

Use a mat with enough strength and elongation to limit stretching and maintain its shape before, during, and after installation under dry or wet conditions. Provide a mat with stabilized components that avoid ultraviolet degradation and are inert to chemicals normally encountered in a natural soil environment. Ensure that the mat conforms to the following physical properties:

Property	Minimum Value	Test Method
Thickness	1/2 in (13 mm)	
Weight	0.60 lbs/yd² (325 g/m²)	
Roll width	38 in (965 mm)	
Tensile strength		ASTM D 5034*
Length (50% elongation)	15 lbs/in (2.5 N/mm)	
Length (ultimate)	20 lbs/in (3.5 N/mm)	
Width (50% elongation)	5 lbs/in (1 N/mm)	
Width (ultimate)	10 lbs/in (2 N/mm)	
Ultraviolet stability	80%	ASTM D 4355
1,000 hours in an Atlas ARC Weatherometer (ASTM G 23, Type D)		ASTM D 822
* Modified to use minimum 6 in (150 mm) wide test specimens.		

B. Stakes or Staples

Use 1 in by 3 in (25 mm by 75 mm) wood stakes made from sound stock cut in a triangular shape. Cut stakes 12 in to 18 in (300 mm to 450 mm) long depending on soil compaction. Use metal staples with the following characteristics:

- 11 gauge steel
- U shape
- Legs at least 8 in (200 mm) long
- Crown 2 in (50 mm) across

C. Filter Fabric

Use woven or nonwoven filter fabric that meets the requirements of Subsection 881.2.05, “Plastic Filter Fabric.”

710.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

Delete Subsection 710.3 and substitute the following:

710.3 Construction Requirements

710.3.01 Personnel

General Provisions 101 through 150.

710.3.02 Equipment

General Provisions 101 through 150.

710.3.03 Preparation

A. Site Preparation

Before protecting areas with mat, prepare the area according to Section 700 with the following steps:

1. Bring to final grade
2. Plow
3. Lime
4. Fertilize
5. Grass

Provide a smooth, firm, and stable surface free of rocks, clods, roots, or other obstructions that would prevent the mat from contacting the soil directly.

710.3.04 Fabrication

General Provisions 101 through 150.

710.3.05 Construction

A. Installing Mat

Do not use a mat in areas with rock outcroppings or large rocks. Install the mat either in ditches or on slopes according to the following requirements:

1. Ditches

   To install the mat in ditches:

   a. Cut a transverse trench 6 in wide by 9 in deep (150 mm wide by 225 mm deep) at the ends of the mat and at 25 ft (7.5 m) intervals along the ditch.

   b. Cut longitudinal, 4 in (100 mm) deep anchor slots along each side of the mat along the full length of the ditch, burying mat edges.

      The Engineer will require additional or deeper anchor slots for large volumes of water.

   c. Roll out the center strip of matting, starting at the lower end of the ditch.

   d. Roll out each adjacent strip of matting to overlap the preceding strip at least 3 in (75 mm).

   e. Overlap the ends of each mat roll 3 ft (1 m) with the upslope mat on top. Stretch the mat to the bottom of the slot, folding it back and staking through two layers of material.

f. Stake each strip of matting at 1 ft (300mm) intervals in each anchor slot, with one stake serving the overlapped edges of adjoining strips.

g. Backfill and compact the slot.

h. Fold the mat back over the slot and continue in the upstream direction (closed anchor slot).

i. Stake the mat snugly in the longitudinal slots and at intervals a maximum of 5 ft (1.5 m) along the ditch (open anchor slot).

j. Backfill and dress the longitudinal anchor slots.

Lay up to 10 ft (3 m) of filter fabric under runs of matting that begin at pipe outlets.

B. Grassing

Grass the entire area where mat will be placed and disturbed soil area according to Section 700.

710.3.06 Quality Acceptance

General Provisions 101 through 150.

710.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

710.4 Measurement

Permanent soil-reinforcing mat complete and accepted is measured for payment by the square yard (meter), surface measured.

710.4.01 Limits

Overlaps and anchor slots are incidental to the work and are not measured for payment.

710.5 Payment

This work will be paid for at the Contract Price per square yard (meter) for permanent soil-reinforcing mat, complete in place and accepted. Payment is full compensation for furnishing and installing the mat according to this Specification, including filter fabric and maintenance.

Preparing the area and grassing will be paid for according to Section 700.

Payment will be made under:

Item No. 710	Permanent soil reinforcing mat	Per square yard (meter)

710.5.01 Adjustments

General Provisions 101 through 150.

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November 17, 2006

Section 800—Coarse Aggregate

Delete Section 800 and substitute the following:

800.1 General Description

This section includes requirements for coarse aggregate. All aggregate shall be the specified type, class, and grade, and shall meet the requirements for the intended use.

800.1.01 Related References

A. Standard Specifications

Section 424—Bituminous Surface Treatment

B. Referenced Documents

AASHTO	ASTM	
T 11 T 27 T 96 T 104	C 277 C 289 C 294	C 295 C 586 E 30 G 23

GDT 104

GDT 129

GDT 133

QPL 2

SOP 1

800.2 Materials

800.2.01 Coarse Aggregate

A. Requirements

The Contractor shall use the type, group, class, and grade of coarse aggregate specified. For coarse aggregate sources, see QPL 2.

1. Coarse Aggregate Types

Type	Characteristics
Crushed stone	Sound, durable rock particles.
Gravel	Sound, durable rock without damaging coatings.
Air-cooled blast furnace slag	Sound, durable particles with uniform density and quality, or other slags that have a good service record. Dry slag shall weigh at least 70 lb/ft³ (1120 kg/m³) compacted and shall contain less than 30% glassy particles by weight. Do not use slag as aggregate for Portland cement concrete.
Synthetic aggregate	Sound, durable, expanded clay, shale, or other manufactured product.

2. Coarse Aggregate Groups

   a. Group I: Limestone, dolomite, marble, or any combination thereof. Ensure Group I aggregates meet the abrasion requirement for Class A stone when used in Portland cement concrete of any type or class.

   b. Group II: Slag, gravel, granitic and gneissic rocks, quartzite, synthetic aggregate, or any combination thereof.

3. Classes

   Aggregates are classified by physical properties that determine how they are used.

   a. Do not blend aggregates that meet abrasion requirements with aggregates that do not meet requirements.

   b. “Class A“ and “Class B” aggregate used in Portland cement concrete, asphaltic concrete, and bituminous surface treatment shall meet these limits:

Percent Wear AASHTO T 96 (“B” Grading)		
	Class A	Class B
Group I Aggregates	0-40	41-55
Group II Aggregates	0-50	51-60

   c. “Class B” aggregates used in all applications other than Portland cement concrete, asphaltic concrete, or bituminous surface treatment shall meet these limits:

Percent Wear AASHTO T 96 (“B” Grading)	
	Class B
Group I Aggregates	41-55
Group II Aggregates	51-65

4. Soundness

   Test coarse aggregate used in Portland cement concrete, bituminous surfaces, bituminous bases, aggregate bases, or surface treatment with five alternations of the magnesium sulfate soundness test.

   a. Use aggregate with a weight loss of less than 15 percent.

   b. The 15 percent soundness loss for a Class “CS” concrete is waived if it has a 5-year service record.

   c. If the material meets all the requirements except for the 15 percent soundness requirement, the material may be used in Zones 3 and 4 (see Subsection 424.3.05, “Construction Requirements”) under the following conditions:

      1) The aggregate in bituminous courses and in all types and classes of Portland cement concrete construction, except as stated in Group I, has a satisfactory five-year service record under similar service and exposure.

      2) The Engineer’s investigation shows that it equals or exceeds the quality of approved aggregate (in cases where the material’s uniformity changes at the source, or does not have a five-year service record).

5. Grades

Use coarse aggregate that is well graded within the limits and sizes specified in Table 800.1.

6. Detrimental Substances

a. Detrimental substances include shale, weathered or decomposed rock, friable particles, or any substance that may be detrimental for the use intended..

b. Do not use any aggregate that can cause a deleterious reaction.

c. Do not use aggregates that contain Chrysotile (defined as fibrous serpentinite) as a temporary or permanent unbound surfacing for roads, nor as stabilizer for soil used as subgrade, base, or surface course.

d. Detrimental substances shall not exceed the following limits:

1) For Portland Cement Concrete:

Substance	Max % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials.	5
Materials that pass the No. 200 (75 μm) sieve.	1.5
Flat and elongated pieces (with lengths more than five times the average thickness).	10
Sulphur content computed as sulfide sulphur (for bridge-type structures)—If the sulphur content exceeds 0.01%, do not use the aggregate unless it passes a petrographic analysis and a weathering test equivalent to 6 months or more of exposure.	0.01
Other local detrimental substances. (Any Combination)	2.0
NOTE: Do not use aggregate in Portland Cement concrete that is capable of producing a deleterious reaction when combined with Portland Cement.	

2) For Asphaltic Concrete:

Substance	Max. % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials. (Use this requirement for Interstate Construction only.)	10
Flat or elongated particles (with lengths more than five times the average thickness).	10
Glassy particles (slag).	30
Other local detrimental substances. (Any combination)	2.0

3) For Bituminous Surface Treatment:

Substance	Max. % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials.	10
Material finer than No. 200 (75 µm) sieve. #5 Stone #6 Stone #7 Stone #89 Stone	 0.5 0.7 0.7 1.0
Flat and elongated particles (with lengths more than five times the average thickness).	10
Glassy particles (slag).	30
Other local detrimental substances. (Any combination)	2

e. Ensure that gravel used in asphaltic concrete and bituminous surface treatment meets the following additional requirements:

- Consists of siliceous particles.
- A minimum of 85%, by count, of the material retained on the No. 4 (4.75 mm) sieve has one or more fractured faces.
- The fracture is for the approximate average diameter or thickness of the particle.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Material that passes the No. 200 (75 µm) sieve	AASHTO T 11
Sulphur content	ASTM E 30, Leco method
Weathering	ASTM G 23
Petrographic analysis	ASTM C 295
Soundness (magnesium sulfate)	AASHTO T 104
Percent wear	AASHTO T 96
Aggregate gradation	AASHTO T 27
Reactivity	ASTM C 227, C 289, and C 586
Schist or phyllite	GDT 104
Flat and elongated particles	GDT 129
Friable Particles	GDT 133

D. Materials Warranty

General Provisions 101 through 150.

TABLE 800.1 - SIZES OF COARSE AGGREGATES

SIZE NO	NOMINAL SIZE SQUARE OPENING S		AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS). %, BY WEIGHT										
	(1)	mm	2 ½"	2"	1 ½"	1"	¾"	½"	3/8"	No. 4	No. 8	No-16	No. 50
			63 mm	50 mm	37.5mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2.36mm	1.18 mm	300 µm
3	2-1	50 - 25	100	90-100	35-70	00-15	-----	00-5	----	-----	-----	-----	-----
357	2- No. 4	50 - 4.75	100	95-100	-----	35-70	-----	10-30	----	00-5	-----	-----	-----
4	1 ½ - 3/4	37.5 - 19	-----	100	90-100	20-55	00-15	-----	00-5	-----	-----	-----	-----
467	1 ½- No. 4	37.5 - 4.75	-----	100	95-100	-----	35-70	-----	10-30	00-5	-----	-----	-----
5	1-1/2	25 – 12.5	-----	-----	100	90-100	20-55	00-10	00-5	-----	-----	-----	-----
56	1-3/8	25 – 9.5	-----	-----	100	90-100	40-75	15-35	00-15	00-5	-----	-----	-----
57	1-No. 4	25 – 4.75	-----	-----	100	95-100	-----	25-60	-----	00-10	00-5	-----	-----
6	¾-3/8	19 – 9.5	-----	-----	-----	100	90-100	20-55	00-15	00-5	-----	-----	-----
67	¾-No. 4	19 – 4.75	-----	-----	-----	100	90-100	-----	20-55	00-10	00-5	-----	-----
68	¾-No. 8	19 – 2.36	-----	-----	-----	100	90-100	-----	30-65	05-25	00-10	0-5	-----
7	½-No. 4	12.5 – 4.75	-----	-----	-----	-----	100	90-100	40-70	00-15	00-5	-----	-----
78	½-No. 8	12.5 – 2.36	-----	-----	-----	-----	100	90-100	40-75	05-25	00-10	0-5	-----
8	3/8-No. 8	9.5 – 2.36	-----	-----	-----	-----	-----	100	85-100	10-40	0-10	0-5	-----
89	3/8-No. 16	9.5 – 1.18	-----	-----	-----	-----	-----	100	90-100	20-55	0-15	0-10	0-5
9	No. 4-No. 16	4.75 – 1.18	-----	-----	-----	-----	-----	-----	100	85-100	10-40	0-10	0-5

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.

November 17, 2006

Section 801—Fine Aggregate

Delete Section 801 and substitute the following:

801.1 General Description

This section includes the requirements for fine aggregate. All aggregate shall be the specified type, class, and grade.

801.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

Section 441—Miscellaneous Concrete

B. Referenced Documents

AASHTO	ASTM
T 11 T 21 T 27 T 112 T 303	C 295

GDT 4

GDT 5

GDT 63

GDT 75

GDT 132

QPL 1

SOP 1

801.2 Materials

801.2.01 Fine Aggregate for Cushion

A. Requirements

Use the type, class, and grade of fine aggregate specified.

1. Types

   Use fine aggregate for cushion under granite curb or brick that is natural or manufactured sand with hard, strong, durable particles. Make manufactured sand from crushed gravel or stone meeting the requirements of Section 800. For a list of fine aggregate sources, see QPL 1.

2. Grades

   Use fine aggregate for cushion with less than 10 percent total silt and clay. Grade as follows:

Size	Percent by Weight
Passing No. 4 (4.75 mm) sieve	100
Passing No. 16 (1.18 mm) sieve	25-75
Passing No. 100 (150 µm) sieve	0-25

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

- Sieve analysis—AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

801.2.02 Fine Aggregate for Portland Cement Concrete of All Types and for Mortar

A. Requirements

1. Concrete and Mortar

   Use fine aggregate for concrete and mortar that consists of natural sand, manufactured sand, or blends of natural and manufactured sands, having hard, clean, strong, durable, uncoated particles, meeting the requirements of the Specifications.

2. Manufactured Sand

   Use manufactured sand made exclusively from crushed stone or gravel that meets Section 800 requirements.

   Manufactured sand used in concrete for construction of Portland cement concrete pavement, approach slabs, and bridge decks, shall be made from Group II aggregates as specified in Subsection 800.2.01.A.2.

3. Miscellaneous Concrete

   Sand manufactured from synthetic aggregate meeting the requirements of Section 800 may be blended with natural sands or manufactured sands made from crushed stone or gravel for use in miscellaneous concrete as described in Section 441.

   Blend at least 50 percent natural sand or manufactured sand made from crushed stone or gravel.

4. Concrete Sand

   Concrete sand that passes the No. 10 (2 mm) sieve shall have these characteristics:

Characteristic	Requirement
Durability index	70 or greater
Sand equivalent	70 or greater

5. Detrimental Substances

   Keep detrimental substances within these limits:

Substance	Maximum Percent by Weight
Clay lumps	0.5 maximum in total sample
Coal and lignite	0.5 maximum in total sample
All detrimental substances (any combination)	2.0 maximum in total sample
NOTE: Do not use fine aggregate in Portland cement concrete that is capable of producing a deleterious reaction with Portland cement	

Provided the material passing the No. 16 (1.18 mm) sieve is petrographically determined to be essentially free of detrimental substances, test results for coal and lignite and other detrimental substances listed will be based upon a petrographic analysis of material retained on the No. 16 (1.18 mm) sieve.

Calculations will be based upon the weighted average for the total sample.

Other detrimental substances include constituents such as shale, weathered or decomposed rock, soft or friable particles, coated grains, or other substances that might be considered detrimental for the use intended.

6. Organic Impurities (natural sands only)

   Ensure all fine aggregate is free from detrimental amounts of organic impurities.

   Do not use materials that have colorimetric test (AASHTO T 21) results darker than the Reference Standard color plate.

7. Grades

   Grade fine aggregates for Portland cement concrete and mortar as follows:

Size No.	Description	Total Percent by Weight Passing Each Sieve					
		3/ 8 in (9.5 mm)	No. 4 (4.75 mm)	No. 16 (1.18 mm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)
10 NS	Natural concrete sand	100	95-100	45-95	8-30	1-10	0-3
20 NS	Natural mortar sand	100	100	90-100	15-50	0-15	0-5
10 SM	Standard manufactured concrete sand	100	95-100	45-95	8-30	1-10	0-4
10 FM	Fine manufactured concrete sand	100	95-100	45-95	15-42	6-22	0-9

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Petrographic analysis	ASTM C 295
Material that passes a No. 200 (75 µm) sieve	AASHTO T 11
Organic impurities	AASHTO T 21
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63
Reactivity	AASHTO T 303
Durability index	GDT 75
Clay lumps	AASHTO T 112
Friable Particles	GDT 132
NOTE: The percent passing the No. 200 sieve (75 µm) for size 10FM will be based upon the total percent determined by AASHTO T-11 and AASHTO T-27. The percent passing the No. 200 sieve (75 µm) for sizes 10NS, 20NS and 10SM will be as determined by AASHTO T-11 only.	

D. Materials Warranty

General Provisions 101 through 150.

Section 802—Aggregates for Asphaltic Concrete

Delete Section 802 and substitute the following:

802.1 General Description

This section includes the requirements for fine and coarse aggregates used in asphaltic concrete.

802.1.01 Definitions

Fine Aggregate: All aggregate passing a No. 8 (2.36 mm) sieve

Coarse Aggregate: All aggregate retained on a No. 8 (2.36 mm) sieve

802.1.02 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

Section 828—Hot Mix Asphaltic Concrete Mixtures

B. Referenced Documents

AASHTO T 27

AASHTO T 96

ASTM C 295

GDT 63

GDT 76

SOP 1

802.2 Materials

802.2.01 Fine Aggregate for Asphaltic Concrete

A. Requirements

Use the appropriate type, group, class, and grade of fine aggregate.

1. Types

   Use fine aggregate made of sharp, strong, angular material meeting the required performance characteristics when combined into a mixture.

   a. Ensure that the aggregate meets the following requirements:

   - Does not contain any deleterious substances.
   - Natural sand is free of organic matter, roots, or twigs.
   - Aggregate is manufactured from Class A or B crushed stone, gravel, slag, or synthetic aggregate that meets the requirements of Section 800.
   - A combination of natural and manufactured sands meets the requirements in Subsection 802.2.01.A.3 and Subsection 802.2.01.A.4 after being combined.

   b. Do not use crushed alluvial gravel as virgin aggregate in any mixture.

2. Groups

   Fine aggregate groups include:

   a. Group I—Limestone, dolomite, marble, or combination thereof

   b. Group II—Gravel, slag, granitic and gneissic rocks, quartzite, natural sand, or a combination thereof

3. Sand Equivalent

   Use these sand equivalent values:

Material	Sand Equivalent Value
Group I	At least 28
Group II	At least 40
Natural sand	At least 25
Blended sand*	Natural sand at least 20; combined blend at least 25
*Blended natural sands or natural sand blended with stone screenings that meet the Group I or Group II sand equivalent limits.	

4. Mica

   a. Use fine aggregate with no more than 35 percent free mica in asphaltic concrete surface mixes.

   b. When approved by the Engineer, use fine aggregate with more than 35 percent mica if blended with natural sand or sand manufactured from Group II aggregates. Ensure the blend has no more than 35 percent free mica and meets all other requirements of this Section, Section 800 and Section 828.

5. Aggregate for Stone Matrix Asphalt

   Manufactured screenings will be considered as fine aggregate and shall contain no more than 20 percent by weight coarser than a No. 4 (4.75 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the fine aggregate as follows:

Test	Method
Aggregate gradation	AASHTO T 27
Sand equivalent	GDT 63
Mica content	GDT 76 or ASTM C 295

D. Materials Warranty

General Provisions 101 through 150.

802.2.02 Coarse Aggregate for Asphaltic Concrete

A. Requirements

1. Types

   Ensure coarse aggregate meets the following requirements:

   - Class A or B crushed stone, gravel, slag, or synthetic aggregate as in Subsection 800.2.

- Have uniform quality throughout without any deleterious substances.
- Meet the required performance characteristics when combined into a mixture.

NOTE: Do not use alluvial gravel as virgin aggregate.

2. Groups

   Coarse aggregate shall be one of either group below as specified in the composition Table in Subsection 828.2.A.2:

   - Group I—Limestone, dolomite, marble, or combination thereof
   - Group II—Gravel, slag, granite and gneissic rocks, quartzite, or combination thereof

3. Aggregate for Stone Matrix Asphalt

   Use coarse aggregate that meets requirements of this Section and Section 800 except as follows:

   - Use Class A aggregate only with percent wear of each individual size not to exceed 45 percent based on the B grading of AASHTO T 96
   - Use aggregate which contains no more than 20 percent flat and elongated pieces (length greater than three times the average thickness) for that portion of the blend of all aggregate retained on the No. 4 (4.75 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Coarse Aggregate	Subsection 800.2.01.C

D. Materials Warranty

General Provisions 101 through 150.

November 17, 2006

Section 803—Stabalizer Aggregate

Delete Section 803 and substitute the following:

803.1 General Description

This section includes the requirements for stabilizer aggregate, Types I through III, and Type IV stabilizer sand.

803.1.01 Related References

A. Standard Specifications

Section 800—Course Aggregate

B. Referenced Documents

AASHTO T 27

AASHTO T 96

GDT 63

SOP 1

803.2 Materials

803.2.01 Type I Stabilizer

A. Requirements

Use the appropriate type, class, and grade of stabilizer aggregate.

Use material of uniform quality that meets the requirements of Section 800, Class A or B aggregate, and SOP 1. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates. Ensure the material meets the following gradation:

Sieve Size	% Passing by Weight
1-1/2 in (37.5 mm)	100
1 in (25 mm)	80-100
No. 8 (2.36 mm)	0-5

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Use the following test:

Test	Method
Sieve analysis	ASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

803.2.02 Type II Stabilizer Aggregate

A. Requirements

Use material that meets the requirements of Section 800, Class A or B aggregate, and SOP 1. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates.

The aggregate shall:

- Not contain overburden soil or disintegrated rock
- Have a sand equivalent value of at least 20 for material passing the No. 10 (2 mm) sieve
- Meet these gradation requirements:

Sieve Size	% Passing by Weight
2 in (50 mm)	100
1-1/2 in (37.5 mm)	95-100
No. 10 (2 mm)	15-45
No. 200 (75 µm)	0-12

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test type II stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

803.2.03 Type III Stabilizer Aggregate

A. Requirements

Use material that meets the requirements of Section 800, Class A or B aggregate, and SOP 1. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates.

Ensure the stabilizer aggregate does not contain soil or decomposed rock and that the Sand Equivalent value of the material passing the No. 10 sieve is not less than 20.

The aggregate shall meet these gradation requirements:

Sieve Size	% Passing by Weight
6 in (150 mm)	100
2 in (50 mm)	25-75
No. 10 (2 mm)	15-35

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test Type III stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Percent wear	AASHTO T 96

D. Materials Warranty

General Provisions 101 through 150.

803.2.04 Type IV Stabilizer Sand

A. Requirements

Make Type IV stabilizer sand from either natural sand, manufactured sand, or any combination of natural and manufactured sands.

1. If using manufactured sand, make the sand from Class A or B crushed stone, gravel, slag, or synthetic aggregate that meets Section 800 requirements and conforms to SOP 1.

2. Type IV stabilizer sand shall have a sand equivalent of at least 35 for material passing the No. 10 (2 mm) sieve and shall also meet these gradation requirements.

Sieve Size	% Passing by Weight
No. 10 (2 mm)	60-100
No. 60 (250 µm)	5-40
No. 200 (75 µm)	0-20

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test Type IV stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

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November 18, 2005

Section 810—Roadway Materials

Delete Subsection 810.2.01.A and substitute the following:

A. Requirements

Do not use materials containing logs, stumps, sod, weeds, or other perishable matter.

1. Classes

The materials are divided into six major classes. Classes I, II, and III are further subdivided and identified by description and physical property requirements specified in the table below and in Table 1. Classes IV, V, and VI are identified by descriptive requirements.

Class I	
IA1 and IA2	Medium- to well-graded sand or clayey sand.
IA3	Fine-grained, silty, or clayey sand; usually less dense than IA1 or IA2. These soils have an excellent bearing capacity.
Class II	
IIB1, IIB2, and IIB3	Medium- to well-graded sandy clays, sandy silts, and clays with some mica. These soils generally have low volume change properties and good densities that serve well as subgrade material.
IIB4	Similar to IIB1, IIB2, and IIB3, but generally contain more mica and are more sensitive to moisture. The bearing value of these soils is less predictable. The soils may or may not be satisfactory for subgrade material. Analyze file data or run laboratory and/or field tests for Class IIB4 when considering it for a subgrade material.
Class III	
IIIC1, IIIC2, IIIC3 and IIIC4	Medium- to fine-graded micaceous sandy silts, micaceous clayey silts, chert clays, and shaly clays. Undesirable characteristics are high volume change properties and/or low densities. The bearing values are unpredictable. The Department recommends testing these materials in a laboratory, where possible, before use. One exception is District 6, where chert clay soils are prevalent. Chert clay soils (IIIC4) with less than 55% passing the No. 10 (2 mm) sieve may be considered suitable for subgrade materials. These soils are found generally in the northwest corner of the state in Dade, Walker, Catoosa, Whitfield, Murray, Chattooga, Gordon, and Floyd counties.
Class IV	Highly organic soils or peat, muck, and other unsatisfactory soils generally found in marshy or swampy areas.
Class V	Shaly materials that are not only finely laminated but have detrimental weathering properties and tend to disintegrate.
Class VI	Rock or boulders that cannot be readily incorporated into the embankment by layer construction, and that contain insufficient material to fill the interstices when they are placed.

Table 1: Physical Properties (Material Passing No. 10 (2.00 mm) Sieve)

Sub-Class	No. 60 (250 µm) Sieve % Passing	No. 200 (75 µm) Sieve % Passing	Clay, %	Volume Change, %	Maximum Dry Density lbs/ft^3 (kg/m^3)
Class I					
A1	15-65	0-25	0-12	0-10	115+ (1840+)
A2	15-85	0-35	0-16	0-12	100+ (1600+)
A3	15-100	0-25	0-12	0-18	98+ (1570+)
Class II					
B1		0-30	0-20	0-10	120+ (1920+)
B2		0-45	0-30	0-15	110+ (1760+)
B3		0-60	0-50	0-20	105+ (1680+)
B4		0-75		0-25	90+ (1440+)
Class III					
C1		0-75		0-30	90+ (1440+)
C2				0-35	80+ (1280+)
C3				0-60	80+ (1280+)
C4*					80- (1280-)
*Chert clay soils in District 6 having less than 55% passing the No. 10 (2.00 mm) sieve may be considered suitable for subgrade material.					

November 17, 2006

Section 812—Backfill Materials

Delete Section 812 and substitute the following:

812.1 General Description

This section includes the requirements for four types of material used as backfill: foundation backfill, Types I and II, imperfect trench backfill, Type III, and mechanically stabilized wall backfill.

812.1.01 Related References

A. Standard Specifications

Section 810—Roadway Materials

B. Referenced Documents

AASHTO T 27

GDT 4

GDT 6

GDT 7

GDT 67

SOP 1

812.2 Materials

812.2.01 Foundation Backfill, Type I

A. Requirements

1. Use natural or artificial mixtures of materials consisting of hard, durable particles of sand or stone, mixed with silt, clay and/or humus material for Type I backfill.
2. Have the final blend of material meet the requirements of Class I or II soils in Subsection 810.2.01.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	GDT 4
Volume change	GDT 6
Maximum density	GDT 7 or GDT 67

D. Materials Warranty

General Provisions 101 through 150.

812.2.02 Foundation Backfill, Type II

A. Requirements

1. Type

   Use material that meets the requirements of Section 800, Class A or B aggregate, and SOP 1. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 Aggregates.

   Do not use backfill aggregate containing soil or decomposed rock.

2. Gradation

   Use material that meets the following gradation requirements:

Sieve Size	% Passing by Weight
1-1/2 in (37.5 mm)	100
1 in (25 mm)	80-100
No. 8 (2.36 mm)	0-5

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Sieve analysis	AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

812.2.03 Imperfect Trench Backfill, Type III

A. Requirements

1. Type

Use material made from either of the following for Type III backfill:

- A natural soil with a density of less than 95 lb/ft³ (1520 kg/m³) when tested with GDT 7
- An artificial mixture of soil and organic material, such as hay, leaves, or straw

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The laboratory will:

Test the soil density with GDT 7.

1. Review the mixture and the percentages of each material, and approve a mixture suitable for the Project.

D. Materials Warranty

General Provisions 101 through 150.

812.2.04 Mechanically Stabilized Embankment Backfill

A. Requirements

Use material comprised of crushed stone, natural sand, or a blend of crushed stone and natural sand free of soils, organic or any other deleterious substances that meet the following additional requirements:

1. Crushed Stone

Use a material manufactured from Class A or B stone that is free of soil overburden has a soundness loss of not more than 15 percent, and conforms to the requirements of SOP 1.

2. Natural Sand

Use material that consists of strong, hard, durable particles, is non-plastic, and has a durability index of at least 70.

3. Gradation

Sieve Size	% Passing by Weight
4 in (100 mm)	100
2 in (50 mm)	80 -100
No. 10 (2 mm)	20 - 90*
No 200 (75 µm)	0 - 12
* Natural Sand may be 20 - 100	

4. Chemical

Ensure the material meets the following chemical requirements:

Test Method	Requirement
pH	6.0 – 9.5
Resistivity	>3000 ohms/cm
Chlorides	<100 ppm
Sulfates	<200 ppm
Note: These chemical requirements are not applicable to MSE walls stabilized with an approved extensible reinforcement.	

5. Maximum Dry Density

   Use backfill material with a maximum dry density equal to or greater than the design unit weight shown on the plans. If no maximum dry density of the backfill material is shown, use a weight of 125 lb/ft^3 (2000 kg/m^3).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the material as follows:

Test Method	Requirement
Percent Wear	AASHTO T96 (“A” Grading)
Sieve Analysis	AASHTO T 27
Material Passing No. 200 (75 µm) Sieve	AASHTO T 11
Durability Index	GDT 75
Maximum Dry Density	GDT 7 or GDT 24a, GDT 24b
Soundness (Magnesium Sulfate)	AASHTO T 104

D. Materials Warranty

General Provisions 101 through 150.

September 16, 2005

Section 814—Soil Base Materials

Delete Subsection 814.1.01 and substitute the following:

814.1.01 Related References

A. Standard Specifications

Section 209– Subgrade Construction

Section 301– Soil-Cement Construction

Section 800–Coarse Aggregate

Section 810–Roadway Materials

Section 831–Admixtures

B. Referenced Documents

AASHTO T 89

AASHTO T 90

ASTM D 516

GDT 4

GDT 6

GDT 7

GDT 65

GDT 67

GDT 98

Delete 814.2.02 and substitute the following:

814.2.02 Soil-Cement Material

A. Requirements

1. Ensure that the material for soil-cement base will:

   a. Meet the requirements of Subsection 810.2.01 for Classes IA1, IA2, IA3, or IIB1 with the following modifications:

Clay content	4 to 25%
Volume change	18% maximum
Liquid Limit	25% maximum
Plasticity Index	10% maximum
Maximum dry density	95 lb/ft³ (1520 kg/m³) minimum
Sulfates	4000 ppm
pH	4.0 minimum

   b. Be friable and not contain large amounts of heavy or plastic clay lumps, organic material, roots, or other substances that would interfere with how the Portland cement sets, plant production, or the finished surface of the base and meet the requirements of Subsection 301.3.05.A.2, “Pulverization” or Subsection 301.3.05.B.1, “Soil”.

   c. Produce a laboratory unconfined compressive strength of at least 450 psi (3.1 MPa). To make the sample, mix in a maximum of 8 percent Type I Portland cement, moist-cure for 7 days, and test with GDT 65.

2. Analyze the soil-cement design and create a Job Mix Formula for each Project where soil-cement base or subbase is specified. Have the Job Mix Formula approved by the Engineer before starting base or subbase construction.

3. You may use fly ash or slag that meets the requirements of Subsection 831.2.03 as admixtures for poorly reacting soils when the blend of soil and fly ash, or slag, meets the design requirements in this Subsection.

4. Ensure that subgrade material used underneath the soil-cement base meets the sulfate and pH requirements of this subsection (See Subsection 209.3.05.A.7).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	GDT 4
Volume Change	GDT 6
Maximum density	GDT 7 or GDT 67
Soil-Cement Design	GDT 65
pH	GDT 98
Sulfates	ASTM D 516
Liquid Limit	AASHTO T 89
Plastic Limit and Plasticity Index	AASHTO T 90

D. Materials Warranty

General Provisions 101 through 150.

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January 20, 2006

Section 815—Graded Aggregate

Delete Section 815 and substitute the following:

815.1 General Description

This section includes the requirements for material to be used for base, subbase, or shoulder course material, and includes graded aggregate, unconsolidated limerock base, and crushed concrete base.

815.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

B. Referenced Documents

AASHTO T 27

ASTM C 295

ASTM D 3042

FL DOT Method FM5-515

SOP–1

GDT 63

815.2 Materials

815.2.01 Graded Aggregate

A. Requirements

1. Type

Use graded aggregate base, subbase, or shoulder course material of uniform quality.

a. Obtain the graded aggregate from an approved source or deposit that will yield a satisfactory mixture meeting all requirements of this Specification.

b. Use material that is crushed or processed as a part of the mining operations, or, mix two grades of material so that when combined in the central mix plant, the mixture meets the specifications.

2. Retained on the No. 10 (2 mm) sieve

Ensure that the material retained on the No. 10 (2 mm) sieve is Class A or B aggregate that meets the requirements of Section 800.

3. Passing the No. 10 (2 mm) sieve

Ensure that any material passing the No. 10 (2 mm) sieve is relatively free of detrimental substances, such as soil overburden, decomposed rock, and/or swelling silts.

4. Stabilized Mixtures

Ensure that mixtures to be stabilized react satisfactorily when mixed with Portland cement. The Engineer will specify the percentage of Portland cement to use.

5. Gradation

Grade the graded aggregate base, subbase, or shoulder material as follows:

Sieve Size	**Percent Passing By Weight**
Group I Aggregates	
2 in (50 mm)	100
1-1/2 in (37.5 mm)	97-100
3/4 in (19.0 mm)	60-95
No. 10 (2 mm)	25-50 (Note 1, 2 and 3)
No. 60 (250 µm)	10-35
No. 200 (75 µm)	7-15
Group II Aggregates	
2 in (50 mm)	100
1-1/2 in (37.5 mm)	97-100
3/4 in (19 mm)	60-90
No. 10 (2 mm)	25-45 (Note 2 and 4)
No. 60 (250 µm)	5-30
No. 200 (75 µm)	4-11
NOTE 1: Group I aggregates having less than 37% passing the No. 10 (2 mm) sieve, shall have at least 9 percent passing the No. 200 (75 µm) sieve.	
NOTE 2: For graded aggregate stabilized with Portland Cement, 30-50 percent by weight shall pass the No. 10 (2 mm) sieve. All other requirements remain the same.	
NOTE 3: Material passing the No. 10 (2 mm) sieve shall have a sand equivalent of at least 20 for Group I aggregates.	
NOTE 4: Material passing the No. 10 (2 mm) sieve shall have a sand equivalent of at least 28 for Group II aggregates. Sand Equivalent values as low as 20 will be acceptable provided they are attributed exclusively to rock flour and the percent passing the No. 10 (2 mm) sieve does not exceed 40.	

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Sand Equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

815.2.02 Unconsolidated Limerock Base

A. Requirements

1. Type

Use limerock base, subbase, or shoulder course material of uniform quality.

a. To ensure uniform quality, the Department may restrict approved sources to specific mining areas, mining processes at a specific mining site, or both.

b. Use a limerock base that yields a mixture to meet these Specifications.

c. Use material that is crushed or processed as a part of the mining operations, or mix two grades of material so that when combined in the central mix plant the mixture meets the specifications.

d. Use limerock base, subbase, or shoulder material that has the following characteristics:

Limerock bearing ratio	At least 100.
Deleterious substances	Do not allow chert or other extremely hard pieces that will not pass the 2 in (50 mm) sieve. Do not allow clay, sand, organics, or other materials in quantities that may damage bonding, finishing, or strength. All material passing the No. 40 (425 µm) sieve shall be non-plastic.
Carbonate content (magnesium or calcium)	At least 90%.

2. Gradation

Grade the limerock base so at least 97 percent by weight passes the 3-1/2 in (90 mm) sieve.

a. Grade the material uniformly to dust. The fine portion passing the No. 10 (2 mm) sieve shall all be dust of fracture.

b. Crush or break the limerock base, if necessary to meet size requirements before placing the material on the road.

c. Ensure that materials having soundness losses of 20% or less, comply with the following gradation requirements:

Gradation Requirements

SIEVE SIZE	PERCENT PASSINGBY WEIGHT
2” (50 mm)	100
1-1/2” (37.5 mm)	97-100
3/4” (19 mm)	60-95
No. 10 (2.00 mm)	25-45
No. 60 (250 µm)	10-30
No. 200 (75 µm)	7-20

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Limerock bearing ratio	FL DOT Method FM5-515
Petrographic analysis	ASTM C 295
Total carbonates (insoluble residue)	ASTM D 3042

D. Materials Warranty

General Provisions 101 through 150.

815.2.03 Crushed Concrete Base

A. Requirements

1. Sources

   Obtain sources of crushed concrete materials approved by the Office of Materials and Research. The criteria for approval will be as outlined in Standard Operating Procedure No. 1, “Monitoring the Quality of Coarse and Fine Aggregates” except that the raw material will be recyclable concrete as specified herein rather than a geological deposit of aggregate.

2. Type

   Use crushed concrete derived exclusively from Portland cement concrete pavement or structural concrete as a base, subbase, or shoulder course.

   Ensure that the material does not contain delivery unit washout material.

3. Gradation

   Ensure that the finished product meets the quality and gradation requirements of Subsection 815.2.01 for Group II aggregates, except that the aggregate will be recycled concrete.

   Ensure that the finished product is free of foreign materials such as asphaltic concrete, steel reinforcement, clay balls, soils, epoxy expansion material, and miscellaneous paving materials.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Sand Equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

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March 17, 2006

Section 819—Fiber Stabilizing Additives

Delete Section 819 and Substitute the following:

819.1 General Description

This Section covers the general requirements for fiber stabilizing additives incorporated into asphaltic concrete mixtures. These fibers are used to stabilize the asphalt film surrounding aggregate particles to reduce drain-down of the asphalt cement., use cellulose or mineral fiber stabilizer listed on QPL 77, Fiber Stabilizing Additives.

819.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

AASHTO T 245

AASHTO T 305

ASTM D 128

GDT 130

QPL 77

819.2 Materials

Use an approved mineral or cellulose fiber stabilizing additive currently listed in QPL 77. Approved additives shall meet the requirements below. Dosage rates below are typical ranges. Use the dosage rate prescribed in the Job Mix Formula, as approved by the Office of Materials and Research.

A. Requirements for all fiber types

1. Use a fiber stabilizer of the type and properties appropriate to the plant's metering and delivery system.
2. When tested in a standard mixture according to AASHTO T 305, the fiber stabilizing additive shall limit drain-down to not more the 0.2% of the weight of the mixture. For the purpose of evaluating these additives, the following test conditions apply.
   - The mixture tested shall consist of a standard No. 7 stone and 6.4% asphalt cement.
   - Mixing and compaction temperatures for the test shall be as prescribed in AASHTO T 245, Section 3.3.1.

- Wet mixing time shall be 60 ± 2 seconds.
- Unseparated fibers, determined by visual inspection of the mixture after the drain-down test, shall not exceed 5% of total fiber content.

B. Cellulose Fibers

Add cellulose fibers at a dosage rate between 0.2% and 0.4% by weight of the total mix, according to the approved Job Mix Formula. Fiber properties shall be as follows:

- Ash Content by ASTM D 128: 23% maximum non-volatile content
- pH: 7.0 to 12.0
- Moisture Content: 5.0% maximum

C. Cellulose Pellets

Use cellulose fiber stabilizing additive in pellet form that meets the requirements of Subsection 819.2.A and Subsection 819.2.B. Use pellets that disperse sufficiently at mixing temperature to blend uniformly into the asphalt mixture. Use pellets that do not exceed 0.24 in (6.0 mm) average pellet diameter. Pellets may contain binder ingredients such as asphalt cement, wax, or polymer. Do not use pellets if the binder ingredient exceeds 20.0% of the total weight of the pellets. Use binder that produces no measurable effect on the properties of the asphalt cement. Do not use fiber pellets which soften or clump together when stored at temperatures up to 122^{o}F (50^{o}C).

Add approved palletized fiber stabilizing additive at a dosage rate between 0.2% and 0.4% by weight of the total mix, according to the approved Job Mix Formula established by the Office of Materials and Research.

NOTE: If the binder material constitutes more than 3% of the pellet weight, the dosage rate shall be based upon the net fiber content.

D. Mineral Fibers

Use mineral fibers made from virgin basalt, diabase, slag or other silicate rock. Add the fiber at a dosage rate prescribed in the approved Job Mix Formula, between 0.3% and 0.6% by weight of the total mix. Use approved mineral fiber from QPL 77, meeting the following requirements for Shot content, as tested according to GDT 130:

Sieve	Minimum Percent Passing
No 60	90
No. 230	60

E. Materials Warranty

General Provisions 101 through 150.

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April 20, 2007

Section 828—Hot Mix Asphaltic Concrete Mixtures

Delete Section 828 and substitute the following:

828.1 General Description

This specification includes the requirements for hot mix asphaltic concrete mixtures, including:

- Open-graded surface mixtures (OGFC and PEM)
- Stone Matrix Asphalt mixtures (SMA)

- Superpave mixtures
- Fine-graded (4.75 mm) mixtures

828.1.01 Definitions

The Nominal Maximum Sieve Size is one standard sieve size larger than the first sieve to retain more than ten percent of the aggregate, per AASHTO PP28. Mixture types in this section are identified according to Nominal Maximum Sieve Size.

828.1.02 Related References

A. Standard Specifications

Section 400-Hot Mix Asphaltic Concrete Construction

Section 800–Coarse Aggregate

Section 802–Aggregates for Asphaltic Concrete

Section 819–Fiber Stabilizing Additives

Section 820–Asphalt Cement

Section 831–Admixtures

Section 882–Lime

Section 883–Mineral Filler

B. Referenced Documents

AASHTO PP 2

AASHTO PP28

AASHTO TP 8-94

AASHTO T 112

AASHTO T 209

AASHTO T 305

AASHTO T 312

AASHTO T-245

ASTM PS-129

SOP-36

SOP-2 SP

GDT 56

GDT 66

GDT 114

GDT 115

GDT 123

QPL 1

QPL 2

QPL 7

QPL 26

QPL 41

QPL 77

QPL 81

828.2 Materials

A. Requirements

Use approved hot mix asphalt concrete mixtures that meet the following requirements:

1. Produce each asphalt mixture according to a Job Mix Formula and Asphalt Mix Design approved by the Department. For submittal and approval of Job Mix Formulas, see Subsection 400.1.
2. Ensure that individual acceptance test results meet the Mixture Control Tolerances specified in the appropriate table below, Subsections 828.2.01 through 828.2.04.
3. Ensure that the Engineer approves all materials used to prepare and place the mixtures before incorporating them into the Work. Use only the ingredients listed in the approved Asphalt Mix Design and Job Mix Formula. For virgin aggregates use sources which meet the requirements of Section 802 and are listed in QPL 1 or QPL 2; for mixes in which local sand is permitted, use the approved sand source identified in the mix design. For mixtures containing Reclaimed Asphalt Pavement (RAP), use only RAP from the approved stockpile identified in the mix design. Use asphalt cement meeting the requirements of Section 820, from a source listed in QPL 7.
4. Obtain approved Superpave mix designs and 4.75 mm mix designs from a mix design laboratory certified by the Department. Obtain approved mix designs for types PEM, OGFC, and SMA mixtures from the Department's Office of Materials and Research, which produces and furnishes these mix designs.
5. Ensure that Superpave and 4.75 mm mix designs are designed in accordance with SOP-2SP ("Control of Superpave Bituminous Mixture Designs") and are approved by the Department as provided therein. Ensure that these mixes are designed by a laboratory and technician certified in accordance with SOP-36, ("Certification of Laboratories and Personnel for Design of Superpave Asphalt Mixtures").
6. Use only mixtures composed of the aggregate groups and blends indicated in the Proposal and Plans by their pay item designations, defined as follows:

Pay Item Designation	Allowable Aggregate Groups
Group I or II	Group I, Group II, or Blend I
Group II only	Group II only
Blend I	Either 100% Group II material or a blend of Group I and Group II. Do not use Group I material for more than 60%, by weight, of the total aggregate nor more than 50%, by weight, of the coarse aggregate fraction.

7. For patching or leveling use Group I, Group II, or Blend I. Mix types for patching and leveling are specified in Subsection 400.3.03.B.
8. Include lime (hydrated lime) from an approved source and meeting the requirements of Subsection 882.2.03 in all paving courses except as otherwise provided in the Contract. For a list of approved sources of lime, see QPL 41.
   a. Add lime to each mixture at the rate prescribed in the approved mix design.
   b. Mix designs using only virgin aggregate shall include lime at a minimum rate of 1.00 % of the total dry aggregate weight. Mix designs using RAP shall include lime at a minimum rate equal to 1.00 % of the virgin aggregate fraction plus 0.50 % of the aggregate in the RAP fraction.

c. If necessary to meet requirements for mixture properties, and pursuant to an approved mix design, add more lime or add lime plus an approved Heat-Stable Anti-Stripping Additive that meets the requirements of Subsection 831.2.04. However, the Department will not make additional payment for these materials. For a list of sources of Heat-Stable Anti-Stripping Additives, see QPL 26.

d. Where specifically allowed in the contract on LARP, airport, and parking lot projects, an approved Heat-Stable Anti-Stripping Additive that meets the requirements of Subsection 831.2.04 may be substituted for hydrated lime. In this case the mix gradation shall be adjusted as necessary to replace the lime with an equivalent volume of fines passing the 0.075 mm sieve. Add Heat-Stable Anti-stripping Additive at a minimum rate of 0.5 percent of the asphalt cement portion.

9. Use performance grade PG 67-22 asphalt cement in all mix designs and mixtures except as follows:

   a. For mixtures containing 25% or greater RAP, the Engineer will determine the performance grade to be used.

   b. On PR, LARP, airport, and parking lot projects, PG 64-22 may be substituted for PG 67-22, with approval of the Office of Materials and Research, on roads having current ADT less than 2,000.

   c. Use only grade PG 76-22 in the following mixes: SMA, 12.5 mm PEM, 12.5 mm and 9.5 mm OGFC, 12.5 mm Superpave, excluding shoulder construction, on projects with ADT greater than 25,000; and in all mixtures for which polymer-modified asphalt is specified in the pay item.

10. Use of local sand is restricted as follows:

   a. Do not place mixtures containing local sand on the traveled way of the mainline or ramps of the Interstate System. Mixtures with local sand may be used for shoulder construction on these facilities.

   b. Local sand shall not constitute more than 20 % of the total aggregate weight of any mix design or production mix.

   c. Subject to the above limits, 19 mm, 12.5 mm, and 9.5 mm Superpave mix designs and 4.75 mm mix designs containing local sand may be used on projects with a current ADT not exceeding 2,000.

   d. 25 mm Superpave mix designs containing not more than 20 % local sand may be used on all facilities except the main line and ramps of the Interstate System.

   e. Obtain local sand for use in asphalt mixtures from a source approved by the Department.

   f. Approval of local sand sources: The Department will sample, test, and approve sources of local sand. Local sand shall not contain more than 7.0 % clay by weight and shall be free of foreign substances, roots, twigs, and other organic matter. It shall be free of clay lumps, as determined by AASHTO T 112, and shall have a sand equivalent value exceeding 25%, as determined by GDT 63.

B. Fabrication

1. Design procedures: For all Superpave and 4.75 mm mixes, designers shall adhere to the Superpave System for Volumetric Design (AASHTO T 312 and AASHTO PP 2), as adapted in SOP-2SP. The Department will design open-graded mixes and Stone Matrix Asphalt (SMA) mixes according to GDT 114 and GDT 123, respectively. In all cases, the procedure for measuring Maximum Specific Gravity (G_{mm}) shall be AASHTO T 209. In addition to gradation and volumetric analysis, mix designs shall include the following performance tests, as applicable.

2. Performance Test:

   a. Permeability test: Superpave and Stone Matrix mix designs shall include testing according to ASTM PS-129. Specimen air voids for this test shall be 6.0 ±1.0 %. The average permeability of three specimens may not exceed 3.60 ft per day (125×10^{-5}cm per sec).

   b. Moisture susceptibility test: Mix designs of all types except open-graded surface mixes shall include testing for moisture susceptibility according to GDT 66. Specimen air voids for this test shall be 7.0 ±1.0%. The minimum tensile splitting ratio is 0.80, except that a tensile splitting ratio of no less than 0.70 may be acceptable if all individual strength values exceed 100 psi (690 kPa). Average splitting strength of the three conditioned and three controlled samples shall be not less than 60 psi (415 kPa) for either group. Retention of coating as determined by GDT 56 shall be not less than 95%.

c. Rutting susceptibility test. Mix designs of all types except Open-graded Surface Mixes (OGFC and PEM), and mixtures designed exclusively for trench widening shall include testing according to GDT 115. Design limits for this test are as follows: Specimen air voids for this test shall be 5.0 ± 1.0% for all mix types. Testing temperature shall be 64°C (147°F) for all mix types except 25 mm Superpave mixes, which shall be tested at 49°C (120°F). Maximum deformation shall be 5.0 mm for all mixes except 4.75 mm mix, 9.5 mm Type I and 9.5 mm Type II Superpave mixes. Maximum deformation for the 9.5 mm Type II Superpave mix shall be 6.0 mm at 64°C (147°F) and 8.0 mm at 64°C (147°F) for the 4.75 mm and 9.5 mm Type I Superpave mix.

d. Fatigue testing: The Department may verify Superpave designs by fatigue testing according to AASHTO TP 8-94 or other procedure approved by the Department.

C. Acceptance

See Subsection 106.03 and Section 400. Ensure that individual test results meet the Mixture Control Tolerances listed in Subsections 828.2.01, 828.2.02, 828.2.03, or 828.04, whichever applies.

D. Materials Warranty

See General Provisions 101 through 150.

828.2.01 Open-Graded Surface Mixtures

A. Requirements

Use approved mixtures that meet the following mixture control tolerances and design criteria:

Sieve Size	Mixture Control Tolerance, %	Design Gradation Limits, % Passing		
		9.5 mm OGFC	12.5 mm OGFC	12.5 mm PEM
3/4 in (19 mm) sieve	±0.0		100	100
1/2 in (12.5 mm) sieve	±6.1	100*	85-100	80-100
3/8 in (9.5 mm) sieve	±5.6	85-100	55-75	35-60
No. 4 (4.75 mm) sieve	±5.7	20-40	15-25	10-25
No. 8 (2.36 mm) sieve	±4.6	5-10	5-10	5-10
No. 200 (75 μm) sieve	±2.0	2-4	2-4	1-4
Range for % AC	±0.4	6.0-7.25	5.75-7.25	5.5-7.0
Class of stone (Section 800)		"A" only	"A" only	"A" only
Drain-down (AASHTO T305), %		<0.3	<0.3	<0.3

* Mixture control tolerance is not applicable to this sieve for this mix.

1. In 12.5 mm and 9.5 mm OGFC and 12.5 mm PEM mixes, use only PG 76-22 asphalt cement (specified in Section 820).
2. All OGFC and PEM mixes shall include a stabilizing fiber of the type (cellulose or mineral) specified in the mix design and meeting the requirements of Section 819. The dosage rate shall be as specified in the mix design and shall be sufficient to prevent drain-down exceeding the above tolerance.

B. Fabrication

See Section 400.

C. Acceptance

See Subsection 106.03 and Section 400. Ensure that individual test results meet the Mixture Control Tolerances listed in Subsections 828.2.01, 828.2.02, 828.2.03, or 828.04, whichever applies.

D. Materials Warranty

See General Provisions 101 through 150.

828.2.02 Stone Matrix Asphalt Mixtures

A. **Requirements**

Use approved mixtures that meet the following mixture control tolerances and design criteria:

Sieve Size	Mixture Control Tolerance	Design Gradation Limits, Percent Passing		
		9.5 mm SMA	12.5 mm SMA	19 mm SMA
1- in (25 mm) sieve	±0.0			100
3/4 in (19 mm) sieve	±7.0	100*	100*	90-100
1/2 in (12.5 mm) sieve	±6.1	98-100**	85-100	44-70
3/8 in (9.5 mm) sieve	±5.6	70-100	50-75	25-60
No. 4 (4.75 mm) sieve	±5.7	28-50	20-28	20-28
No. 8 (2.36) mm sieve	±4.6	15-30	16-24	15-22
No. 50 (300 μm) sieve	±3.8	10-17	10-20	10-20
No. 200 (75 μm) sieve	±2.0	8-13	8-12	8-12
Range for % AC	±0.4	6.0-7.5	5.8-7.5	5.5-7.5
Design optimum air voids (%)		3.5 ±0.5	3.5 ±0.5	3.5 ±0.5
% aggregate voids filled with AC (VFA)		70-90	70-90	70-90
Tensile splitting ratio after freeze-thaw cycle GDT-66		80%	80%	80%
Drain-down (AASHTO T305), %		<0.3	<0.3	<0.3

*Mixture control tolerance is not applicable to this sieve for this mix.

**Mixture control tolerance shall be ± 2.0% for this sieve for 9.5 mm SMA mixes placed at spread rates greater than 135 lb/yd^2. For 9.5 mm SMA mixes placed at spread rates of 135 lb/yd^2 or less, 100 % passing is required on this sieve.

1. SMA mixtures shall be compacted at 50 gyrations with the Superpave Gyratory compactor or 50 blows with the Marshall compactor.
2. All SMA mixtures shall contain mineral filler and fiber stabilizing additives and shall meet the following requirements:
   a. Asphalt cement grade PG-76-22 (specified in Section 820) is required in all SMA mixtures.
   b. Aggregates for SMA shall meet the requirements of Subsection 802.2.02.A.3.
   c. Use mineral filler that meets requirements of Section 883 and is approved by the Department.

      Approved sources of mineral filler are listed in QPL 81.
   d. Do not use local sand in lieu of mineral filler.
   e. Use an approved Fiber Stabilizing Additive of the type (cellulose or mineral) specified in the mix design and meeting the requirements of Section 819. Approved sources of Fiber Stabilizing Additive are listed in QPL 77. The dosage rate will be as specified in the mix design and shall be sufficient to prevent drain-down exceeding the above tolerance.

B. Fabrication

See Section 400.

C. Acceptance

See Subsection 106.03 and Section 400. Ensure that individual test results meet the Mixture Control Tolerances listed in Subsections 828.2.01, 828.2.02, 828.2.03, or 828.04, whichever applies.

D. Materials Warranty

See General Provisions 101 through 150.

828.2.03 Superpave Asphalt Concrete Mixtures

A. Requirements

Ensure that Superpave mixtures meet the following mixture control tolerances and design limits:

1. All mixes are to be designed at a design gyration number (N_{des}) of 65 gyrations and an initial gyration number (N_{ini}) of 6 gyrations.
2. Gradation limits for Superpave mixtures are as follows:

Sieve Size	Mixture Control Tolerance	Design Gradation Limits, Percent Passing				
		9.5 mm Superpave Type I	9.5 mm Superpave Type II	12.5 mm Superpave Note 1	19 mm Superpave	25 mm Superpave
1-1/2 in (37.5 mm) sieve						100
1- in (25.0 mm) sieve	± 8.0			100*	100*	90-100
3/4 in (19.0 mm) sieve	±8.0**	100*	100*	98-100****	90-100	55-89**
1/2 in (12.5 mm) sieve	±6.0***	98-100****	98-100****	90-100	60-89	50-70
3/8 in (9.5 mm) sieve	±5.6	90-100	90-100	70-89	55-75	
No. 4 (4.75 mm) sieve	±5.6	65-85	55-75			
No. 8 (2.36 mm) sieve	±4.6	48-55	42-47	38-46	32-36	30-36
No. 200 (75 µm) sieve	±2.0	5.0-7.0	5.0-7.0	4.5-7.0	4.0-6.0	3.5-6.0

* Mixture control tolerance is not applicable to this sieve for this mix.

** Mixture control tolerance shall be ± 10.0% for this sieve for 25 mm Superpave.

***Mixture control tolerance shall be ± 8.0% for this sieve for 19 mm Superpave.

****Mixture control tolerance shall be ± 2.0% for this sieve for 12.5 mm and 9.5 mm mixes.

Note 1: Use PG 76-22 in 12.5 mm Superpave, excluding shoulder construction, on all projects with ADT greater than 25,000.

3. The Mixture Control Tolerance for asphalt cement shall be ± 0.4% for all mix types.
4. Volumetric limits are as follows:

Design Parameter	Mix Type	Limits
% of Max. Specific Gravity (G_{mm}) at design gyrations, N_{des})	All	96%
% G_{mm} at the initial number of gyrations, N_i	All	91.5% maximum
% voids filled with asphalt (VFA) at N_{des}	9.5 mm Type I	Min. 72; Max. 80
	9.5 type 2 and 12.5 mm	Min. 72; Max. 76
	19 mm	Min. 71; Max 76
	25 mm	Min. 69; Max 76
Fines to effective asphalt binder ratio (F/P_{be})	9.5 mm Type I	0.6 to 1.4
	all other types	0.8 to 1.6
Minimum % Voids in Mineral Aggregate (VMA) Note: VMA shall be calculated using the effective specific gravity of the aggregate (G_{se}). See SOP-2SP.	25 mm	13.0
	19 mm	14.0
	12.5 mm	15.0
	9.5 Type I	16.0
	9.5 Type II	16.0

B. Fabrication

See Section 400.

C. Acceptance

See Subsection 106.03 and Section 400. Ensure that individual test results meet the Mixture Control Tolerances listed in Subsections 828.2.01, 828.2.02, 828.2.03, or 828.04, whichever applies.

D. Materials Warranty

See General Provisions 101 through 150.

828.2.04 Fine-Graded Mixtures

A. Requirements

Design gyrations (N_{des}) for fine-graded mixes shall be 50 gyrations. Ensure that fine-graded mixtures meet the following mixture control tolerances and design limits:

ASPHALTIC CONCRETE - 4.75 mm Mix		
Sieve Size	Mixture Control Tolerance	Design Gradation Limits, % passing
1/2 in (12.5 mm) sieve*	±0.0	100*
3/8 in (9.5 mm) sieve	±5.6	90-100
No. 4 (4.75 mm) sieve	±5.7	75-95
No. 8 (2.36 mm) sieve	±4.6	60-65
No. 50 (300 µm) sieve	±3.8	20-50
No. 200 (75 µm) sieve	±2.0	4-12
Range for % AC	±0.4	6.00 – 7.50
Design optimum air voids (%)		4.0 – 7.0
% Aggregate voids filled with AC		60 - 80

* Mixture control tolerance is not applicable to this sieve for this mix.

B. Fabrication

See Section 400.

C. Acceptance

See Subsection 106.03 and Section 400. Ensure that individual test results meet the Mixture Control Tolerances listed in Subsections 828.2.01, 828.2.02, 828.2.03, or 828.04, whichever applies.

D. Materials Warranty

See General Provisions 101 through 150.

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August 1, 2007

Section 830—Portland Cement

Delete Section 830 and Substitute the following:

830.1 General Description

This section includes the requirements for Portland cement, including Portland blast-furnace slag cement and Portland-Pozzolan cement.

830.1.01 Related References

A. Standard Specifications

Section 831–Admixtures

B. Referenced Documents

AASHTO M 85

AASHTO M 240

QPL 3

830.2 Materials

830.2.01 Portland Cement

A. Requirements

Use only Portland cements that are listed in QPL 3.

1. Types

   Use Portland cement that meets the requirements in AASHTO M 85. Portland cement types include:

Use	High Early Strength Concrete	Remaining Portland Cement Concrete
*Portland cement	Types I or III	Types I or II

   *Portland cement – a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic crystalline calcium silicates, and usually containing one or more of the following: water, calcium sulfate, up to 5% limestone, and processing additions.

2. Ensure that the Portland cement concrete meets the low alkali and the false set requirements of AASHTO M 85.
3. Do not use cement that is damaged, partially set, lumpy, or caked.

4. Mixing and Storing

   Do not mix or store different brands or types of cement in the same bin. Do not mix or store the same brand of cement from different mills in the same bin.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

See the requirements in AASHTO M 85.

D. Materials Warranty

General Provisions 101 through 150.

830.2.02 Portland Blast-Furnace Slag Cement

A. Requirements

Use Portland blast-furnace slag cement in cement stabilization that meets the requirements of AASHTO M 240, Type IS.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

See requirements of AASHTO M 240, Type IS.

D. Materials Warranty

General Provisions 101 through 150.

830.2.03 Portland-Pozzolan Cement

A. Requirements

Use Portland-Pozzolan cement that meets the requirements of AASHTO M 240, Type IP, with the following modifications:

1. Limit the fly ash content to a maximum of 25 percent by weight.
2. Limit the Pozzolan to fly ash that meets the requirements of Subsection 831.2.03.
3. If grinding fly ash with Portland cement clinker to produce Portland-Pozzolan cement, do the following:

   Exclude the fineness and the loss-on-ignition requirements of Subsection 831.2.03.

   Ensure that the final blend of Portland-Pozzolan cement meets AASHTO M 240, Type IP requirements.
4. Wherever the Standard Specifications allow or specify Portland cement that meets the requirements of Subsection 830.2.01, you may substitute Portland-Pozzolan cement that meets the requirements of this Subsection.
5. If the substitute cement results in a higher cement factor than required for Type I cement, the cost of the additional cement will be borne by the Contractor.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

See the requirements of AASHTO M 240, Type IP.

D. Materials Warranty

General Provisions 101 through 150.

January 20, 2006

Section 841—Iron Pipe

Delete Section 841 and substitute the following:

841.1 General Description

This section includes the requirements for iron pipe, including cast iron soil pipe and fittings, and ductile iron pipe and appurtenances.

841.1.01 Related References

A. Standard Specifications

Section 106—Control of Materials

Section 848—Pipe Appurtenances

B. Referenced Documents

ASTM A 74

ASTM B 29

ASTM C 564

ANSI/AWWA A 21.4

ANSI/AWWA A 21.10

ANSI/AWWA A 21.11

ANSI/AWWA A 21.50

ANSI/AWWA A 21.51

ANSI/AWWA A 21.53

841.2 Materials

For each item in this Section, submit a certification from the manufacturer as per the requirements in Subsection 106.05, “Materials Certification.”

Include the chemical and physical properties of the materials and their conformance with this Specification on the certification.

841.2.01 Cast Iron Soil Pipe and Fittings

A. Requirements

1. Type

   Use cast iron soil pipe and fittings that meet the requirements of ASTM A 74, including the inside and outside coatings.

a. Rubber Gasket Joints: Use rubber gasket joints for cast iron soil pipes that meet the requirements of ASTM C 564.

b. Lead Joints: Use refined lead that meets the requirements of ASTM B 29. Do not use reclaimed lead.

c. Plain End Cast Iron Soil Pipe: Plain end cast iron soil pipe may be joined with steel bolted couplings if they meet the requirements of Subsection 848.2.02.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department accepts material that is properly certified by the manufacturer.

D. Materials Warranty

General Provisions 101 through 150.

841.2.02 Ductile Iron Pipe and Appurtenances

A. Requirements

Use ductile iron pipe that meets the requirements of ANSI/AWWA A 21.50 and A 21.51 for the class and joint specified.

1. Fittings

   Use fittings that meet the requirements of ANSI/AWWA A 21.10 or A21.53 for the class and joint specified.

2. Rubber Gasket Joints

   Use rubber gasket joints that meet the requirements of ANSI/AWWA A 21.11.

3. Flanges

   Use flanges that meet the requirements of ANSI/AWWA A 21.11.

4. Plain End Ductile Iron Pipe

   Plain end ductile iron pipe may be joined with steel-bolted couplings if they meet the requirements of Subsection 848.2.02.

5. Cement Mortar Linings

   Use cement mortal linings that meet the requirements of ANSI/AWWA A 21.4. Line all ductile iron pipe and fittings with cement mortar unless specified otherwise.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department accepts material that is properly certified by the manufacturer.

D. Materials Warranty

General Provisions 101 through 150.

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July 21, 2006

Section 843—Concrete Pipe

Delete Section 843 and substitute the following:

843.1 General Description

This section includes the requirements for reinforced concrete pipe, nonreinforced concrete pipe, and concrete underdrain pipe.

843.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

Section 801—Fine Aggregate

Section 831—Admixtures

Section 880—Water

B. Referenced Documents

AASHTO M 86(M 86M), Class II

AASHTO M 170 (M 170M)

AASHTO M 175 (M 175M) or AASHTO M 176 (M 176M)

QPL 4

SOP-19

843.2 Materials

843.2.01 Reinforced Concrete Pipe

A. Requirements

1. Type

   Use reinforced concrete pipe that meets the requirements of AASHTO M 170 (M 170M), with the changes described in the following table. For a list of sources, see QPL 4.

Material	Requirements	Other Modifications
Coarse aggregate	Subsection 800.2.01	Gradation requirements do not apply
Fine aggregate	Subsection 801.2.02	Gradation requirements do not apply
Fly ash	Subsection 831.2.03.A	None
Water	Subsection 880.2.01	None

NOTE: Before manufacture, you may request approval of modified designs that differ from the Specifications.

2. Certification

   a. File a certificate with the Engineer stating that the concrete pipe manufactured for Department use meets the requirements of reinforcement steel specified in this Section.

      A bonded legal authority of the manufacturing company shall endorse the requirements certification.

   b. Submit a guarantee with the certificate stating that concrete pipe will be replaced, without cost to the purchaser, if the reinforcement steel does not meet these Specifications.

c. Ensure that the guarantee remains in effect as long as the manufacturer furnishes concrete pipe for Department use.

d. This guarantee does not limit the right of the Department to inspect and check the materials in manufactured concrete pipe prior to and during pipeline construction.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will test and inspect using SOP-19.

D. Materials Warranty

See the Certification requirements under Subsection 843.2.01.A.2.

843.2.02 Nonreinforced Concrete Pipe

A. Requirements

1. Type

Use nonreinforced concrete pipe to convey sewage, industrial waste, and storm water that meets the requirements of AASHTO M 86 (M 86M), Class II, with the following changes:

Material	Requirements	Other Modifications
Coarse aggregate	Subsection 800.2.01	Gradation requirements do not apply
Fine aggregate	Subsection 801.2.02	Gradation requirements do not apply
Fly ash	Subsection 831.2.03.A	None
Water	Subsection 880.2.01	None

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test and inspect with SOP-19.

D. Materials Warranty

General Provisions 101 through 150.

843.2.03 Concrete Underdrain Pipe

A. Requirements

1. Type

Use concrete underdrain pipe that meets the requirements of AASHTO M 175 (M 175M) or AASHTO M 176 (M 176M), with the following changes unless the Plans state otherwise:

Material	Requirements	Other Modifications
Coarse aggregate	Subsection 800.2.01	Gradation requirements do not apply
Fine aggregate*	Subsection 801.2.02	Gradation requirements do not apply
Fly ash	Subsection 831.2.03.A	None
Water	Subsection 880.2.01	None
*Use fine aggregate in standard strength, perforated, nonreinforced concrete underdrain pipe.		

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test and inspect with SOP-19.

D. Materials Warranty

General Provisions 101 through 150.

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January 20, 2007

Section 846—Polyvinyl Chloride (PVC) Profile Wall Drain Pipe

Delete Section 846 and Substitute the following:

Section 846—Polyvinyl Chloride (PVC) Drain Pipe

846.1 General Description

This section includes the requirements for Polyvinyl Chloride (PVC) Drain Pipe.

846.1.01 Related References

A. Standard Specifications

Section 106–Control of Materials

B. Referenced Documents

AASHTO M 304

ASTM F 477

ASTM F 949

ASTM D 3212

846.2 Materials

846.2.01 Polyvinyl Chloride (PVC) Profile Wall Drain Pipe

A. Requirements

Use pipe that meets the requirements of AASHTO M 304.

Ensure joints are watertight and have elastomeric seals that meet the requirements of ASTM F 477.

Assemble the joints according to the manufacturer's recommendations.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Have the manufacturer test the joint tightness according to ASTM D 3212 and certify the results according to Subsection 106.05.

D. Materials Warranty

General Provisions 101 through 150.

846.2.02 Polyvinyl Chloride (PVC) Corrugated Smooth Interior Drain Pipe

A. Requirements

Use pipe that meets the requirements of ASTM F 949.

Ensure joints are watertight and have elastomeric seals that meet the requirements of ASTM F 477.

Assemble the joints according to the manufacturer's recommendations.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Have the manufacturer test the joint tightness according to ASTM D 3212 and certify the results according to Subsection 106.05.

D. Materials Warranty

General Provisions 101 through 150.

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January 20, 2006

Section 854—Castings and Forgings

Delete Section 854 and Substitute the following:

854.1 General Description

This section includes the requirements for the following castings and forgings:

- Gray iron drainage castings
- Cast aluminum alloy railing posts
- Aluminum alloy sand mold castings

- Steel castings
- Steel forgings
- Cold-finished carbon shafting
- Steel castings for bridges

854.1.01 Related References

A. Standard Specifications

Section 501—Steel Structures

B. Referenced Documents

AASHTO	ASTM
M 102/ M 102M	ASTM A 27/ A 27M
M 169	ASTM B 26/ B 26 M, Alloy UNS A03560
M 306	ASTM B 108

QPL 11

ANSI 356 Temper T 6

854.2 Materials

854.2.01 Gray Iron Drainage Castings

A. Requirements

Each foundry shall conform to Standard Operating Procedure 18 (SOP 18), “Inspection of Gray Iron Drainage Castings”.

1. Type

   Use gray iron drainage castings that meet the requirements of AASHTO M 306, Class 35B.

   Use foundries listed on QPL 11.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the castings based on the following:

- Quality of work and conformance to dimension and shape requirements, including acceptable proof load tests and drawings on file with the Office of Materials and Research-Inspection Services Branch for each casting design supplied.
- Tension bar test results

D. Materials Warranty

General Provisions 101 through 150.

854.2.02 Cast Aluminum Alloy Railing Posts

A. Requirements

1. Type

   Use permanent mold types of cast-aluminum alloy roadway railing post that meet ASTM B 108 requirements.

   Ensure that the finish on the castings meets the specifications on the Plans.

2. Certification

   Submit a report with each shipment of castings that includes test results and certifies compliance with this Specification.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the castings based on the following:

- Quality of work and conformance to dimension and shape requirements
- Certification that the physical and chemical properties of the material meet these Specifications

D. Materials Warranty

General Provisions 101 through 150.

854.2.03 Aluminum Alloy Sand Mold Castings

A. Requirements

1. Type

   Use aluminum base alloy and castings that meet the requirements of ASTM B 26/ B 26M, Alloy UNS A03560 or ANSI 356 Temper T 6.

2. Certification

   Submit a report with each shipment of castings that includes test results and certifies compliance with this Specification.

B. Fabrication

Sandblast or otherwise clean the scale and sand off the castings to produce a smooth and uniform surface.

C. Acceptance

The Department will accept the castings based on the following:

- Quality of work and conformance to the dimension and shape requirements, as inspected when received
- Certification that the physical and chemical properties of the material meet these Specifications

D. Materials Warranty

General Provisions 101 through 150.

854.2.04 Steel Castings

A. Requirements

1. Type

   Use carbon steel castings that meet the requirements of ASTM A 27/ A 27M, Grade 65-35 (450-240). Ensure that the form and dimensions of the steel castings are true to pattern.

2. Certification

Submit a report with each castings shipment that includes test results and certifies compliance with this Specification.

B. Fabrication

1. If the Plans require large castings, suspend and hammer them all over. Ensure that no cracks, flaws, or other defects appear after this treatment. The Department will not accept sharp unfilleted angles or corners.
2. Coat surfaces marked “Finished” as soon as practical after finishing with a corrosion-resistant grease before removing them from the shop.
3. Apply a shop coat of paint to casting surfaces milled for removing scale, scabs, fins, blisters, or other surface deformations. Ensure that the shop coat of paint meets the requirements of Subsection 501.3.04.D.10, “Shop Painting.”

C. Acceptance

The Department will accept the castings based on the following:

- Quality of work and conformance to the dimension and shape requirements, as inspected when received
- Certification that the physical and chemical properties of the material meet these Specifications

D. Materials Warranty

General Provisions 101 through 150.

854.2.05 Steel Forgings

A. Requirements

1. Type

   Use steel forgings that meet the requirements of AASHTO M 102/M 102M for the class shown on the Plans.

2. Certifications

   a. Submit a record to the Engineer of the annealing charges that show the forgings in each charge, the melt or melts from which they were secured, and the treatment they received.

   b. Submit a report with each castings shipment that includes test results and certifies compliance with this Specification.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the castings based on the following:

1. Quality of work and conformance to the dimension and shape requirements, as inspected when received
2. Certification that the physical and chemical properties of the material meet these Specifications

D. Materials Warranty

General Provisions 101 through 150.

854.2.06 Cold-finished Carbon Shafting

A. Requirements

1. Type

   Use cold-finished carbon steel bars that meet the requirements of AASHTO M 169 for the grade shown on Plans.

2. Certification

   Submit a certification to the Engineer that shows the chemical properties of the material and conformance to the Specifications.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the material based on favorable review of the certification.

D. Materials Warranty

General Provisions 101 through 150.

854.2.07 Steel Castings for Bridges

A. Requirements

1. Type

   Use steel castings for bridge components that meet the requirements of ASTM A 27/ A 27M for the class shown on the Plans.

2. Certification

   Submit a certification to the Engineer that shows the physical and chemical properties of the material and conformance to the Specifications.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the material based on favorable review of the certification.

D. Materials Warranty

General Provisions 101 through 150.

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March 17, 2006

Section 861—Piling and Round Timber

Delete Section 861 and substitute the following:

861.1 General Description

This section includes the requirements for timber piles and timber poles.

861.1.01 Related References

A. Standard Specifications

Section 863–Preservative Treatment of Timber Products

B. Referenced Documents

ANSI 05.1

National Electrical Safety Code (National Institute of Standards and Technology)

QPL 50

861.2 Materials

A. Definition and Limitation of Defects

Decay: Disintegration of the wood substance due to wood-destroying fungi. The words “dote” and “rot” mean the same as decay. Red heart is a form of decay.

Compression Wood: An abnormal, dense, hard growth frequently occurring on the underside of limbs and leaning trunks of coniferous trees. It is characterized by very wide and eccentric annual growth rings and includes what appears to be an exceptional proportion of summerwood growth.

The contrast in color between springwood and summerwood, however, is usually less in compression wood than in normal wood.

Turpentine Butt: A scar caused from bleeding the trees to obtain turpentine.

Scar: A damaged surface caused from injury to the tree during growth.

Sweep: Deviation of a piece or stick from a straight line measured from the center of one end to the center of the other end. A straight line from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

Short Crook: A crook in which the direction of the piece or stick changes in a very short distance measured lengthwise.

Burst Check: A crack approximately at right angles to the annual rings, usually radial cracks in sticks from the center or from near the center to the outside, or a combination of this crack and a ring shake caused through either seasoning, exposure to high temperature, or the process of preservative treatment.

Unsound Knot: A knot solid across the face, but containing incipient decay.

Cluster Knot: Two or more knots grouped together, the fibers of the wood being deflected around the entire unit.

A group of single knots with fibers deflected around each knot separately is not a cluster, even though the knots may be close together.

Punk Knot: A fungus decay that extends from the interior of the piece of pile to the outside, which when prodded is usually found to contain a snuff-like substance.

Ring Knots: Three or more knots appearing in the same line of circumference, or any foot of length.

861.2.01 Timber Piles

A. Requirements

1. Use round timber piles of any species of wood that will withstand driving and support the load specified. Use plants listed on QPL 50.
2. Soundness.

   Use piles of sound wood, free from decay, red heart, or insect attack.

   a. Cedar and Cypress: The butt ends may have a pipe or stump rot hole not more than 1-1/2 in (40 mm) in diameter. Cypress piles may have peck aggregating not more than 1-1/2 in (40 mm) in diameter.

   b. Southern Pine: Piles may have unsound knots less than half the permitted size of a sound knot, providing that the unsoundness does not extend more than 1-1/2 in (40 mm) deep and that the adjacent areas of the trunk are not affected.
3. Density

a. All piles shall be dense with at least 6 annual rings per 1 in (25 mm) and 1-1/2 in (40 mm) or more of summerwood (the darker, harder portion of the annual ring), as measured over the outer 3 in (75 mm) of butt diameter on a radial line from the pith.

The contrast in color between summerwood and springwood shall be sharp and the summerwood shall be darker in color.

b. Piles excluded by the above rule may be accepted provided they have at least four annual rings per 1 in (25 mm) and 1/3 or more summerwood, as measured over the outer 3 in (75 mm) of butt diameter on a radial line from the pith.

4. Knots

a. Sound knots:

For piles 50 ft (15 m) long or less, and in 3/4 of the length of piles over 50 ft (15 m), measured from the butt	Sound knots less than 4 in (100 mm) or 1/3 the diameter of the pile, whichever is smaller.
For the top 1/4 length of piles over 50 ft (15 m) long	Sound knots less than 5 in (125 mm) or 1/2 the diameter of the pile, whichever is smaller
The size of a knot shall be its diameter measured at right angles to the length of the pile.	

b. Unsound knots are not permitted except in Southern Pine piles as specified in Subsection 861.2.01.A.2.b.

c. The sum of sizes of all knots in any 12 in (300 mm) of the pile shall not exceed twice the size of the largest permitted single knot.

5. Holes

Allow holes that average less than 1/2 inch (15 mm) in diameter if the sum of the average diameter of all holes in any 1 ft^2 ($0.1m^2$) of pile surface is less than 1-1/2 in (40 mm).

6. Splits and Shakes

Splits shall not be longer than the butt diameter of the pile.

The length of any shake or combination of shakes in the outer half of the radius of butt of the pile, when measured along the curve of the annual ring, shall not exceed 1/3 the circumference of the butt of the pile.

7. Sapwood

Piles to be treated with preservative shall have at least 1 in (25 mm) of sapwood at the butt end.

8. Heartwood

a. In untreated piles for use in exposed work, the diameter of the heartwood at the butt shall be at least 8/10 of the diameter of the pile at the butt.

b. If high heartwood content is required for untreated foundation piles, the Plans will specify the ratio of heartwood to total diameter.

9. Peeling

a. Peel piles by removing all of the outer bark and at least 80 percent of the inner bark, well distributed over the surface of the pile.

b. If piles will be treated with preservative, do not leave inner bark wider than 1/2 in (15 mm).

c. Do not remove more than three annual rings of the solid wood.

10. Cutting and Trimming

a. Saw butts and tips square with the axis of the pile.

b. Trim or smoothly cut all knots and limbs flush with the surface of the pile or the surface of the swell surrounding the knot.

11. Straightness

In general, a straight line from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

If specified, the Department can accept long piles for foundations (but not for trestles) if the straight line lies partly outside the body of the pile. The maximum distance between the line and the pile shall not exceed 0.5 percent of the length of the pile or 3 in (75 mm), whichever is smaller.

12. Taper

Cut piles above the butt swell so it has a continuous taper from the point of butt measurement to the tip.

13. Twist of Grain

Do not allow spiral grain to exceed 180 degrees of twist when measured over any 20 ft (6 m) section of the pile.

14. Limits of Defects

a. Piles shall not have short crooks that deviate more than 2-1/2 in (65 mm) from straightness in any 5 ft (1.5 m) length.

b. Burst checks in piles shall be less than 1 in (25 mm) wide, measured at the outside, and shall not extend over 12 in (300 mm) long.

15. Circumferences, Diameters, and Lengths

a. The circumferences of piles measured under the bark shall have the minimum and maximum values in Table 1 (metric Table 1) for the class specified. No more than 10 percent of the piles in any shipment may have circumferences 2 in (50 mm) less than the tabulated minimum values.

NOTE: Requirements for tip circumference of piles that are longer than the required length may be applied at the tip end of the required length.

b. The ratio of the maximum to the minimum diameter at the butt of any pile shall not exceed 1.2.

c. Individual piles may vary from the length specified by ± 12 in (300 mm) in piles shorter than 40 ft (12 m), and ± 2 ft (600 mm) in piles 40 ft (12 m) or longer.

d. The average length of all piles of a specified length in each lot shall not be less than the length specified.

Table 1: Circumferences and Diameters of Timber Piles

	3 ft (900 mm) from butt				At tip, minimum	
	Minimum		Maximum			
Length	**Circumference**	**Dia. (approx.)**	**Circumference**	**Dia. (approx.)**	**Circumference**	**Dia. (approx.)**
Feet (meter)	**In (mm)**	**In (mm)**	**In (mm)**	**In (mm)**	**In (mm)**	**In (mm)**
Douglas Fir, Hemlock, Larch, Pine, Spruce, or Tamarack						
Under 40 (12)	38 (950)	12 (300)	63 (1575)	20 (500)	25 (625)	8 (200)
40 to 50 (12 to 15)	38 (950)	12 (300)	63 (1575)	20 (500)	22 (550)	7 (175)
51 to 70 (15.1 to 21.4)	41 (1025)	13 (325)	63 (1575)	20 (500)	22 (550)	7 (175)
71 to 90 (21.5 to 27.5)	41 (1025)	13 (325)	63 (1575)	20 (500)	19 (475)	6 (150)
Over 90 (27.5)	41 (1025)	13 (325)	63 (1575)	20 (500)	16 (400)	5 (125)
Oak and Other Hardwoods, Cypress						
Under 30 (9)	38 (950)	12 (300)	57 (1425)	18 (450)	25 (625)	8 (200)
30 to 40 (9 to 12)	41 (1025)	13 (325)	63 (1575)	20 (500)	22 (550)	7 (175)
Over 40 (12)	41 (1025)	13 (325)	63 (1575)	20 (500)	19 (475)	6 (150)
	Cedars					
Under 30 (9)	38 (950)	12 (300)	69 (1725)	22 (550)	25 (625)	8 (200)
30 to 40 (9 to 12)	41 (1025)	13 (325)	69 (1725)	22 (550)	25 (625)	8 (200)
Over 40 (12)	41 (1025)	13 (325)	69 (1725)	22 (550)	22 (550)	7 (175)

NOTE: If the pile length is 25 feet (7.6 m) or less, a minimum circumference of 34 in (850 mm) and minimum diameter of 11 in (275 mm) at a point 3 ft (900 mm) from the butt are required.

16. Branding and Inspection

    a. Ensure the pile length and the diameter of the butt and tip are branded in the butts of the piles.

    b. Legibly brand the Preliminary inspection date in the tips.

B. Fabrication

Seasoning and Preservative Treatment: Where required, season and treat according to Section 863.

C. Acceptance

The Department will reject the pile based on any of the following defects:

- Decay
- Deep scars
- Unsound knots
- Punk knots
- Ring knots
- Cluster knots
- Compression wood (if readily identifiable based on ordinary visual inspection)

The Department may accept piles with sound turpentine scars undamaged by insects, provided they meet all other requirements.

D. Materials Warranty

General Provisions 101 through 150.

861.2.02 Timber Poles

A. Requirements

1. Select timber poles from plants listed on QPL 50.
2. Ensure that the poles that meet the requirements of the latest revision of ANSI 05.1, in the National Electrical Safety Code published by the National Institute of Standards and Technology, with the following exceptions:
   a. Section 2 Definitions—Modify the "Short Crook" definition as follows:

      "Any localized deviation from straightness within any section 5 ft (1.5 m) or less in length shall not be more than 1 in (25 mm) when measured with a straightedge parallel to the long axis of the pole."

   b. Section 4 Material Requirements, 4.4.9 Shape (1), (a)—shall read as follows:

      "For poles 50 ft (15 m) and shorter, of all species except northern white cedar, a straight line joining the edge of the pole at the butt and the edge of the pole at the top, in 90 percent or more of those poles supplied, shall not be distant from the surface of the pole at any point by more than 1 in (25 mm) for each 10 ft (3 m) of length between these points. In the remainder of those poles supplied (10 percent), the poles may have a deviation of 1 in (25 mm) for each 6 ft (1.8 m) of length when measured as above."

   c. Section 4 Material Requirements, 4.4.9 Shape (2)—shall read as follows:

      "Sweep in two planes (double sweep) - NOT PERMITTED."
3. Use the class and length specified on the Plans.
4. You may peel poles by machine, except that poles more than 55 ft (17 m) long may be debarked and trimmed by hand in lieu of machine peeling. Trim so that you preserve the buttressing effects of all overgrown knots.
5. Unless otherwise specified or indicated on the Plans, frame poles with flat roofs and slab grains.
6. Frame, drill, and machine poles as necessary before preservative treatment.

B. Fabrication

Seasoning and Preservative Treatment: Where required, season and treat according to Section 863.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

March 17, 2006

Section 866—Precast Concrete Catch Basin, Drop Inlet, and Manhole Units

Delete Section 866 and substitute the following:

866.1 General Description

This section includes the requirements for manufacturing the following to the dimensions shown on the Plans:

- Precast reinforced concrete catch basins
- Drop inlets
- Manhole units

866.1.01 Related References

A. Standard Specifications

Section 500–Concrete Structures

Section 853–Reinforcement and Tensioning Steel

B. Referenced Documents

AASHTO M 199

AASHTO T 22

AASHTO T 24

SOP 19

QPL 4

QPL 86

866.2 Materials

The materials to be used shall meet AASHTO M 199 and the following requirements:

Material	Section
Concrete, Class AA-1, Vibrated, Air Entrained	500*
Reinforcement for Concrete	
Steel Bars	853.2.01
Steel Wire	853.2.06
Welded Steel Fabric	853.2.07
Macro-Synthetic Fibers	941
*Ensure that the concrete compressive strength is at least 4,000 psi (28 MPa). Do not use the gradation requirements.	

For a list of sources, see QPL 4.

866.2.01 Precast Concrete Catch Basin, Drop Inlet, and Manhole Units

A. Requirements

1. Reinforcement

   Follow the Plans, except as follows:

   a. Do not let steel reinforcement vary by more than 1/4 in (5 mm) from the position shown in the design, except at pipe connections.

   b. Ensure the cover on the steel reinforcement is not less than that shown on the Plans.

   c. Macro-synthetic fibers are permitted as reinforcement in lieu of steel reinforcement in precast manhole riser sections only. Approved fibers are listed on the Department's Qualified Products List 86 (QPL 86), entitled Macro-Synthetic Fibers for Concrete Reinforcement.

2. Ensure all precast concrete units are true to shape with smooth, dense, and uniform surfaces.

B. Fabrication

1. Casting

   a. Place the concrete in each unit without interruption.

b. Consolidate the concrete with an approved vibrator and hand-tamping as necessary. Force the concrete into the corners of the forms to prevent stone pockets or cleavage planes.

2. Holes for Pipes

Make each hole about 4 in (100 mm) larger than the outside diameter of the appropriate pipe.

3. Curing:

Cure the units with one of the following methods until the minimum compressive strength has been achieved, or for 24 hours, whichever comes first.

a. Method 1

1) Place the units in a curing chamber, free from outside drafts, and cure them in a moist atmosphere not exceeding 160 °F (70 °C).

2) Use steam injection for the time and temperature needed to obtain proper curing.

3) Construct the curing chamber and place the units so that steam may fully circulate around the entire unit.

b. Method 2

1) Keep the units wet by covering the concrete not in contact with the forms with wet burlap or other suitable material.

2) Protect the units from freezing between when you place the concrete until curing is complete.

4. Removing the Forms

Leave the forms in place until you can remove them without damaging the unit.

5. Quality of Work

a. Correct minor surface cavities or irregularities that do not impair the service value of the unit by pointing with an approved mortar. Apply the mortar immediately after removing the forms.

b. Minor defects will not be cause for rejection.

C. Acceptance

1. Testing Facilities

Ensure that the manufacturer furnishes facilities and assistance as required for the Inspector to sample and test quickly and efficiently.

NOTE: Check QPL 4 for pre-approved manufacturers that supply material compliant with this Specification.

2. The Department will accept the units based on the results of compressive tests on concrete cylinders and on inspection during manufacture. The tests will determine the unit’s conformance with the design and quality of work prescribed in these Specifications and on the Plans.

3. The Department will accept any unit that meets the test requirements, regardless of age.

4. Rejection

The Inspector will reject units if they fail to meet any requirements in this Specification, and for any of the following defects:

- Imperfect mixing and molding
- Honeycombed or open texture
- Exposure of the reinforcement that indicates the reinforcement is misplaced

5. Marking

Ensure that each approved unit is marked with the name or trademark of the manufacturer and the date it was cast. The mark will be stenciled or otherwise placed on the inside of the unit so it is clearly legible at time of delivery.

a. When approved by the Inspector, each unit will be stamped with the official mark of the Department or Certified Pipe Technician number (CPT).

b. Accepted units or finished units will be rejected at any time if found to be defective.

6. Test as follows:

Test	Method
Compressive strength	AASHTO T 22 and AASHTO T 24

7. Compressive Strength Test

The Inspector shall do the following:

a. Make compression tests on cylinders to satisfy the minimum strength requirements.

b. Make at least three cylinders from each day’s pour and cure them in the same manner as the precast units.

D. Materials Warranty

1. Shipping

Do not ship or transport any unit to the installation site unless it bears the required markings, stated in Subsection 866.2.01.C.5.

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March 17, 2006

Section 868—Bituminous Adhesive for Raised Pavement Markers

Delete Section 868 and substitute the following:

868.1 General Description

This section includes the requirements for bituminous hot-melt adhesive used to place raised pavement markers.

868.1.01 Related References

A. Standard Specifications

Section 106—Certification of Materials

B. Referenced Documents

AASHTO	ASTM	
T 48 T 49 T 53 T 202	C 430 D 70 D 1754 D 1796	D 1856 D 2669 D 2712 D 3407

868.2 Materials

868.2.01 Bituminous Adhesive

A. Requirements

1. Adhesive

Use an adhesive made of asphaltic material and a homogeneously mixed filler that meets the following physical requirements:

a. Adhesive Properties: Use the asphaltic material with filler.

	Min.	Max.	Test Method
Softening point	200° F (95 °C)	—	AASHTO T 53
Penetration, mm 3.5 oz (100 g), 5 sec., 77 °F (25 °C)	10	20	AASHTO T 49
Flow	—	0.2 in (5 mm)	ASTM D 3407 (modified in Subsection 868.2.01.C)
Viscosity, 400 °F (204 °C)	—	60 Poises (6.0 Pa-s)	ASTM D 2669 (modified in Subsection 868.2.01.C)
Flash point, C.O.C.	550 °F (285 °C)	—	AASHTO T 48

b. Asphalt Properties: Use the filler-free material derived from the extraction and Abson recovery process explained in Subsection 868.2.01.C.

	Min.	Max.	Test Method
Penetration, mm 3.5 oz (100 g), 5 sec., 77° F (25° C)	25	—	AASHTO T 49
Viscosity, 275° F (135° C)	12 Poises (1.2 Pa-s)	—	AASHTO T 202
Viscosity ratio, 275° F (135° C)	—	2.2	See Subsection 868.2.01.C

c. Filler Properties: Use the filler separation techniques described in Subsection 868.2.01.C.

	Min.	Max.	Test Method
Filler content, percent by weight	50	70	See Subsection 868.2.01.C
Filler fineness, percent passing			
No. 325 (45 µm) No. 200 (75 µm) No. 100 (150 µm)	75 95 100		ASTM C 430 (modified in Subsection 868.2.01.C)

d. Certification: Submit a certification from the manufacturer that includes the physical properties of the bituminous adhesives and that the material conforms with this Specification, as stated in Subsection 106.05, “Materials Certification.”

2. Packaging and Labeling

a. Pack the adhesive in a self-releasing cardboard container of approximately 10 in (250 mm) that can be stacked properly.

b. Fill the containers with two 30 lb (13.5 kg) cubes that have a net weight of 60 lbs (27 kg).

c. Put the manufacturer, quantity, and batch number on the label.

d. Print “Bituminous Adhesive for Pavement Markers” on the label.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

1. Flow

Determine flow according to Section 6, Flow, of ASTM D 3407.

a. Set the oven temperature at 158 ° ± 2 °F (70 ° ± 1 °C).

b. Prepare samples according to Subsection 7.1 of AASHTO T 49.

2. Viscosity

Determine viscosity according to ASTM D 2669 using a spindle speed of 10 rpm.

a. Heat the adhesive to approximately 410 °F (210 °C) and then let cool.

b. Determine viscosity at 400 ° ± 1°F (204 ° ± 0.6 °C).

3. Asphalt Properties

Determine the base asphalt properties based on the material obtained from the following extraction and Abson recovery methods:

a. Extract the asphalt by heating the adhesive to the point where it will easily flow.

b. Add 125 to 150 g of adhesive to 400 mL of trichloroethylene that has a temperature of 125 ° to 150 °F (51 ° to 66 °C).

c. Stir the mixture to dissolve the asphalt.

d. Decant the trichloroethylene-asphalt mixture.

e. Recover the asphalt using the Abson recovery method described in ASTM D 1856, except do not use the extraction methods of ASTM D 2712, and do not filter the solvent-asphalt mixture.

f. Centrifuge the extraction solution of trichloroethylene and asphalt for at least 30 minutes at 770 times gravity in a batch centrifuge.

g. Decant the solution into a distillation flask. Do not include any filler sediment.

h. Apply heat and bubble carbon dioxide slowly until the solution reaches a temperature of 300 °F (149 °C).

i. Increase the carbon dioxide flow to between 800 to 900 mL per minute.

j. Maintain the decanted solution temperature between 320 ° and 335 °F (160 ° and 168 °C) with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors are completely removed from the distillation flask.

k. Repeat the extraction-recovery method as necessary to obtain the desired quantity of asphalt.

l. Determine penetration, 275 °F (135 °C) viscosity, and viscosity ratio with the recovered asphalt.

4. Viscosity Ratio

Determine the 275 °F (135 °C) viscosity ratio by comparing the 275 °F (135 °C) viscosity on the base asphalt before and after the Thin-Film Oven Test.

a. Perform the Thin-Film Oven Test as described in ASTM D 1754.

b. Determine the specific gravity with a pycnometer as described in ASTM D 70 for use in the Thin-Film Oven Test.

c. Calculate the 275 °F (135 °C) viscosity ratio by dividing the viscosity after the Thin-Film Oven Test by the original 275 °F (135 °C) viscosity.

5. Filler Material

Separate the filler material from the asphalt to determine filler content and filler fineness.

a. Filler Content

1) Determine the portion by weight of the adhesive that is insoluble in 1, 1, 1-trichloroethane by weighing 10.00 ± 0.01 g of solid adhesive into a centrifuge flask with a volume of approximately 100 mL, as specified in ASTM D 1796.

2) Add 50 mL of 1, 1, 1-trichloroethane to the adhesive.

3) Break the adhesive into small pieces to dissolve the solids.

4) Place the sample flask in a balanced centrifuge and spin with a minimum relative centrifugal force of 150 (as determined in Section 6 of ASTM D 1796) for 10 minutes.

5) Remove the sample flask and decant the solvent, without losing any solids.

6) Repeat the application of solvent and centrifuging until the solvent is clear and the filler is visually free of asphalt.

7) Dry the filler at 160 °, ± 5 °F (71°, ± 3 °C) to remove solvent and weigh the resulting filler.

8) Filter the decanted solvent to verify that no filler was lost.

9) Calculate the percent filler content as follows:

$$\text{Filler Content, \% by weight (g)} = \frac{\text{Filler Wt. (g) x 100}}{\text{Original Adhesive Wt. (g)}}$$

b. Filler Fineness

1) Determine filler fineness according to ASTM C 430, using No. 325 (45 μm), No. 200 (75 μm), and No. 100 (150 μm) sieves.

2) Modify this method by using a water-soluble, non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Use a surfactant solution that is approximately 1 percent by weight.

3) Thoroughly wet the 1-gram dry sample in the surfactant solution.

4) Soak the sample for 30 minutes.

5) Transfer the filler to the sieve cup.

6) Spray water on the filler for two minutes.

7) Add surfactant solution as needed and physically disperse clumped particles.

8) Dry the sample and handle as directed in ASTM C 430.

The Department will reject any bituminous adhesive if it meets all requirements of this Specification but fails in actual use.

D. Materials Warranty

General Provisions 101 through 150.

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May 19, 2006

Section 881—Fabrics

Delete Section 881 and substitute the following:

881.1 General Description

This section includes the requirements for the following fabrics:

- Plain cotton duck
- Rubber-impregnated cotton duck
- Burlap and cotton bags
- Plastic filter fabric
- Pavement reinforcement fabric
- Silt fence filter fabric

881.1.01 Related References

A. Standard Specifications

Section 106—Materials Certification

B. Referenced Documents

Federal Specification CCC-C 419 Type III

ASTM D 36

ASTM D 146

ASTM D 412

ASTM D 1777

ASTM D 3786

ASTM D 4355

ASTM D 4632, GRAB

ASTM D 4751

ASTM D 4833

GDT 87

GDT 88

GDT 95

QPL 28

QPL 36

QPL 40

QPL 47

881.2 Materials

881.2.01 Plain Cotton Duck

A. Requirements

1. Use plain cotton duck that meets the requirements of Federal Specification CCC-C 419 Type III.
2. Ensure that the duck weighs at least 8 oz./yd² (270 g/m²).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

881.2.02 Rubber-Impregnated Cotton Duck

A. Requirements

1. Use preformed rubber-impregnated fabric pads made of multiple layers of 8 oz (270 g) cotton duck, impregnated and bound with high quality natural rubber, or made of equivalent materials compressed into resilient pads of uniform thickness.
2. Use enough plies to reach the specified thickness after compression and vulcanizing.
3. Ensure that the finished pad withstands compression loads of not less than 10,000 psi (70 MPa) when applied perpendicular to the plane of the laminations. Ensure that the pad does not extrude or harmfully reduce in thickness.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

881.2.03 Burlap Bags

A. Requirements

1. Use burlap bags made of at least 95 percent jute and manila fibers.
2. Use burlap that weighs 8 to 18 oz/10 ft² (250 to 550 g/m²).
3. Use bags with a capacity of 1 to 2 ft³ (0.03 to 0.06 m³).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

881.2.04 Cotton Bags

A. Requirements

1. Use cotton bags with Osnaburg 40 x 26 thread count and a nominal fabric weight of 6.8 oz/yd^2 (230 g/m^2).
2. Use bags that have 1/2 in (13 mm) sewn seams with at least 1 stitch per 1/5 in (5 mm).
3. Use 4 or 5 ply, 12 cotton yarn or equivalent for the stitches.
4. Ensure that seam efficiency is at least 80 percent. Ensure that the inside measurements tolerance is ± 1/2 in (13 mm).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

881.2.05 Plastic Filter Fabric

A. Requirements

1. Use pervious sheets of plastic yarn made from a long-chain synthetic polymer. Use polymer composes of at least 85 percent by weight of propylene, ethylene, amide, ester, or vinylidene chloride.

   Use a sheet of plastic yarn that contains stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultra-violet and/or heat exposure.
2. Ensure that the fabric is finished so that the filaments will retain their relative position with respect to each other.
3. Use fabric without defects, rips, holes, or flaws.
4. Use fabric that meets the following physical requirements for woven and non-woven fabric:

Woven Fabrics	
Tensile strength (any direction)	200 lbs (890 N) minimum
Bursting strength	500 psi (3.5 MPa) minimum
Elongation before breaking	10% to 35%
Percent open area	4.0% to 6.5%
Non-woven Fabrics	
Puncture resistance	30 lbs (135 N) minimum
Grab tensile strength	65 lbs (290 N) minimum
Grab elongation	40% minimum
Flow rate [H from 3 to 1 in (75 to 25 mm)]	50 gal/min/ ft^2 (34 liters/second/m^2) (minimum) to 350 gal/ min/ft^2 (240 liters/second/m^2) (maximum)

5. Seams
   a. Get approval on the seams from the Engineer before use on a Project.

b. Use fabric that is sewn with thread of the same chemical requirements as the fabric, or use fabric bound with cement or heat. Either have the fabric bound or sewn at the point of manufacture or at a location approved by the Engineer.

c. Seam Uses: You may use one seam in edge drain and underdrain applications. You may bond or sew fabric together to form sections at least 6 ft (1.8 m) wide for use under rip rap or behind retaining walls.

6. Fabric Use

a. Use woven fabrics beneath rip rap when dropping stone from 3 ft (1 m) or less.

b. You may use woven fabrics that meet the flow rate for edge drains.

c. Use non-woven fabrics to line edge drains, underdrains, or behind retaining walls, where specified.

d. Do not use non-woven fabrics for filter beneath rip rap.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test according to the following:

Test	Method
Puncture resistance	ASTM D 4833
Tensile strength, elongation, grab strength	ASTM D 4632
Bursting strength	ASTM D 3786
Percent open area	GDT 88
Flow rate	GDT 87

1. See QPL 28 for acceptable woven and non-woven fabrics that meet the requirements of this Specification. See QPL 47 for acceptable Geocomposite wall drains.
2. The Department will reject any fabrics that meet this Specification but fail to perform in actual use.

D. Materials Care and Warranty

Wrap fabric in burlap or similar heavy duty protection during shipment and storage to protect it from mud, dirt, dust, and debris.

881.2.06 Pavement Reinforcement Fabric

A. Requirements

Type I and Type II Pavement Reinforcement Fabric

1. Use pavement reinforcement fabric that has the following properties:

- Is non-woven, heat-resistant material composed of polypropylene or polyester fibers
- Can be saturated with asphalt cement
- Can be placed smooth with mechanical devices and be without wrinkles
- Can withstand the heat of asphaltic concrete mixes during paving operations
- Can withstand normal field handling and construction operations without damage

For a list of sources, see QPL 40.

- Meets the following physical requirements. The bid item or Plans will indicate which type of fabric is required for a Project.

	Type I	Type II
Tensile strength, minimum	90 lbs (400 N)	125 lbs (555 N)
Elongation at break	40% min., 100% max.	40% min., 100% max.
Asphalt retention, minimum	0.18 gal/yd² (0.8 L/m²)	10.28 gal/yd² (1.3 L/m²)

2. Submit a certificate from the manufacturer that shows the physical properties of the material used and how it meets this Specification. Submit the certificate according to Subsection 106.05, "Materials Certification."
3. Demonstrate to the Department that fabric meeting the physical properties requirements of this Specification has been used successfully in installations with similar environmental and Project conditions.

High Strength Pavement Reinforcement Fabric

1. Use pavement reinforcement fabric that has the following properties:
   - Is a flexible, water-resistant, high-density asphaltic membrane laminated between two layers of high strength, heat resistant polypropylene or polyester fabric.
   - Can be placed smooth with mechanical devices and be without wrinkles.
   - Can withstand the heat of asphaltic concrete mixes during paving operations.
   - Can withstand normal field handling and construction operations without damage.
   - Has a self-adhesive backing adhered to a film release liner.

   For a list of sources, see QPL 40.

   - Meets the following physical requirements. The bid item or Plans will indicate which type of fabric is required for a Project.

Width, minimum	18 in (450 mm)
Tensile strength, minimum	1,800 lbs/in^2 (12 MPa)
Elongation	20% to 50%
Softening Point (Asphaltic membrane), minimum	190^{0}F (87°C)
Caliper	0.135 inch (3.43 mm) 95% retained after loading
Pliability (Cold Flex) 2" (50 mm) X 5" (125 mm) specimen, condition specimen at 0°F (-18°C)for 1 hour, 180° bend on 2" (50 mm) mandrel	No Separation

2. Submit a certificate from the manufacturer that shows the physical properties of the material used and how it meets this Specification. Submit the certificate according to Subsection 106.05, "Materials Certification."
3. Demonstrate to the Department that fabric meeting the physical properties requirements of this Specification has been used successfully in installations with similar environmental and Project conditions.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Type I and Type II Pavement Reinforcement Fabric

Test according to the following:

Test	Method
Tensile strength	ASTM D 4632 Grab
Elongation	ASTM D 4632 Grab
Asphalt retention	GDT 95

High Strength Pavement Reinforcement Fabric

Test according to the following:

Test	Method
Tensile strength	ASTM D 412
Elongation	ASTM D 412
Softening Point	ASTM D 36
Caliper	ASTM D 1777
Pliability (Cold Flex)	ASTM D 146

D. Materials Warranty

General Provisions 101 through 150.

881.2.07 Silt Fence Filter Fabric

A. Requirements

1. Use approved silt fence from QPL 36.
   a. Type "A" and "B" Fences: Use either woven or nonwoven filter fabric for Type "A" and "B" fences. If using woven fabric, the fabric may have slit tape yarns in one direction (warp or fill) only.
   b. Type "C" Fences: Use non-calendered woven fabric constructed with monofilament yarns only.

NOTE: Approved fabrics must consistently exceed the minimum requirements of this Specification as verified by the Office of Materials and Research. If a fabric is removed from the Qualified Products List, do not use it in the work until the Department has reestablished the product's acceptability.

2. Ensure that silt fence filter fabrics have the following characteristics:
   - Has strong rot-proof synthetic fibers formed into either a woven or non-woven fabric
   - Has no treatment or coating that might significantly alter its physical properties after installation
   - Contains stabilizers and/or inhibitors to make the filaments resistant to deterioration resulting from exposure to sunlight or heat
   - Makes a pervious sheet of synthetic fibers oriented into a stable network so that the fibers retain their relative position with respect to each other under normal handling, installation, and service conditions
   - Has finished fabric edges to prevent the outer yarn from pulling away from the fabric
   - Has no defects or flaws that would significantly affect its physical and/or filtering properties
   - Meets the following physical or dimensional requirements:

Type Fence	A	B	C
Minimum tensile strength, pounds (newtons) (1)	Warp – 120 (530) Fill – 100 (445)	Warp – 120 (530) Fill - 100 (445)	Warp– 260 (1155) Fill – 180 (800)
Elongation (% Max.)	40	40	40
Apparent opening size (max. sieve size)	No. 30 (600 um)	No. 30 (600 um)	No. 30 (600 um)
Flow rate, gal/ min./ft² (L/min./m²)	25 (1015)	25 (1015)	70 (2850)
Ultraviolet stability (2)	80	80	80
Bursting strength, psi (kPa)	175 (1200)	175 (1200)	175 (1200)
Minimum fabric width	36 in (900 mm)	22 in (550 mm)	36 in (900 mm)
1. Minimum roll average of five specimens. 2. Percent of required initial minimum tensile strength.			

B. Fabrication

The fabric may be manufactured with pockets for posts, hems with cord, or with posts pre-attached using staples or button head nails.

Ensure that the fabric has the manufacturer's name and product trade name labeled on the fabric at a minimum of 25 ft (7.6 m) intervals. Ensure that the fabric has a color yarn mark in the fabric 14 inches (355 mm) ± 0.5 inch (12 mm) from both top and bottom ends for Type A and C and 8 inches (203 mm) ± 0.5 inch (12 mm) from both top and bottom ends for Type B fabric.

C. Acceptance

Test according to the following:

Test	Method
Tensile strength	ASTM D 4632
Elongation	ASTM D 4632
Apparent opening size	ASTM D 4751
Flow Rate	GDT 87
Ultraviolet stability	ASTM D 4632 (after 300 hours weathering according to ASTM D 4355)
Bursting strength	ASTM D 3786, Diaphragm Bursting Strength Tester

D. Materials Care and Warranty

Wrap fabric in a heavy-duty protective covering during shipment and storage to protect it from mud, dirt, dust and debris.

Do not expose fabric to temperatures greater than 140 ^{o} F (60 ^{o} C).

881.2.08 Filter Fabric for Embankment Stabilization

See Special Provision.

Section 882—Lime

Delete Subsection 882 and substitute the following:

882.1 General Description

This Section includes the requirements for agricultural lime; lime for soil stabilization; and lime for asphaltic concrete.

882.1.01 Related References

A. Specifications

General Provisions 101 through 150.

B. Referenced Documents

AASHTO M 303

ASTM C 25

ASTM C 110

ASTM C 977

"Official Methods of Analysis," Association of Official Agricultural Chemists

QPL 41

882.2 Materials

882.2.01 Agricultural Lime

A. Requirements

1. Use agricultural lime made of ground dolomitic limestone with the following properties:

Requirements	Percent by Weight
Total carbonates, min.	85
Elemental magnesium derived from magnesium carbonate, min.	6
Passing No. 10 (2.00 mm) sieve, min	90
Passing No. 100 (150 µm) sieve, min	25

2. If desired, substitute liquid lime concentrate for one ton per acre (2240 kg/ha) of the ground dolomitic limestone. Use liquid lime concentrate conforming to the following composition by weight:

Component	Minimum	Maximum
Calcium Carbonate ($CaCO_3$)	30.0%	
Magnesium Carbonate ($MgCO_3$)	30.0%	
Moisture		30.0%

3. Add liquid lime concentrate to the hydroseeding mix at a rate of 2.5 gallons per acre (23 liters per hectare)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test agricultural lime according to the "Official Methods of Analysis" of the Association of Official Agricultural Chemists.

D. Materials Warranty

General Provisions 101 through 150.

882.2.02 Lime for Soil Stabilization

A. Requirements

Use either a commercial dry hydrated lime or a commercial granular or pelletized quicklime for soil stabilization.

1. Hydrated Lime: Use hydrated lime that meets the requirements of ASTM C 977, except that at least 85 percent by weight of the lime shall pass the No. 200 (75 µm) sieve.
2. Quicklime: Use quicklime that meets the requirements of ASTM C 977, except that the lime shall contain at least 94 percent total calcium oxide and magnesium oxide (CaO + MgO), and at least 90 percent total available calcium oxide (CaO).
   a. Ensure the quicklime meets one of the following grade requirements (by weight):

Grade A	Grade B
100% passes the 3/8 in (9.5 mm) sieve	100% passes the No. 10 (2.00 mm) sieve
0% passes the 1/4 in (6.3 mm) sieve	

   b. Furnish certified test reports with each shipment of lime attesting that the lime meets the requirements of the Specification. However, the Engineer may inspect, test, and reject the material at any time.
   c. You may use lime from more than one source or more than one type on the same Project, but do not mix the limes.
   d. Protect the lime from exposure until used. Ensure that the lime is dry enough to flow freely when handled.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the hydrated and quicklime used for soil stabilization according to ASTM C 977.

D. Materials Warranty

General Provisions 101 through 150.

882.2.03 Lime for Asphaltic Concrete

A. Requirements

Use hydrated lime that meets the chemical and physical properties of AASHTO M 303, Type I.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

1. Run the chemical analysis of hydrated lime used in asphaltic concrete according to ASTM C 25.
2. Test the physical properties of the hydrated lime according to the residue test in ASTM C 110.

NOTE: QPL 41 for lime is used in asphaltic concrete only.

3. See QPL 41 for acceptable hydrated lime that meets the requirements of this Specification.

D. Materials Warranty

General Provisions 101 through 150.

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March 17, 2006

Section 893—Miscellaneous Planting Materials

Delete Section 893 and substitute the following:

893.1 General Description

This section includes the requirements for miscellaneous planting materials, such as the following:

- Plant topsoil
- Mulch
- Vines, shrubs, trees, and miscellaneous plants
- Inoculants
- Porous material
- Prepared plant topsoil
- Tree paint
- Stakes
- Organic soil additives
- Erosion Control Compost

893.1.01 Related References

A. Specifications

Section 814—Soil Base Materials

Section 822—Emulsified Asphalt

B. Referenced Documents

“USA Standard for Nursery Stock” of the American Association of Nurserymen, Inc.

“Standardized Plant Names”

“Method of Test for Moisture Content of Hay or Straw” United States Department of Agriculture and the United States Composting Council, “Test Methods for the Examination of Composting and Compost” (TMECC).

GDT 41

893.1.02 Submittals

A. Submissions for Erosion Control Compost

Submit a notarized certification that includes the following:

- The feedstock by percentage in the final compost product.

- A statement that the compost meets federal and state health and safety regulations.
- A statement that the composting process has met time and temperature requirements.
- A copy of the lab analysis, less than four months old, performed by a Seal of Testing Assurance certified lab verifying that the compost meets the physical requirements specified.

When requested by the Engineer, one Solvita Compost Maturity Test kit (six tests) for every 1000 yd^3 (765 m^3) of compost supplied shall be provided.

893.2 Materials

893.2.01 Plant Topsoil

A. Requirements

1. Use plant topsoil with the following characteristics:
   - Obtained from well-drained, arable land, but not from fields where tobacco grew in the last three years, or where Johnson grass or kudzu is present.
   - Friable, loamy soil with between 2 and 30 percent organic matter. Determine the percentage by measuring the loss on ignition of oven-dried samples ignited at 1,200 °F (650 °C).
   - Reasonably free from subsoil, heavy or stiff clay, coarse sand, and other deleterious substances.
   - Has no toxic amounts of acid or alkaline elements.
   - Can sustain healthy plant life.
   - Meets the grade requirements of Subsection 814.2.01.A.8.
2. The Department reserves the right to inspect all plant topsoil during the planting period. The Department will reject any material that does not meet the Specifications.
3. Do not use frozen, muddy, or nonfriable topsoil.
4. Before delivering any topsoil to the job site, clear stones larger than 2 in (50 mm) size and roots, sticks, brush, coarse litter, and other substances that would interfere with mixing, planting, and maintenance.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

893.2.02 Mulch

A. Requirements

1. Use mulch materials from two groups:
   a. Grassing and Erosion Control: Threshed rye, oat or wheat straw; or Bermuda grass hay.
   b. Vine, Shrub, Tree, and Miscellaneous Plant Plantings: Pine straw, pine bark, or hardwood mulch (see Subsection 893.2.09.A.2 for pine bark and hardwood mulch).
2. Use mulch materials from either group that meet the following requirements:
   - Are accepted by the Engineer.

- Can be distributed uniformly when properly loosened
- Produce the desired results
- Meet the moisture requirements specified herein
- Contain no excessive amounts of noxious weed seeds

3. Noxious Weed Seeds

Do not use hay or straw mulch material that has an excessive quantity of matured seeds from noxious weeds or other species that would harm surrounding farmland.

4. Moisture Content

Ensure that the mulch material is reasonably dry, especially when bituminous treated mulches must retain the bituminous material.

5. Erosion Control Compost

Use erosion control compost that consists of 50% untreated wood chips blended with 50% general use compost measured by volume.

a. Wood Chips shall be fresh or partially composted wood chips less than or equal to 3 in (75 mm) in length with 100% passing a 2 in (50 mm) sieve and less than 10% passing a 1 in (25 mm) sieve. Wood chips shall not contain any visible refuse or other physical contaminants, material toxic to plant growth, or over 5% sand, silt, clay or rock material.

b. Produce General Use Compost by aerobic (biological) decomposition of organic matter. Compost feedstock may include, but is not limited to, leaves and yard trimmings, Class A biosolids, food scraps, food processing residuals, manure or other agricultural residuals, forest residues, bark, and paper. Compost shall not contain any visible refuse or other physical contaminants, material toxic to plant growth, or over 5% sand, silt, clay or rock material. Mixed municipal solid waste compost and Class B biosolids, as defined in the United States Environmental Protection Agency Code of Federal Regulations (USEPA, CFR), Title 40, Part 503 are unacceptable. Ensure Compost meets all applicable USEPA, CFR, Title 40, Part 503 Standards for Class A biosolids and the following requirements:

Table 1-- Physical Requirements for Compost

Test	Requirements	Test Method
Organic Matter Content	30-65% (dry mass)	TMECC 05.07-A
Particle Size	100 % passing 5/8 in (15.62 mm) sieve 70% retained on 3/8 in (9.5 mm) sieve	TMECC 02.02-B
Soluble Salts	5.0 max. * dS/m	TMECC 04.10-A
Fecal Coliform	Pass	TMECC 07.01-B
pH	5.5 – 8.5 pH	TMECC 04.11-A
Stability	8 or below	TMECC 05.08-B
Maturity	greater than 80%	TMECC 05.05-A
Heavy Metals	Pass	TMECC 04.06 and TMECC 04.13-B

*A soluble salt content up to 10.0 dS/m for compost used in Compost Manufactured Topsoil will be acceptable.

NOTE: All physical requirements are in accordance with the United States Department of Agriculture and the United States Composting Council, "Test Methods for the Examination of Composting and Compost" (TMECC).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

1. If the material feels damp, the Department will use GDT 41 to test for moisture content.
2. To pass, materials shall have a moisture content of 12 percent or less.

D. Materials Warranty

General Provisions 101 through 150.

893.2.03 Vines, Shrubs, Trees, and Miscellaneous Plants

A. Requirements

1. Use stock that meets the requirements of all State and Federal Laws for inspection of plant diseases and infestation.
2. Use nursery grown and collected plant materials that meet all regulations of the States of their origin and destination, and that meet Federal regulations governing interstate movement of nursery stock.
3. Use stock that is true to name and variety and is of first class quality with well developed tops and vigorous, healthy root systems.

NOTE: Use plant names according to the edition of "Standardized Plant Names" in effect at the time of Invitation For Bids.

4. Use only nursery-grown stock that have had their roots pruned during their development, unless otherwise specified.
   a. The Department will not accept plants and/or trees that are severely cut back or pruned to conform to contract size requirements.
   b. The Department will reject trees and shrubs that are undersized, have poorly developed tops or root systems, or are infected with disease or infested with insects.
5. Certification

   Furnish all certificates of disease and infestation inspection, a list of plant materials purchased, and a complete list of nurseries from which each plant was grown.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will inspect plants at the nursery whenever necessary.

1. Inspect and grade living plants for type, size, and quality according to the requirements and recommendations of "USA Standard for Nursery Stock" of the American Association of Nurserymen, Inc.
2. Even if the Department accepts materials after a test at the source, the Department may inspect the stock during planting and reject any that does not meet specification.
3. The Department will reject any of the following:
   - Stock damaged during digging, loading, transporting, planting, and transplanting
   - Broken or loose balls or balls of less diameter than that specified
4. Replace rejected stock at your own expense.
5. Dispose of rejected stock to the satisfaction of the Engineer.

D. Materials Warranty

1. Delivery
   a. Give the Engineer at least 24 hours notice before delivering any stock to the job site.

b. Send an invoice with each shipment that shows the sizes and varieties of material included.

2. Packaging

Pack stock for shipment to properly protect against drying, freezing, breaking, or other injury.

a. Pack and clearly label each variety in separate bundles.

b. Designate plants that are to be balled and burlapped as “B&B.”

1) Place as many fibrous roots as possible in the ball.

2) Securely and tightly wrap the ball with burlap. Tie a cord or wire around the ball, or pin it with nails to hold the burlap in place.

c. For remaining plants, dig them bare-rooted and puddle them immediately after digging them up and when receiving them at the Project. Use the standard practices of the nursery trade.

893.2.04 Inoculants

A. Requirements

1. Use a pure culture of nitrogen-fixing bacteria for an inoculant to treat seeds. Select an inoculant for maximum vitality and ability to transform nitrogen from the air into soluble nitrates and deposit them into the soil.
2. Use only purebred cultures less than one year old.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Engineer will review acceptable cultures.

D. Material Warranty

General Provisions 101 through 150.

893.2.05 Porous Material

A. Requirements

Protect roots with gravel, broken stone, slag, broken concrete, brick bats, or other acceptable coarse aggregate ranging in size from 1-1/2 to 4 in (38 to 100 mm). Excessive amounts of lime in the form of brick mortar shall be grounds for rejection.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will reject the material if it has excessive amounts of lime in the brick mortar.

D. Material Warranty

General Provisions 101 through 150.

893.2.06 Tree Paint

A. Requirements

Use tree paint that meets the requirements of Subsection 822.2.01, or use any commercial tree paint with antiseptic qualities.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

See Subsection 822.2.01.C.

D. Material Warranty

General Provisions 101 through 150.

893.2.07 Prepared Plant Topsoil

A. Requirements

1. Use prepared plant topsoil made from plant topsoil, organic soil additive, commercial fertilizer, and lime, as described in Subsection 893.2.07.B.
2. Base any volume for peat moss used as an organic soil additive on the compressed bale.
3. For loose peat, double the volume.

B. Fabrication

1. Make prepared plant topsoil from the following:
   - Four parts plant topsoil, Subsection 893.2.01
   - At least one part organic soil additive, by volume, Subsection 893.2.09
   - A commercial fertilizer, grade 6-12-12, at the rate of 3 lb/yd^3 (1.8 kg/m^3)
   - Lime at the rate of 5 lb/yd^3 (3 kg/m^3)
2. Base the above volumes on naturally compacted, undisturbed topsoil.

C. Acceptance

See the appropriate subsections.

D. Material Warranty

General Provisions 101 through 150.

893.2.08 Stakes

A. Requirements

1. Use wood stakes as indicated in the Specifications or shown on the Plans. Use the stakes for vine, shrub, tree, and miscellaneous plantings.
2. Saw wood stakes from either oak or gum. Use only stakes that are number two common or better, either rough or dressed.

B. Fabrication

1. Cut the stakes from sound, solid, undecayed wood, without unsound knots.
2. Shape stakes to within 1/4 in (6 mm) for all dimensions.
3. Taper all stakes at one end.

C. Acceptance

The Department will reject any stake that does not meet the following test:

1. Draw a line from the center of the top to the center of the butt of each stake.

2. Ensure that the line stays within the body of the stake and is not more than 1 in (25 mm) from the geometric center of the stake.

D. Materials Warranty

General Provisions 101 through 150.

893.2.09 Organic Soil Additives

A. Requirements

Use four types of organic additives: peat moss, pine bark, compost, and hardwood mulch.

1. Peat Moss

   Use peat moss that meets the following requirements:

   - Be granulated sphagnum virtually free from woody substances, consisting of at least 75 percent partially decomposed stems and leaves of sphagnum
   - Be essentially brown in color
   - Be free of sticks, stones, and mineral matter
   - Be in an air-dry condition
   - Shows an acid reaction of 3.5 pH to 5.5 pH
   - Meets State and Federal regulations

2. Pine Bark

   Use pine bark that meets the following requirements:

   - Be obtained from disease-free wood, 100 percent of which is 9 in^2 (5625 mm^2) or less in area, and 50 percent is more than 1 in^2 (625 mm^2) in area.
   - Contain no noxious weed seeds, soil, sawdust or any substance toxic to plant growth
   - Be at least two years old

3. Compost

   Use compost that meets the following requirements:

   - Be organic materials that have undergone biological decomposition
   - Be disinfected using composting or similar technologies
   - Be stabilized so it is beneficial to plant growth
   - Be mature, dark brown or black in color and have minimal odors
   - Contain no human pathogens
   - Fall within a pH range of 5 to 8

   Provide to the Department a list of all the ingredients in the original compost mix in the order of their relative proportions on a weight basis.

4. Hardwood Mulch

   Use hardwood mulch that meets the following requirements:

   - Derived from disease-free deciduous trees

- Particle size of less than 1 in (25 mm) diameter and less than 3 in (75 mm) in length. Hardwood mulch shall complete two composting cycles of 140º F (60º C) so that all viable weed seeds are destroyed and no further decomposition due to nitrification will occur.
- Free from toxic levels of acidity and alkalinity

Provide test results stating that the ingredients meet Federal, State, and local requirements for priority pollutant limits and do not contain levels of any chemicals that are harmful to plants or humans.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will accept the materials based upon their compliance with this specification.

D. Material Warranty

General Provisions 101 through 150.

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May 19, 2006

Section 894—Fencing

Delete Section 894 and substitute the following:

894.1 General Description

This section includes the requirements for the following types of fence and fencing accessories:

- Chain link fence
- Woven wire fence
- Barbed wire
- Ground rods
- Field fencing
- Silt fabric fencing

894.1.01 Related References

A. Standard Specifications

Section 862—Wood Posts and Bracing

Section 881—Fabrics

B. Referenced Documents

ASTM		AASHTO
A 116 A 121 A 123/ A 123M A 153/ A 153M	A 239 A 584 A 585 A 702 F 1043	M 111 M 181 M 232/ M 232M

894.2 Materials

894.2.01 Chain Link Fence

A. Requirements

Use zinc or aluminum coated steel fabrics, fittings, accessories, and posts for chain link fence conforming to the following requirements:

1. Fence Fabric

   Use woven wire with reasonably uniform 2 in (50 mm) square mesh. Ensure that the mesh has parallel sides and horizontal and vertical diagonals of uniform dimensions. Use the wire size specified on the Plans or in the Proposal.

   a. Zinc Coated: Use steel fabric that conforms to AASHTO M 181. Ensure that the wire and hot-dip coating conform to AASHTO M 181, Type I, Class C.

   b. Aluminum Coated: Use steel fabric conforming to AASHTO M 181. Ensure the wire and coating conform to AASHTO M181, Type II.

2. Fittings and Accessories

   a. Tension Wire: Use wire that conforms to AASHTO M 181. Use wire coated according to AASHTO M 181, Section 25.2 for aluminum coated fabric. Use wire coated according to AASHTO M 181, Section 3.5.2 for zinc-coated fabric.

   b. Fittings: Use fittings conforming to AASHTO M 181.

      1) Ensure fittings or accessories not included in AASHTO M 181 conform to industry standards for heavy, industrial-type fences.

      2) Hot-dip the materials in zinc with AASHTO M 111 Grade 50 Coating. For aluminum coated fabric, you may use materials made from Aluminum Alloy 360, die-cast, or Sand Alloy 356, ZG61A, or Tenzalloy.

      3) Use bolts and nuts that conform to industry standards and are zinc coated with the hot-dip process according to AASHTO M 232/ M 232M.

3. Posts, Rails, and Braces

   Use posts, rails, and braces that conform to AASHTO M 181 and ASTM F 1043. Diameter, wall thickness, and weight must conform to ASTM F 1043, Figure 2, Summary of Requirements for Industrial Fence, and the physical tolerance and material requirements must conform to AASHTO M 181. Do not use Light Industrial/Commercial Fence as detailed in ASTM F 1043, Figure 3. Check the Plans for specifications on posts used for special applications. Use special posts that conform to AASHTO M 181 or that are approved by the Office of Materials and Research.

4. Gates

   Use support posts and gate frames as designated on the Construction Detail or Project Plans. Use gate materials that meet the requirements of Subsection 894.2.01.A.3.

   a. Use the same coating requirements as for the fence posts. Coat gate frames after completing all welding.

   b. Use fittings and hinges conforming to Subsection 894.2.01.A.2.b.

B. Fabrication

Ensure that the chain link fence fabric is produced by recognized, good commercial practices.

1. Apply the zinc or aluminum coating to the fabric in a continuous process. Do not apply in roll form.
2. Carefully inspect the coated fabric visually, both before and after weaving, to determine the coating quality.

C. Acceptance

The Department will reject chain link fabric that has excessive roughness, blisters, sal ammoniac spots, bruises, flaking, bare spots, or other obvious defects to any considerable extent.

D. Materials Warranty

General Provisions 101 through 150.

894.2.02 Woven Wire Fence

A. Requirements

1. Fabric

   Use fabric that meets the requirements of ASTM A 116, Design Number 1047-6-11, with Class 3 coating.

   a. Ensure that the galvanizing is uniform.

   b. Ensure that less than 5 percent of the joints are deficient in zinc coating, as determined by ASTM A 239.

   c. You may use aluminum coated steel that meets the requirements of ASTM A 584, Design Number 1047-6-11, for the woven wire fence fabric.

2. Posts

   Use steel or wood posts of the sizes shown on the Plans.

   a. Use wood posts that meet the requirements of Subsection 862.2.01.

   b. Use steel posts and bracing that meet the requirements of ASTM A 702. Galvanize posts and braces with the hot-dip method according to ASTM A 123/A 123M.

3. Certification

   Furnish a certification to the Engineer from the manufacturer that shows the physical properties of the materials.

4. Accessories

   Galvanize the following accessories according to ASTM A 153/ A 153M. Use 0.80 oz./ft^2 (245 g/m^2) as the galvanizing minimum. Galvanize other accessories as necessary or specified on the Plans.

   a. Wire Fasteners: Use fasteners that meet the requirements of ASTM A 702.

   b. Tension Wire: Use No. 11 gauge wire.

   c. Staples: Use No. 9 gauge staples 1-1/2 in (38 mm) long.

   d. Nails: Use 1 in (25 mm) roofing nails to fasten metal caps to wooden posts.

5. Gates

   Use support posts and gate frames of the size designated on the Construction Detail or Project Plans.

   a. Use a frame that is an all welded unit. Ensure that the gate is galvanized after welding with 2 oz./ft^2 (610 g/m^2) of spelter coating.

   b. Use hinges, latches, and other accessories of good commercial quality that are coated as in Subsection 894.2.02.A.4.

B. Fabrication

1. Ensure that the woven wire fence fabric is produced by methods recognized as good commercial practices.
2. Carefully inspect the galvanized fabric to determine the zinc coating quality.

C. Acceptance

The Department will reject woven wire fabric that has excessive roughness, blisters, sal ammoniac spots, bruises, flaking, bare spots, or other obvious defects to any considerable extent.

D. Materials Warranty

General Provisions 101 through 150.

894.2.03 Barbed Wire

A. Requirements

1. Galvanized Steel Barbed Wire

   Use wire that meets the requirements of ASTM A 121 and has a Class 3 zinc coating.

2. Aluminum Coated Steel Barbed Wire.

   Use wire that meets the requirements of ASTM A 585.

3. Posts

   Use posts as specified in Subsection 894.2.02.A.2 for barbed wire fence.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

894.2.04 Ground Rods

A. Requirements

1. Use ground rods that are 9/16 to 5/8 in (14 to 16 mm) diameter and at least 8 ft (2.4 m) long, unless otherwise shown on the Plans.
2. Ensure that the ground rods are galvanized steel with a minimum coating of 2 oz./ft² (610 g/m²) according to the requirements of ASTM A 153/ A 153M.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

894.2.05 Field Fencing (Woven Wire and Barbed Wire)

A. Requirements

1. Definition

   Field fencing designates replacement fencing outside the Right of Way or temporary fencing inside the Right of Way, provided you do not reuse the materials for permanent fencing inside the Right of Way.

2. Fence fabric

   Use woven wire fabric that meets the requirements of ASTM A 116 Design No. 939-6-12-1/2, and has a Class I coating, unless otherwise designated.

3. Barbed wire

   Use wire that meets the requirements of ASTM A 121 and has a Class I coating. Use the same number of barbed wire strands as the existing or replaced fence, or as specified in the Plans.

4. Posts

   Use either galvanized steel, painted steel, or treated timber of the dimensions and spacing shown on the Construction Detail or Plans.

5. Gates

   Use posts, frame material, hinges, and fittings of acceptable commercial quality. Get approval from the Engineer before use.

6. Use the Special Plan Details and/or Special Provisions for any special design of the field fence.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

1. Get approval from the Engineer for all materials. Ensure that the materials are of an acceptable commercial quality and are equivalent in quality to the fence being replaced or to the existing fence, as applicable.
2. Do not send materials to the laboratory unless requested by the Engineer or required by the Plans.

D. Materials Warranty

General Provisions 101 through 150.

894.2.06 Silt Fabric Fencing

A. Requirements

1. Fabric
   a. See Subsection 881.2.07, "Silt Fence Filter Fabric," for the types of fabric available.
   b. Use a woven wire support fence with Type "C" fence.
      1) Ensure that the wire fence fabric is at least 26 inches (660 mm) high with at least 6 horizontal wires.
      2) Ensure that the vertical wires have a maximum spacing of 12 in (155 mm).
      3) Ensure that the top and bottom wires are at least 10 gauge (2.49 mm) and all other wires are at least 12-1/2 gauge (2.03 mm).
      4) You may use other designs subject to approval by the Office of Materials and Research.
2. Posts

   Use post sizes and types as determined by the type of fence being installed. Generally hardwood posts will be limited to ash, hickory, or oak. Other hardwoods may be acceptable if approved by the Office of Materials and Research.

   a. Type "A" Fence: Use either wood or steel posts that are at least 4 ft (1.2 m) long.

1) If using soft wood, use posts that are at least 3 in (75 mm) in diameter or nominal 2 x 4 in (33 x 89 mm) and straight enough to provide a fence without noticeable misalignment.

2) If using hardwood, use posts that are 1-1/2 x 1-1/2 in (38 x 38 mm) with a minus tolerance of 3/8 in (9 mm) providing the cross sectional area is at least 2.15 in^2 (1385 mm^2).

3) If using steel, use posts that are “U,” “T,” or “C” shaped with a minimum weight of 1.15 lb/ft (1.7 kg/m), and have projections for fastening the fence to the posts.

b. Type “B” Fence: Use either wood or steel posts that are at least 3 ft (900 mm) long.

1) If using soft wood, use posts that are at least 2 in (50 mm) in diameter or nominal 2 x 2 in (33 x 33 mm).

2) If using hardwood, use posts that are 1 x 1 in (25 x 25 mm) with a minus tolerance of 1/ 4 in (6 mm) providing the cross sectional area is at least 0.95 in^2 (610 mm^2).

3) If using steel posts, use types “U,” “T,” or “C” shapes with a minimum weight of 0.75 lb/ft (1.1 kg/m).

c. Type “C” Fence: Use only steel posts with a minimum length of 4 ft (1.2 m). Use “U,” “T,” or “C” shaped posts with a minimum weight of 1.15 lb/ft (1.7 kg/m). Use posts that have projections for fastening the woven wire and filter fabric.

NOTE: You must use woven wire to provide extra support for Type “C” fence installations.

3. Fasteners for Wooden Posts

a. Wire Staples: Use staples that are at least 17 gauge (1.37 mm), legs at least 1/2 in (13 mm) long, and a crown at least 3/4 in (19 mm) wide.

b. Nails: Use nails that are at least 14 gauge (2.03 mm), 1 in (25 mm) long, with button heads of at least 3/4 in (19 mm).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

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July 21, 2006

Section 911—Sign Posts

Delete Section 911 and substitute the following:

911.1 General Description

This section includes the requirements for the following:

- Galvanized steel sign posts
- Galvanized steel structural shape posts
- Aluminum structural shape posts
- Delineator posts
- Wood sign posts
- Ground-mounted breakaway sign supports

911.1.01 Related References

A. Standard Specifications

Section 106—Certification of Materials

Section 859—Guard Rail Components

Section 862—Wood Posts and Bracing

Section 863—Preservative Treatment of Timber Products

Section 913—Reflectorizing Materials

B. Referenced Documents

ASTM		
A 1 A 123/A 123M A 153/A 153M A 193/A 193M A 307	A709/A 709M A 499 A 653/A 653M B 209 (B 209M) B 211 (B 211M)	B 221 (B 221M) B 308 (B 308M) B 695 B 766 G 53

AASHTO M 181, Section 32

ANSI B 1.13M

ANSI B 18.22.1

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (current edition)

Georgia Standard No. 9055

Southern Pine Inspection Bureau Grading Rules, 1977 Edition

NCHRP 350

QPL 29

QPL 35

QPL 69

911.2 Materials

911.2.01 Galvanized Steel Sign Posts (Drive Type)

A. Requirements

Use drive-type steel posts made of flanged "U" channel or square tubular sections. For a list of sources, see QPL 35.

1. U-Channel

   Use U-channel posts made of rerolled rail steel or new billet steel that meets the mechanical requirements of ASTM A 499, Grade 60, and the chemical requirements of ASTM A 1 for rails with nominal weights of 91 lbs/yd (45 kg/m) or greater.

   a. Dimensions, Weights, Tolerances: Use the dimensions, weights, and tolerances in Table 1 for U-channel posts, unless otherwise indicated on the Plans.

      1) Use post lengths as specified on the Plans.

      2) Use post assemblies within a sign structure from the same manufacturer.

Table 1—Dimensions, Weights, and Tolerances for Galvanized Steel Sign Posts

(Drive Type)

Outside Diameters	TP 1 in (mm)	TP 2 in (mm)	TP 3 in (mm)	TP 4 in (mm)	Tolerance in (mm)
Flange Width					
a. Rib Back	2.063 (50)	3.125 (80)	3.5 (90)	3.75 (95)	± 0.125 (± 3)
b. Flat Back	2.313 (60)	3.125 (80)	3.5 (90)	3.75 (95)	± 0.125 (± 3)
Depth of "U"					
a. Rib Back	0.875 (22)	1.500 (40)	1.875 (50)	2.000 (50)	± 0.125 (± 3)
b. Flat Back	0.875 (22)	1.500 (40)	1.750 (45)	1.750 (45)	±0.125 (± 3)
Weight per linear foot (meter) before drilling, punching holes, or galvanizing)					
a. Rib Back	1.12 lb (1.7 kg)	2 lb (3 kg)	3 lb (4.5 kg)	4 lb (6 kg)	± 5%
b. Flat Back	1.12 lb (1.7 kg)	2 lb (3 kg)	3 lb (4.5 kg)	4 lb (6 kg)	± 5%

   b. Bolt Holes: Ensure the bolt holes are properly punched or drilled with the following characteristics:

      1) Holes are 3/8 in (10 mm) diameter and spaced 1 in, ±1/32 in (25 mm, ± 1 mm), center to center.

      2) Ensure that the holes start 1 in (25 mm) from the top and extend the full length of the post for Types II, III, and IV, and at least 18 in (450 mm) for Type I.

      3) The Department will not accept field-punched holes.

c. Coatings: Ensure that the posts are coated according to ASTM A 123/A 123M after the holes are punched or drilled.

2. Square Tubular

Use square tubular posts that meet the requirements of ASTM A 653/A 653M, Structural Steel, Grade 50, Class 1 (Grade 340, Class 1).

a. Dimensions, Weights, Tolerances: Use the dimensions, weights, and tolerances shown in Table 2 for square tubular posts unless otherwise indicated on the Plans:

Table 2—Dimensions, Weights, and Tolerances for Square Tubular Posts

	TP 5	TP 6	TP 7	TP 8	TP 9	Tolerance
Outside size, in (mm)	1.000 (25)	1.7 50 0 (45)	2.000 (50)	2.500 (63)	2.250 (57.2)	± 0.010 (0.3)
Wall thickness, in (mm)	0.0 65 (1.7)	0.083 (2.1)	0.083 (2.1)	0.105 (2.7)	0.083 (2.1)	± 0.010 (0.2)
Weight before drilling/ punching holes or galvanizing, lb/ft (kg/m)	0.83 (1.2)	1.8 (2.7)	2.1 (3.1)	3.4 (5.1)	2.27 (3.4)	± 5%

1) Use post lengths as specified on the Plans.

2) Use post assemblies within a sign structure from the same manufacturer.

b. Bolt Holes: Ensure all bolt holes are properly punched or drilled with the following characteristics:

1) Holes are 7/16 in, ± 1/64 in (11 mm, ± 0.5 mm) diameter and spaced 1 in, ± 3/64 in (25 mm, ± 1 mm) center to center.

2) Ensure that the holes start 1 in (25 mm) from the top and extend the full length of the post on all four sides for Types 6, 7, and 8, and at least 18 in (450 mm) on all four sides for Type 5.

3) The Department will not accept field-punched holes.

c. Coatings: Coat square tubular posts with zinc at a minimum thickness of 0.90 oz/ft^2 (275 g/m^2).

3. Bolts, Nuts, and Washers

Use bolts, nuts, metallic washers, and spacers made of aluminum, stainless steel, or galvanized steel. Use stainless steel that meets the requirements of ASTM A 193/A 193M, Type B8.

a. Bolts: Use bolts 5/16 in (8 mm) diameter with hexagonal heads. Ensure they are long enough to extend at least 0.25 in (6 mm) beyond the nut when installed.

1) Use a bolt thread fit of ANSI B 1.13M, Class 6H.

2) If using aluminum bolts, ensure that the aluminum meets the requirements of ASTM B 211 (B 211M), Alloy 2024-T4.

b. Nuts: Use self-locking, plastic-insert hex nuts.

1) Use a bolt thread fit of ASNI B 1.13, Class 6G.

2) If using aluminum bolts, ensure that the aluminum meets the requirements of ASTM B 211(B 211M), Alloy 2017-T4.

c. Washers: Place metallic washers under all bolt heads. Place nylon washers between the metallic washer and the sign face.

1) If using aluminum washers, ensure that the aluminum meets the requirements of ASTM B 209 (B209M), Alloy 2024-T4.

2) Use aluminum washers with 25/64 in (10 mm) inside diameter, 0.75 in (19 mm) outside diameter, and 0.091 in (2.3 mm) thick.

3) Use standard galvanized and stainless steel washers that meet the size requirements of ANSI B 18.22.1.

4) Use nylon washers with 13/32 in (10 mm) inside diameter, 13/16 in (21 mm) outside diameter, and 1/16 in (1.6 mm) thick. Use nylon washers in combination with metallic washers to prevent torsional damage caused by the twisting action of the bolt heads.

d. Coatings: Use galvanized steel bolts and nuts that meet ASTM A 307 requirements.

B. Fabrication

1. Roll or form post sections of the dimensions specified.
2. Round all sharp corners and make rough or burred parts smooth.
3. Punch or drill holes as specified in Subsection 911.2.01.A.1.b.
4. Galvanize as necessary, according to ASTM A 153/A 153M.

C. Acceptance

Get approval for each sign support matrix from the FHWA.

The FHWA evaluates the matrix according to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, current edition.

D. Materials Warranty

General Provisions 101 through 150.

911.2.02 Galvanized Steel Structural Shape Posts

A. Requirements

1. Ensure that the galvanized steel shapes for sign posts match the shape and dimensions shown on the Plans.
   a. Use steel that meets the requirements of ASTM A 709 (A 709M) Grade 36 (245).
   b. Galvanize the shapes according to ASTM A 123/A 123M. Handle the structural shape through only one hole during galvanizing.
2. Submit a certification according to Subsection 106.05, “Materials Certification.”

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

911.2.03 Aluminum Structural Shape Posts

A. Requirements

1. Ensure that the aluminum shapes for sign posts match the shape and dimensions shown on the Plans.

NOTE: Use aluminum that meets the requirements of ASTM B 308/B 308M, Alloy6061-T6.

2. Submit a certification according to Subsection 106.05, “Materials Certification.”

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

911.2.04 Delineator Posts

A. Requirements

1. Check the Plans for the types of delineator posts to use. For a list of sources, see QPL 69.
2. If using flexible delineator posts, use only those indicated on the Georgia Department of Transportation Qualified Products List.
3. Mounting

   Fasten all delineators to be mounted on galvanized or aluminum posts with commercial aluminum lock bolts.

   NOTE: Fasten delineators to be mounted on wood posts with galvanized wood screws.

4. Galvanized Steel Posts

   Use posts that meet the requirements of Subsection 911.2.02.A.

5. Aluminum Flange Type Posts

   Use aluminum that meets the requirements of ASTM B 221 (B 221M), Alloy 6063-T6.

   a. Provide a post section in the form of a flanged “U” with dimensions shown on the Plans. Point the bottom of the post.

   b. Punch or drill holes as specified in Subsection 911.2.01.A.1.b.

6. Wood Delineator Posts

   Use 4 in (100 mm) square posts of the length specified on the Plans.

   a. Use wood posts that meet the requirements of Subsection 862.2.02.

   b. Treat wood posts with preservative according to Section 863.

7. Flexible Delineator Posts

   Use posts made of a durable plastic or poly resin material. Check the Plans to see the type of flexible delineator post used for each location.

   a. Physical Characteristics: Use posts that can either be driven into the ground with equipment that does not damage the posts or reflective sheeting, or be surface-mounted onto pavement.

      1) Drill or form pilot holes where necessary to embed the posts as shown on the Plans.

      2) Classify flexible delineator posts as follows:

Type I A B	Curved or flat Soil mount Surface mount
Type II A B	Tubular Soil mount Surface mount

3) Use durable, flexible, non-discoloring posts that can recover from repeated vehicle impacts.

4) Ensure that materials used to manufacture flexible delineator posts are stabilized with UV (ultraviolet) inhibitors to prevent degradation.

5) Ensure that the posts are inert to normal atmospheric elements and chemicals possibly used in grass or weed control.

6) Use material for the post that can accept reflective sheeting.

b. Color: Use gray, white, or yellow posts, as required.

c. Reflective Sheeting: Use white or yellow reflective sheeting on the posts as required.

Use sheeting that meets the requirements of Subsection 913.2.01, Type III.

Obtain approved reflective sheetings from QPL 29.

d. Certification: Submit a certification from the manufacturer that the flexible delineator posts are formulated of the same material as when tested by National Transportation Product Evaluation Program (NTPEP) and will meet the requirements of this Specification.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

1. Performance Criteria

Get approval for flexible delineator posts through the evaluation performed by NTPEP.

The Department will use the data generated by the NTPEP testing to select usable materials that performed satisfactorily when tested with the following material and field tests.

2. Shapes and Dimensions (Materials Test)

a. Ensure that flexible delineator posts are curved, flat, or tubular with the upper 14 in (350 mm) presenting at least a 3 in (75 mm) wide profile facing approaching traffic.

b. Place the top of the wide profile sheeting 0.5 in (13 mm) from the top of the delineator post.

c. Cap the top of tubular posts to prevent water inclusion.

d. Design flexible delineator posts that are soil mounted to connect with a drive-type anchor base made of corrosion-resistant material. When a post is no longer serviceable, remove it and replace it in the same anchor base.

e. Ensure that the minimum length for the anchor base is 18 in (450 mm) and the minimum height above ground for the soil mount flexible delineator posts is 48 in (1200 mm).

f. Design surface-mount flexible delineator posts to connect with the base assembly and be easily replaced when the existing post is no longer serviceable. Use post heights of 24 in (600 mm), 36 in (900 mm), or 48 in (1200 mm), as required.

3. Weathering (Materials Test)

a. Ensure that flexible delineator posts withstand 1,000 hours of UV exposure in the QUV weatherometer without significant color change or physical deterioration. If the Department sees splitting, cracking, delaminating, or other failures, it will reject the delineator post.

b. The Department will conduct the test according to ASTM G 53.

4. Field Tests

Perform impact tests on the flexible delineator posts as described below:

a. Install 8 delineator posts in 2 rows of 4 each so that 1 row will be bumper hits and 1 row will be wheel hits in 1 pass of the vehicle.

b. Set the delineator post with a height of 48 in, ± 1 in (1200 mm, ± 25 mm) from ground level with the reflective sheeting facing the test vehicle.

c. Use a standard American sedan or pickup for the test vehicle. Ensure that the vehicle has no unusually sharp hood ornaments or other appurtenances.

d. Impact 8 delineator posts 10 times with the test vehicle at 55 mph (90 kph)

e. Hit the posts five times at an ambient temperature of 32 °F, ± 5 °F (0 °C, ± 2 °C) and five times at an ambient temperature of 85 °F, ± 5 °F (30 °C, ± 2 °C).

f. After concluding the impact test, ensure that at least 5 of the 8 posts remain intact, are securely anchored, and return to their original vertical orientation within an angle of ±10 degrees.

g. Of the 5 posts that remain intact, ensure that they also retain at least 50 percent of their reflective sheeting and show minimal signs of distress (cracking, loss of rigidity).

5. The Department will place flexible delineator posts that pass the laboratory material test and field test requirements on the approved list.

D. Materials Warranty

General Provisions 101 through 150.

911.2.05 Wood Sign Posts

A. Requirements

1. Use wood sign posts to support special signs, when noted on the Plans. Use posts that comply with Georgia Standard No. 9055.
2. Treat the posts with preservative according to Section 863 and Standard No. 9055 notes.
3. Use wood that matches that specified in Subsection 859.2.04, except that it shall meet the grading requirements for No. 1 SR or No. 2 SR as specified in the current Southern Pine Inspection Bureau Rules.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

911.2.06 Ground Mounted Breakaway Sign Supports

A. Requirements

1. Use ground-mounted breakaway sign supports of any assembly approved by the Department as a breakaway foundation. For a list of sources, see QPL 63.

2. Design the support to modified AASHTO wind loads of 70 mph (112 kph).
3. Certification

   Furnish a copy from the manufacturer of an independent testing agency report showing that the support has been dynamically tested according to AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals, current edition.

   a. Furnish evidence that the support has been tested and has met the criteria established in NCHRP 350.
   b. Supply a certification showing the physical properties of the material and how it meets the Specifications, as stated in Subsection 106.05, “Materials Certification.”
   c. Show evidence that the assembly has been used successfully in installations with similar environmental and Project conditions to the satisfaction of the Department.
4. Sign Support Design
   a. Type A: A single-post mount that can support a 7 ft² (0.65 m²) sign mounted to the centroid 9 ft (2.7 m) above ground.
   b. Type B: A two-post mount that can support a 18 ft² (1.67 m²) sign mounted to the centroid 9 ft (2.7 m) above ground.
   c. Type C: A three-post mount that can support a 37 ft² (3.4 m²) sign mounted to the centroid 9 ft (2.7 m) above ground.
5. Base Assembly
   a. Ensure that the furnished base assembly protrudes no more than 4 in (100 mm) above ground.
   b. Ensure that the foundation assembly is compatible with the applicable sign post in Subsection 911.2.01.
   c. Ensure that the assembly is galvanized with the hot-dip method as per ASTM A 123/A 123M or an approved equal.
   d. To use an alternate protective coating, obtain approval from the Office of Materials and Research before using it on Department Projects.
6. Assembly Hardware
   a. Use base attachment hardware that matches the Plans and is as recommended by the manufacturer.
   b. Ensure that the hardware is protectively coated as in ASTM A 153/A 153M, ASTM B 695 Class 55, or ASTM B 766 Type II, class 12-, whichever is applicable.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Use foundation assemblies that are FHWA-approved for the specific design category for which the unit was evaluated.

Foundation assemblies are evaluated according to AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals, current edition.

D. Materials Warranty

General Provisions 101 through 150.

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July 10, 2006

Section 925—Traffic Signal Equipment

Delete Section 925 and substitute the following:

925.1 General Description

This section provides Specifications for a variety of traffic signal equipment. Ramp Meters are defined as a form of traffic signalization and all general provisions for traffic signalization are applicable unless otherwise noted in the Plans and Specifications.

925.1.01 Related References

A. Standard Specifications

Section 500—Concrete Structures

Section 639—Strain Poles for Overhead Sign and Signal Assemblies

Section 647—Traffic Signal Installation

Section 682—Electrical Wire, Cable and Conduit

Section 833—Joint Fillers and Sealers

Section 861—Piling and Round Timber

Section 870—Paints (Field Painting)

Section 915—Mast Arm Assemblies

Section 922—Electrical Wire and Cable

Section 923—Electrical Conduit

Section 935—Fiber Optic System

Section 938—Detection

Section 939—Communications and Electronic Equipment

B. Referenced Documents

- National Electrical Manufacturers Association (NEMA) Standards Publication TS 1 Section 15
- NEMA Standard Publication TS 2- 1998
- Institute of Transportation Engineers (ITE)Vehicle Traffic Control Signal Heads Specification
- ITE Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED)Circular Signal Supplement June 27, 2005 Specification
- ITE Vehicle Traffic Control Signal Heads – Part 3: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Modules Specification
- ITE Pedestrian Traffic Control Signal indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules Specification
- International Municipal Signal Association (IMSA) #20-1 Specification
- IMSA #20-4Specification
- IMSA #20-6Specification
- IMSA #50-2Specification
- IMSA #51-1Specification
- Underwriters Laboratory Inc. (UL) 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
- UL 493 Standard for Safety for Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables

- Traffic Signal Control Equipment Specifications, January 1989 edition and applicable addenda, State of California Business, Transportation & Housing Agency
- State of California Department of Transportation (CALTRANS) Qualified Products List (QPL) Controller Assemblies for the Model 170/2070 Traffic Controller,
- CALTRANS Transportation Electrical Equipment Specifications (TEES) August 16, 2002 and applicable addenda
- Georgia Department of Transportation Qualified Products List 75"Polyurethane Sealant for Inductive Loops"(American Society of Testing and Materials(ASTM) A36 Standard Specification for Carbon Structural Steel
- ASTM A53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
- ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products
- ASTM A153 Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
- ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A475 Standard Specification for Zinc-Coated Steel Wire Strand
- ASTM A572 Standard Specification for High- Strength Low-Alloy Columbium-Vanadium Structural Steel
- ASTM C1028 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
- ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- ASTM D638 Standard Test Methods for Tensile Properties of Plastics
- ASTM D785 Standard Test Method for Rockwell Hardness of Plastics: Electrical Insulating Materials
- ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

925.2 Materials

925.2.01 General

A. Requirements

Ensure that the traffic signal equipment and materials meet the Plans and Specifications.

All equipment furnished shall be new and meet the requirements of the following:

- Underwriter's Laboratory Incorporated (UL)
- Electronic Industries Association (EIA)
- National Electric Code (NEC)
- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- International Municipal Signal Association (IMSA)
- National Electrical Manufacturers Association (NEMA)
- Applicable Standards, Specifications, and Regulations of the:

  Georgia Department of Transportation
  Traffic Signal Electrical Facility & NaviGAtor Support (TSEF)
  935 E. Confederate Avenue, Building 5
  Atlanta, GA 30316

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide to the District Signal Engineer or maintaining agency all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the Plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the Plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

925.2.02 Type 2070 Controller Assemblies

A. Requirements

For 2070 controller cabinet assemblies, use 2070 controller units that meet the requirements of the following or are previously approved by TSEF:

- *Traffic Electrical Equipment Specifications (TEES)* published by the State of California Business, Transportation, and Housing Agency; Department of Transportation, current edition and current addenda
- *CALTRANS* Qualified Products List (QPL)
- Ensure the unit supplied is compatible with current GDOT licensed firmware.

The following Specifications augment the CALTRANS Specifications and take precedence over conflicting CALTRANS Specifications.

1. Input/output (I/O) and Configuration

   The 2070 Controller shall be supplied in one of the following configurations, as specified in the Plans (all modules are specified in TEES, but these configurations supersede the defined configurations in TEES):

   - 2070L: Provide Chassis, 2070-1B Single-Board CPU, 2070-2A Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4B 3.5-amp Power Supply, and a 2070-7A Module. This unit is intended for interfacing in Type 170E or ITS cabinets and shall provide the default input and output configuration as shown in Tables 925-13, 925-15 and 925-16 for ITS cabinets using a traffic signal application.
   - 2070LC: Provide Chassis, 2070-1B Single-Board CPU, 2070-2B Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4B 3.5-amp Power Supply, and a 2070-7A Module. This unit is intended for interfacing in ITS cabinets only and shall provide the default input and output configuration as shown in Tables 925 -13, 925-15 and 925-16 for ITS cabinets using a traffic signal application.
   - 2070 LB: Provide Chassis, 2070-1B Single –Board CPU, 2070-2A Field I/O Module, 2070-3C Front Panel, 2070-4B 3.5-amp Power Supply, This unit is intended for interfacing in Type 170E or ITS cabinets where a

user interface is not required and shall provide the default input and output configuration as shown in Tables 925 -13, 925-15 and 925-16 for ITS cabinets using a traffic signal application.

- 2070 LN1: Provide Chassis, 2070-1B Single-Board CPU, 2070-2B Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4NB 3.5-amp Power Supply, 2070-8 NEMA Interface Module, and a 2070-7A Module. This unit is intended for interfacing in NEMA TS 1 or NEMA TS 2 Type 2 cabinets.
- 2070 LN2: Provide Chassis, 2070-1B Single-Board CPU, 2070-2N Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4NB 3.5-amp Power Supply, and a 2070-7A Module. This unit is intended for interfacing in a NEMA TS 2 Type 1 cabinet.

2. Power Supply Modules

   Either the 2070-4A, 2070-4B, 2070-4NA or 2070-4NB module shall be provided as required in the configuration requirements in the preceding Item. In addition to all requirements of the TEES, the power supplies shall be clearly marked as a “2070-4A”, “2070-4B”,”2070-4NA”, or “2070-4NB”. The Vendor may supply a 2070-4A or 4NA power supply module in lieu of a 2070-4B or 4NB, as long as it is so marked and adds no additional cost to GDOT.

3. Documentation

   Include with each controller, manuals that document the programming, operation, and maintenance of the unit. Include schematic drawings and pin assignment charts in the manuals for maintenance. Documentation shall include all components, including communications modules. Specific reference is made to section 1.2.4 Documentation in the CALTRANS TEES concerning required documentation to be provided.

4. Testing

   Provide for complete testing of unit before it is shipped. If unit is shipped with applications firmware installed, it must be tested with the application (e.g. Traffic Signal Control). If a random sample of greater than 10 percent of the units tested is rejected then the total shipment shall be rejected and vendor will be responsible for all costs to test and repair all units provided.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

See Subsection 925.2.01 for compliance with CALTRANS QPL. Also see item 4 Testing in Section A above.

D. Materials Warranty

(See Subsection 925.2.01 D for Materials Warranties).

925.2.03 Type 2070 Controller Subassemblies

A. Requirements

For 2070 controller subassemblies, use 2070 controller subassembly units that meet the requirements of the following or are previously approved by TSEF:

- *Traffic Electrical Equipment Specifications (TEES)* published by the State of California Business, Transportation, and Housing Agency; Department of Transportation, current edition and current addenda
- *CALTRANS* Qualified Products List (QPL)

The following Specifications augment the CALTRANS Specifications and take precedence over conflicting CALTRANS Specifications.

1. 2070 1B Module

   The 2070 1B module may be supplied as a separate item to be used in all versions of the 2070 controller. The 2070 1B module shall be supplied complete with the operating software. Ensure it contains the required files to be compatible with the current GDOT applications software.

2. 2070 2A Field I/O Module

The 2070 2A Field I/O module may be supplied as a separate item. The 2070 2A Field I/O module shall consist of the Field Controller Unit; Parallel Input/Output Ports; other Module Circuit Functions (includes muzzle jumper); Serial Communication Circuitry; Module Connectors C1S, C11S and C12S mounted on the module front plate; VDC Power Supply (+12VDC to + 5VDC) and required software. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software. Ensure the 2070 2A field I/O Module functions with a Model 2070L or 2070LB Controller Assembly and is compatible with current GDOT applications software.

3. 2070 2B Field I/O Module

The 2070 2B Field I/O module may be supplied as a separate item and consist of the Serial Communication Circuitry, DC power Supply, and Module Connector 12S mounted on the module front plate only. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software. Ensure the 2070 2B field I/O Module functions with a Model 2070 LC or 2070LN1 Controller Assembly and is compatible with current GDOT applications software.

4. 2070 2N Field I/O Module

The 2070 2N Field I/O module may be supplied as a separate item and provides a NEMA TS2-1compatible SDLC interface via Serial Port 3. AC power to the 2070 Unit and Fault Monitor Logic Output via 2070 Serial Port 5 and Output Frame Byte 9 Bit 6 to the NEMA TS2 Cabinet Monitor Unit (CMU). Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software. Ensure the 2070 2N field I/O Module functions with a Model 2070 LN2 Controller Assembly and is compatible with current GDOT applications software.

5. 2070 3B Front Panel Display Module

The 2070 3B Display Module may be supplied as a separate item and provides a Front Panel Assembly controller, two keyboards, AUX switch alarm bell and an 8 line by 40 character display. This assembly shall also include a panel with latch assembly and two TSD #1 hinge attaching devices, assembly PCB, external serial port connectors, CPU active LED indicator, contrast adjustment knob, and Front Panel Harness. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software. Ensure the 2070 3B Front Panel Assembly Module functions with Models 2070L, 2070LC, 2070LN1 and 2070 LN2 Controller Assemblies and is compatible with current GDOT applications software. Ensure the hardware hinge attaching devices mate with existing 2070 assemblies. Ensure the Front Panel Harness is connected to the front panel via a removable connector. Ensure the front panel connector supports the aux switch.

6. 2070 3C Front Panel Display Module

The 2070 3C Display Module may be supplied as a separate item and provides a System Serial Port 6Lines, Isolated and vectored to Connector C60S. This assembly shall also include a panel with latch assembly and two TSD #1 hinge attaching devices, assembly PCB, external serial port connectors, CPU active LED indicator, and Front Panel Harness. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software. Ensure the 2070 3B Front Panel Assembly Module functions with Model 2070LB Controller Assembly and is compatible with current GDOT applications software. Ensure the hardware hinge attaching devices mate with existing 2070 assemblies. Ensure the Front Panel Harness is connected to the front panel via a removable connector. Ensure the front panel connector supports the aux switch.

7. 2070 4B Power Supply Module

The 2070 4B Power Supply Module may be supplied as a separate item and is an independent, self contained module. Ensure that it is vented and cooled by convection only. Provide module that slides into power supply compartment from the back of the chassis and is attached to the Backplane mounting surface by its four TSD #3 Devices. Ensure the module supplies at least 3.5 amperes of +5VDC. Ensure the 2070 4B Power Supply Module is compatible with Models 2070L, 2070LB, and 2070LC Controller Assemblies and is compatible with current GDOT applications software. Ensure the connection harness PS 2 on existing units can be mated with the 4B module supplied. A 2070 4A Power Supply Module may be provided in place of a 4B module as long as it is labeled as such and there is no additional cost to GDOT. Ensure the module supplied is appropriately marked as a 4B or 4A module.

8. 2070 4NB Power Supply Module

   The 2070 4NB Power Supply Module may be supplied as a separate item and is an independent self contained module. Ensure that it is vented and cooled by convection only. Provide module that slides into power supply compartment from the back of the chassis and is attached to the Backplane mounting surface by its four TSD #3 Devices. Ensure the module supplies at least 3.5 amperes of +5VDC. Ensure the 2070 4B Power Supply Module is compatible with Models 2070 LN1 and 2070 LN2 Controller Assemblies and is compatible with current GDOT applications software. Ensure the connection harness PS 2 on existing units can be mated with the 4B module supplied. Ensure the 4NB power supply module supports the NEMA TS1 and TS2 Standards. A 2070 4A Power Supply Module may be provided in place of a 4B module as long as it is labeled as such and there is no additional cost to GDOT. Ensure the module supplied is appropriately marked as a 4NA or 4NB module.

9. 2070 6B Communications Module

   The 2070 6B Communications Module is supplied as a separate item. The 6B communications module is a dual async/modem serial module. Ensure the module supports both Serial and modem FSK communications on both of two separate ports. Ensure the Modem data baud rate supports 0 to 9600. Ensure the module is configured to support FSK communications on the C2S connection. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software.

10. 2070 7A Communications Module

    The 2070 7A Communications Module may be supplied as a separate item. The 7A communications module is a dual async serial communications module. Ensure the module supports serial communications on both ports. Ensure it contains any configuration jumpers to be compatible with current GDOT Applications software.

11. 2070 8 Field I/O Module

    The 2070 8 Field I/O Module may be supplied as a separate item. The 8 Field I/O Module consists of the module chassis, module power supply, Field Control Unit Controller, parallel input/output ports, serial communications circuits and module connectors. Ensure the EX1 connector is provided with appropriate mating connections to interface with either 6B or 7A communications modules. Ensure the 2070 8 Field I/O module is provided with the appropriate mating connector to mate with the C12S connector on the 2070 2B Field I/O module. Ensure the 2070 8 Field I/O module functions as part of a Model 2070 LN1 controller.

12. 2070 D Panel

    The 2070 D panel is supplied as a separate item. The 2070 D panel supports the inputs and outputs of the “D” connector provided on a 2070-8 module which is also part of a Model 2070 LN1. Ensure the “D” Connector panel supports all 61 pins with a connecting MS “D” connector and terminal blocks. Ensure the 2070 D Panel provides adequate cable length to allow attachment in an existing NEMA Cabinet. Ensure that the terminal blocks allow for two connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

(See Subsection 925.2.01 for compliance with CALTRANS QPL).

D. Materials Warranty

(See Subsection 925.2.01.D for Materials Warranties).

925.2.04 Type 170E Cabinet Assemblies

A. Requirements

In addition to the CALTRANS Specifications, ensure that the cabinet assembly conforms to the requirements listed below, which take precedence over conflicting CALTRANS Specifications.

1. Cabinet configuration:

   Supply cabinets in accordance with these Specifications. Equip the cabinets with auxiliary equipment as follows:

   a. Model 332A Cabinet:

      Lower input field termination panel

      1 – Model 242 DC Isolator in Slot 14 of Upper Input File

      4 – Flash Transfer Relays

      2 – Model 204 Flashers

      1- Auxiliary Cabinet Shelf to support Communication Devices

      1- 4 Position Power Strip

   b. Model 336S Cabinet:

      1-Model 242 DC Isolator in Slot 14 of Input File

      4- Flash Transfer Relays

      2-Model 204 Flashers

      1- Auxiliary Cabinet Shelf to support Communication Devices

      1- 4 Position Power Strip

      1-"M" Base Adapter installed (Base Mount Cabinets Only)

      1-Aluminum Cover Plate for Cabinet Bottom (Pole Mount Cabinets Only)

   c. Model 337 Cabinet

      3-Flash Transfer Relays

      1-Model 204 Flasher

   d. Model 334 Cabinet with Auxiliary Output File for Ramp Metering Operations

      1- Auxiliary Equipment Shelf

      1- Output/PDA Type 3 with Model 206 24 Volt DC Power Supply with flash transfer relay

      1- Model 208 Monitor Unit

      1- Model 420 Auxiliary Output File

      1-Load Switch Model 200

      1- 4 Position Power Strip

      1- Lower Input Field Termination Panel

      1- Detector Test Switch Panel

   NOTE: Include above components in cabinet at time of delivery.

   Other auxiliary cabinet components such as controllers, monitors, load switches, etc. will be ordered as separate items.

2. Finish

   Use cabinets that have a bare aluminum finish (see Subsection 925.2.07.A.1 for controller-cabinet minimum fabrication Specifications).

3. Locks

   Equip the main cabinet door with locks that accept No. 2 Corbin keys. Provide two sets of keys with each cabinet. One set of keys is defined as one – No. 2 key and one - police panel key.

4. Power

   Equip the cabinet assemblies with a power distribution assembly to generate AC and DC power for the electronic components, except the DC power for the controller units. Provide the Model 332 and 336S cabinets with a DC isolator for stop time/flash sense, located in slot 14 of the input file.

5. Mounting

   Equip the cabinets for pole or base mounting, as specified in the Plans.

   a. Base Mount

      Supply Model 336S cabinets, when specified as base mount, with a “M” base-mounting adapter installed.

   b. Pole Mount

      Supply Model 336S or 337 cabinets, when specified as pole mount, with two exterior pole mounting brackets that allow for mounting on steel, concrete, and timber poles.

      Ensure that the bracket mounting holes are properly reinforced with metal plates of adequate size and strength, welded longitudinally across the inside depth of the cabinet.

      Ensure that the exterior-mounting bracket is shipped installed on the cabinet housing. Additionally, provide an aluminum plate, which covers the bottom cabinet opening.

6. Unused Phase Monitoring

   Provide odd-phase reds with ballast resistor dummy loads. Do not wire the cabinet to monitor pedestrian yellow indications.

   Neatly lace and bundle the wiring from the signal monitor for pedestrian yellow monitoring on the back panel.

7. Red Monitoring

   Provide a connector and terminal assembly designated as P20 for monitoring the absence of red as an integral part of the output file. Terminate the connector and ensure compatible with the cable and C connector of a Type 2010 conflict monitor unit capable of monitoring the absence of red.

   Provide the pin assignments of the P20 connector and terminal assemble with the cabinet Plans.

   Ensure that the P20 connector is physically alike to the cable and connector of a Type 2010 conflict monitor unit to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

   Submit details for programming of the unused red channels for approval.

8. Cabinet Light

   Include in each cabinet one fluorescent strip lighting fixture mounted inside the top front portion of the cabinet. Do not use screw in type fluorescent lamp.

   The fixture includes a cool white lamp, covered, and operated by a normal power factor, UL listed ballast.

   Install a door-actuated switch to turn on the cabinet light when either door is opened.

9. Cabinet Interlock

   Do not install the interlock circuit, as detailed in the CALTRANS Specifications.

10. Cabinet Drawer

    Equip each Model 334, 332A, and 336S cabinet with an aluminum storage compartment mounted in the rack assembly with the approximate following dimensions: 16 inches (400 mm) wide, 14 inches (350 mm) long, and 1.75 inches (44 mm) deep.

Mount this compartment directly under the Type 2070 controller. Provide a drawer with telescoping drawer guides to allow full extension from the rack assembly.

When extended, the storage compartment opens to provide storage space for cabinet documentation and other miscellaneous items.

Ensure that the storage compartment be of adequate construction to support a weight of 25 pounds (12 kg) when extended.

Provide a top for the storage compartment that has a non-slip plastic laminate attached, which covers a minimum of 90% of the surface area of the top.

11. Auxiliary Equipment Shelf

Provide a “shelf” in each cabinet that provides a location to mount Fiber modem, dialup modem and/or Field hardened switch. Provide shelf in location that allows easy access to AC power outlets and communications links (telephone, interconnect). Locate shelf so as not block access to other equipment or modules including Battery Backup System.

12. Power Strip

Equip each cabinet with a metal power strip (minimum of 4 outlets) to support AC power for external communications devices in cabinet. Provide metal strip that is mounted vertically on the rear rail. Ensure that the power strip may be used by block power supplies such that the block power supply does not block other outlets. Attach power strip to a permanent location that is easily accessible to devices in the rear of the cabinet. Provide hard wire connection to the Cabinet AC power. Do not use plug in power strips.

13. Surge Protection

Equip each cabinet with devices to protect the control equipment from surges and over voltages.

Design the surge protector panels to allow for adequate space for a wire connection and surge protector replacement without the removal of terminal blocks or panels. Provide surge protectors for the input sections as detailed below and as shown in the Input Terminal and Surge Arrestor Detail.

Supply surge protectors that meet the following Specifications.

a. AC Service Input

- Include a surge protection unit for each cabinet on the AC service input that meets or exceeds the following requirements: Provide a hybrid type power line surge protection device on the cabinet service panel..
- Install the protector between the applied line voltage and earth ground. Use a surge protector capable of reducing the effect of lightning transient voltages applied to the AC line that conforms to the following:

Peak surge current for an 8 x 20 µs waveform:	20,000A for 20 occurrences
Clamp voltage @ 20,000A:	280V max
Maximum continuous operating current:	@ 120V / 60 Hz 10A
Series Inductance:	AC Line/AC Neutral - 200 micro henries
Response time:	Voltage never exceeds 280V during surge
Spike suppression for +/- 700 V spike :	+/- 40 V deviation from sine wave at all phases angles between 0 and 180 degrees

- Provide a protector that is modular and uses a 12 pin Beau connector with the following terminals:
    - Main Line (AC line first stage terminal)
    - Main Neutral (AC neutral input terminal)
    - Equipment Line In (AC line second stage input terminal, 10A)

- Equipment Line Out (AC line second stage output terminal, 10A)
- Equipment neutral out (neutral terminal to protected equipment)
- GND (Earth connection)

- Supply a protector that is epoxy encapsulated in a flame-retardant material.
- Configure the Equipment Line Out to provide power to the Type 2070 and to the 24 V power supply.

b. AC+ Interconnect Cable Inputs

Use a surge protection device to protect each AC interconnect line as it enters the cabinet with a surge protection device that meets or exceeds the following requirements:

- 3-electrode gas tube type of surge arrestor
- Striking voltage of 300-500 V DC with a minimum holder over voltage of 155V DC
- A three terminal device, one of which is connected to ground, the other two are connected across each input respectively
- The units must meet the following minimum requirements:

Impulse breakdown:	Less than 100V in less than 1.1 µs at 10 kV/µs
Impulse breakdown balance:	0.01 microsecond (or less) difference at 10 kV/µs impulse
Energy application:	Withstands 20A AC for one (1) second applied ten (10) times at three (3) minute intervals on either section
Current rating:	10,000A (8 x 20 µs impulse)
Capacitance:	6 pF, line to ground

c. Inductive Loop Detector Inputs

Provide surge arrestors in the cabinet as shown in Table 925-5, Table 925-7 or Table 925-9 for the applicable cabinet. Protect each inductive loop detector channel input by an external surge protection device that meets or exceeds the following requirements:

- A three-terminal device, two (2) of which are connected across the signal inputs of the detector with the third connected to the chassis ground to protect against common mode damage.
- Instantly clamps differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array appears as a low capacitance to the detector.
- Clamps common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.
- Withstand 25-100A surge current occurrences of a 10 x 700 µs waveform.
- Have the following clamp characteristics:

Maximum break over voltage:	170 V
Maximum on-stage clamping voltage:	3V
Response Time:	<5 µs
Off-stage leakage current:	<10 µA
Capacitance:	less than 220 pf

- Ensure that the unit also meets the following minimum requirements:

Peak surge current:	6 times
Differential mode:	400 A (8 x 20 µs)
Common mode:	1,000 A (8 x 20 µs)
Estimated occurrences:	500 @ 200 A
Response time:	40 µs
Input capacitance:	35 pF typical
Temperature:	-40° F to +185° F (-40º C to 85º C)
Mounting:	No. 10-32 x 3/8-inch (No. 5 x 10 mm) bolt
Clamp voltage	
@400 A diff. Mode:	30 V max.
@1,000 A comm. Mode:	30 V max.

d. Signal Load Switches (Switchpacks)

Provide the output of all switchpacks in all output files and output/PDAs with metal oxide varistors (MOV) tied from the AC positive field terminal to the chassis ground to protect switchpacks from surges on the AC output lines.

Ensure that these MOVs meet or exceed these requirements:

- Steady state sinusoidal voltage (RMS) rating at 50 to 60 Hz of at least 150 V at 77º F (25° C)
- Steady state applied DC voltage rating of at least 200 V at 77º F (25° C)
- Transient energy rating is of at least 80 J for a single impulse of 10/1,000 µs current waveform at 77º F (25° C)
- Peak current rating of 6,500 A for a single impulse of 8/20 µs waveform with the rated continuous voltage applied
- Varistor voltage of at least 212 V at 1.0mA of DC current applied for the duration of 20 µs to 5s
- Clamping voltage of at least 395 V with an applied 8/20 µs impulse of 100 A
- Typical capacitance at a frequency of 0.1 to 1.0 MHz of 1600 pF
- Two-terminal device, one of which is connected to the AC output of the signal load switch on the output file terminals (backside of the field terminals) with the other connected to AC neutral

e. Communication Inputs

Protect low voltage communications input as it enters the cabinet with a solid-state surge protection unit that meets or exceeds these requirements:

- Dual pair (4-wire) module with a printed circuit board connector, double sided and gold plated for reliability
- Ability to mate with and be installed in a 10-circuit Buchanan connector Part Number PCB1B10S or Tyco Part Number 2-1437410-3 or equivalent
- Usable as two independent signal pairs
- The data circuits pass through the protection in a serial fashion
- C2 connector of the 2070 controller that terminates on the line side of the unit
- Communication field wires for this local side that terminate on the line side of the unit
- Ground terminals connected to power ground
- Ensure that the unit meets the following minimum requirements:

Peak surge current:	10 kA (8 x 20 µs wave shape) 500A (10 x 700 µs wave shape)
Occurrences @ peak:	50 typical
Response time:	<1ns
Voltage Clamp:	8V line to line
Series Resistance:	24 Ω total
Temperature:	-40º F (-40º C) to +185º F (85º F)
Primary protector:	3 element gas tube 5kA, (8 x 20µs wave shape), per side
Secondary protector:	Silicon avalance, 1.5 kW minimum

f. Low Voltage DC Inputs

Provide an external surge protection device for each low voltage DC input channel which meets the same requirements as the communication inputs with the following exception of the Voltage clamp, which shall be 30 V line-to-line.

14. Type 2010 Signal Monitors:

a. Introduction

This Specification sets forth the minimum requirements for a rack-mountable, sixteen channel, solid-state 2010 Signal Monitor for a Type 170E Traffic Cabinet Assembly. Ensure that as a minimum, the Signal Monitor complies with all Specifications outlined in Chapter 3 Section 6 of the California TEES, August 2002. Where differences occur, this Specification governs. Ensure that the manufacturer of the unit is listed on the current California Department of Transportation (CALTRANS) Qualified Products List (QPL) for signal monitors.

Provide a Signal Monitor that is capable of monitoring sixteen channels consisting of a Green input, a Yellow input, and a Red input for each channel. Ensure that the unit also includes the enhanced monitoring functions described in Subsection 925.2.04.A.15.b, diagnostic display functions described in Subsection 925.2.04.A.15.c, event logging functions described in Subsection 925.2.04.A.15.d, communications functions described in Subsection 925.2.04.A.15.e, and hardware functions described in Subsection 925.2.04.A.15.f.

b. Monitor Functions

Except for Conflict faults, compute all fault timing for each channel individually.

1) Conflict Monitoring

Ensure that the Signal Monitor is able to detect the presence of conflicting green or yellow signal voltages on the AC field terminals between two or more non-compatible channels. A Conflict fault (CONFLICT) shall be a latching fault.

2) Conflict Recognition Time

Ensure the Signal Monitor shall trigger when voltages on any conflicting channels are present for more than 500 ms. Ensure that the Signal Monitor does not trigger when voltages on any conflicting channels are present for less than 200 ms. Conflicting signals sensed for more than 200 ms and less than 500 ms may or may not trigger the unit.

3) 24VDC Monitoring VDC

Ensure that the Signal Monitor is able to detect that the cabinet +24 Vdc supply has fallen below 18 Vdc. A 24VDC failure (VDC FAIL) shall be a latching fault.

4) 24VDC Recognition Time

Ensure that the Signal Monitor shall trigger when the voltage on the +24V input is below 18 Vdc for more than 500 ms. Ensure that the Signal Monitor does not trigger when the voltage on the +24V input is below 18 Vdc for less than 200 ms. A voltage level of +22 Vdc will be required to prevent the unit from triggering.

5) Controller Watchdog Monitoring

Ensure that the Signal Monitor triggers when the Watchdog input does not toggle within the programmed time period (WDT ERROR). Ensure that the unit remains latched in the fault state until reset by the Reset button, an External Reset input command, or AC Line voltage restoring from an AC Line Brownout event (see 2.4). Ensure that a reset resulting from an AC Line Brownout event does not clear the WDT ERROR LED.

a) Controller Watchdog Latch Option

Ensure a programming option sets the Watchdog monitoring function to a latching mode and that only a reset from the Reset button or External Reset input can clear a Watchdog fault. An AC Line brownout condition will not reset the fault.

b) Controller Watchdog Recognition Time

Ensure a programming option sets the maximum Watchdog recognition time to: 1000 + or - 100 ms; or 1500 + or - 100 ms.

c) Controller Watchdog Enable Switch

Provide an internal switch to disable the Watchdog monitoring function. Mount the switch on the PCB and be clearly label "WD ENABLE - ON...OFF". Ensure that placement of the switch in the OFF position causes monitoring of the Watchdog to be inhibited.

d) WDT ERROR LED Control

Ensure that the WDT ERROR LED illuminates when the unit has been triggered by a Watchdog fault. Ensure that it can only be cleared by a reset command from the front panel Reset switch or External Reset input. If the Watchdog monitoring function is inhibited due to the Watchdog Enable switch, the WDT ERROR LED shall flash at a 0.5 Hz rate.

6) AC Line Monitoring

a) AC Line Brownout Recognition

Ensure that the Signal Monitor is able to detect that the AC Line has fallen below 98 + or - 2 Vac for greater than 400 + or - 50 ms. This shall force the output Relay to the de-energized "fault" state, enable the Stop-Time output, and cause the AC POWER LED to flash at a 2 Hz rate. Ensure that the unit maintains this state until the AC Line voltage rises above 103 + or - 2 Vac for greater than 400 + or - 50 ms. Provide a jumper option which will change the AC Brownout dropout level to 92 + or - 2 Vac and the restore level to 98 + or - 2 Vac.

b) AC Line Power-up and Brownout Delay Time

When the AC Line is greater than 103 + or - 2 volts after power-up or Brownout restore, ensure that the Signal Monitor holds the Output Relay in the de-energized "fault" state and enable the Stop-Time output, for a period of not less than 6.0 + or - 0.5 seconds and not greater than 10.0 + or - 0.5 seconds. Ensure that this flash interval is terminated after at least 6.0 + or - 0.5 seconds if the Signal Monitor has detected at least five transitions of the Watchdog input. If the Signal Monitor does not detect five transitions of the Watchdog input before 10.0 + or - 0.5 seconds, ensure that the Signal Monitor goes to the fault state. During this interval, ensure that the AC POWER LED flashes at a 4 Hz rate.

7) Red Fail Monitoring

Ensure that the Signal Monitor is able to detect the absence of an active voltage on the green and yellow and red field signal inputs of a channel. Red Fail fault (RED FAIL) shall be a latching fault. Ensure that the Red Fail monitoring function is enabled for all channels except when the Red Enable input is not active, or pin #EE is active, or Special Function #1 input is active, or Special Function #2 input is active.

a) Red Fail Recognition Time

Ensure the Signal Monitor triggers when an active voltage on one of the three inputs of a channel are absent for more than 1500 ms. Ensure that the Signal Monitor does not trigger when an active voltage on one of the three inputs of a channel are absent for less than 1200 ms. Channels without proper voltages sensed for more than 1200 ms and less than 1500 ms may or may not trigger the unit. Provide an option switch (RF 2010) which will change the fault recognition time to between 700 ms and 1000 ms.

b) Red Interface Cable Fault

Ensure a programming option is provided such that operating without the Red Interface cable installed shall cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode, ensure that the Red Fail indicator is illuminated with all fault channel indicators Off.

Ensure that any Red Fail preemption control to the monitor uses the Special Function inputs #1 or #2.

8) Dual Indication Monitoring

Ensure that the Signal Monitor is able to detect the presence of active voltage on the green and yellow, green and red, or yellow and red field signal inputs of a channel. GYR Dual Indication fault (DUAL IND) shall be a latching fault. Ensure this function is enabled on a per channel basis using dip switches mounted on the PCB labeled "CH1" through "CH16". Ensure that the GYR Dual Indication monitoring function is enabled for all selected channels except when the Red Enable input is not active or pin #EE is active.

a) GY Dual Indication Monitoring

Ensure that the Signal Monitor is able to detect the presence of active voltage on the green and yellow field signal inputs of a channel. GY Dual Indication fault (DUAL IND) shall be a latching fault. Enable this function with a dip switch on the PCB labeled "GY ENABLE". When the switch is in the ON position, monitor all channels for simultaneous active green and yellow inputs on a channel. When selected by the GY ENABLE switch, ensure that the GY Dual Indication monitoring function is disabled when pin #EE is active.

b) Dual Indication Recognition Time

Ensure that the Signal Monitor triggers when multiple inputs are active on a channel for more than 500 ms. Ensure that the Signal Monitor does not trigger when multiple inputs are active on a channel for less than 250 ms. Channels with multiple voltages active for more than 250 ms and less than 500 ms may or may not trigger the unit.

9) Sequence (Short or Absent Yellow) Monitoring

Ensure that the Signal Monitor is able to detect that a channel has not provided an adequate Yellow Clearance interval during a green to yellow to red sequence. A Sequence failure (SEQUENCE) shall be a latching fault. Ensure that this function is enabled on a per channel basis using dip switches mounted on the PCB labeled "CH1" through "CH16". Ensure that the Sequence monitoring function is enabled for all selected channels except when the Red Enable input is not active or pin #EE is active.

10) Sequence Recognition Time

The minimum Yellow Clearance interval may be modified by switches mounted on the PCB labeled "YEL TIME 1", "YEL TIME 2", and "YEL TIME 3". Ensure that the Yellow Clearance interval is 2.7 seconds plus 0.2 seconds times the binary sum of the three switches. The minimum Yellow Clearance interval shall therefore have a range of 2.7 seconds to 4.1 seconds, 0.1 seconds.

11) Flickering Indication Detection

Ensure that the Signal Monitor provides a method of detecting Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs that may not meet the duration requirements but continue to flicker for an extended period of time. These flickering indications shall result in a latching fault with an indication illuminated along with the resulting Conflict, Red Fail, or Dual Indication indicator. Provide an option switch to disable this option.

12) Configuration Change Monitoring

On power-up, reset, and periodically during operation, ensure that the Signal Monitor compares the current configuration settings with the previously stored value and if the settings have changed, the Signal Monitor automatically logs the new setting. Ensure that these settings include the permissive diode matrix, all switches, all jumpers, and the Watchdog Enable switch.

Provide a programming option such that any change in the configuration parameters will cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode ensure that the PCA indicator will flash at a 4 Hz rate. Depressing the Reset button for 5 full seconds is required to clear this fault and log the new configuration parameters.

If the programming option is not selected, ensure that the unit does not set the fault mode but will still log the configuration change.

13) Program Card Ajar

Ensure that when the Programming Card is removed or not seated properly, the Signal Monitor forces the Output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the PCA LED. A reset command from the front panel Reset switch or External Reset input is required once the Program Card is in place.

14) Exit Flash

When the Signal Monitor exits the flash state (Output relay de-energized) as a result of a Reset command or AC Line brownout restore, ensure that the Stop Time output goes to the inactive state 250 + OR - 50 ms before the Output relay transfers to the energized state. This transition will provide an early indication to the Controller Unit that the cabinet will transfer from flash to signal operation.

c. Display Functions

Ensure that it is possible to view the active channels for each individual color (GYR) during operation and when latched in a fault state. When the Signal Monitor is latched in a fault state ensure that it is also be possible to view the active channels for each individual color and fault status for each channel for the current fault and the two previous faults.

1) Previous Fault GYR Display

When the Signal Monitor has been triggered by a fault the channel status display will alternate between the channels which were involved in the fault (fault status) for 2 seconds, and the field signals active at the time of the fault for 6 seconds. The channels involved in the fault will flash their respective Green, Yellow, and Red indicators simultaneously at a 4 Hz rate for the 2 second interval.

The two previous faults may also be displayed individually. This status is not reset by an AC Line power interruption. To enter this display mode remove the Program Card. The sequence is as follows:

Reset	Event	PCA LED	Fault Status LEDs	Channel Status LEDs
---	#1	Single flash	Current Fault Status (newest)	Current Field status
#1	#2	Double flash	Event #2 Fault Status	Event #2 Field status
#2	#3	Triple flash	Event #3 Fault Status (oldest)	Event #3 Field status
(repeats back to top)				

d. Event Logging Functions

Ensure that the Signal Monitor is capable of storing in non-volatile memory a minimum of 100 events. Mark each event with the time and date of the event. These events consist of fault events, AC Line events, reset events, and configuration change events. Provide a graphical means of displaying the signal states of all field inputs for 30 seconds prior to a fault trigger event. Provide the capability to assign a four-digit identification number to the unit shall be provided. Upload the event logs to a PC using the serial port of the Signal Monitor and software provided by the manufacturer.

Ensure each event log report contains the following information:

- Monitor ID#: a four digit (0000-9999) ID number assigned to the monitor.
- Time and Date: time and date of occurrence.
- Event Number: identifies the record number in the log. Event #1 is the most recent event.

1) Monitor Status Report (CS)

Ensure the Current Status report contains the following information:

a) Fault Type: the fault type description.

b) Field Status: the current GYR field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.

c) Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.

d) AC Line Voltage: the current AC Line voltage if the monitor is not in the fault state, or the AC Line voltage at the time of the fault.

e) Control Input Status: the current state and RMS voltages of the Red Enable input, EE input, and Special Function #1 and #2 inputs if the monitor is not in the fault state, or the status latched at the time of the fault.

2) Previous Fault Log (PF)

Ensure the Previous Fault log contains the following information:

a) Fault Type: the fault type description.

b) Field Status: the latched field status with RMS voltages, and fault channel status at the time of the fault.

c) Cabinet Temperature: the latched temperature at the time of the fault.

d) AC Line Voltage: the AC Line voltage at the time of the fault.

e) Control Input Status: the latched state of the Red Enable input, EE input, and Special Function #1 and #2 inputs at the time of the fault.

3) AC Line Event Log (AC)

The AC Line log shall contain the following information:

a) Event Type: describes the type of AC Line event that occurred.

- Power-up—AC on, monitor performed a cold start
- Interrupt—AC Line < Brownout level
- Restore—AC restored from brown-out or interruption (AC Off), no cold start

b) AC Line Voltage: the AC Line voltage at the time of the event.

4) Monitor Reset Log (MR)

Ensure the Monitor Reset log contains the following information:

a) The monitor was reset from a fault by the front panel Reset button or External Reset input.

5) Configuration Change Log (CF)

Ensure the Configuration Change log contains the following information:

a) Program Card Matrix: the permissive programming for each channel.

b) Yellow Disable Jumpers: the Yellow Disable programming for each channel.

c) Dual/Sequence Switches: the switch programming for each channel.

d) Option Switches: RF 2010, RP Disable, GY Enable, SF1 Polarity, Sequence Timing, Minimum Flash Enable, Configuration Fault Enable, Red Cable Fault enable, AC Brownout timing.

e) Watchdog Programming: Watchdog Enable, Watchdog Latch, and Watchdog timing.

f) Configuration CRC: A unique CRC value which is based on the configuration of items #a though #e above.

Indicate on the log, which items have been changed since the last log entry.

6) Signal Sequence Log

Provide a log that graphically displays all field signal states for up to 30 seconds prior to the current fault trigger event. Ensure that the resolution of the display is at least 50 milliseconds.

e. Communications Functions

1) Controller Unit Communications

Ensure that the Signal Monitor is compatible with the protocol of the current GDOT licensed firmware for 2070 controllers and Central System Control. Ensure the 2010 Conflict Monitor supplied is able to communicate via a serial link to the 2010 Controller and then to a Central System using the current licensed GDOT Central System Software for reporting, configuring and logging.

2) Personal Computer Communications

Have the manufacturer provide software to access the Signal Monitor status and event logs described in Subsection 925.2.04.A.15.d. Ensure this software operates with Microsoft Windows 2000™ or Windows XP™.

f. Hardware

1) Red Monitoring

a) Red Field Inputs

Ensure that the Signal Monitor is capable of monitoring sixteen Red field signals. Ensure that a Red input is sensed active when the input voltage exceeds 70 Vrms. Ensure that a Red input is sensed not active when the input voltage is less than 50 Vrms. A Red input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.

b) Red Enable Input

Ensure that the Red Enable input provides an AC input to the unit which enables Red Monitoring, Dual Indication Monitoring, and Sequence monitoring when the input is sensed active.

Ensure that the Red Enable input is sensed active when the input voltage exceeds 70 Vrms. Ensure that the Red Enable input is sensed not active when the input voltage is less than 50 Vrms. The Red Enable input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.

c) Special Function Preemption Inputs

Ensure that the Special Function Preemption inputs #1 and #2 provide an AC input to the unit which disables only Red Fail Monitoring (Lack of Output) when either input is sensed active.

Ensure that a Special Function input is sensed active when the input voltage exceeds 70 Vrms. Ensure that a Special Function input is sensed not active when the input voltage is less than 50 Vrms. A

Special Function input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.

Use a PCB mounted switch to provide the option to invert the active status of the Special Function #1 input. When the switch is in the ON position, ensure that the Special Function #1 input is sensed not active when the input voltage exceeds 70 Vrms. Ensure that the Special Function #1 input is sensed active when the input voltage is less than 50 Vrms. The Special Function #1 input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.

d) Red Interface Connector

This connector provides the required inputs for the unit to monitor the Red field signal outputs. Ensure the connector is a 20 pin connector that mates with the P20 Cable from the output file. Provide a high quality connector that is polarized to insure proper mating with the cable. Ensure Ejector latches are included to facilitate removal and prevent the cable from inadvertently disconnecting. Ensure the unit shall function as a standard 210 Signal Monitor when the cable is disconnected. Use the pin assignments shown in Table 925-1.

Table 925 -1 Red Interface Connector

Pin	Function	Pin	Function
1	Channel 15 Red	11	Channel 9 Red
2	Channel 16 Red	12	Channel 8 Red
3	Channel14 Red	13	Channel 7 Red
4	Chassis Ground*	14	Channel 6 Red
5	Channel 13 Red	15	Channel 5 Red
6	Special Function #2	16	Channel 4 Red
7	Channel 12 Red	17	Channel 3 Red
8	Special Function #1	18	Channel 2 Red
9	Channel 10 Red	19	Channel 1 Red
10	Channel 11 Red	20	Red Enable
*A jumper option shall be provided to allow the connection of Pin #4 to be made with Chassis Ground.			

2) Front Panel

Ensure the front panel is constructed of sheet aluminum with a minimum thickness of 0.090 in. (2.286 mm), and finished with an anodized coating. Ensure the model information shall be permanently displayed on the front surface.

a) Indicators

Ensure that all display indicators are mounted on the front panel of the Signal Monitor and are water clear, T-1 package, Super Bright type LEDs. Ensure that all fault LEDs are red except the AC POWER indicator which is green. Provide a separate Red, Yellow, and Green indicator for each channel. Label the indicators and provide the information as follows:

i. AC POWER

Ensure the AC Power indicator flashes at a rate of 2 Hz when the unit has detected a low voltage condition as described in Subsection 925.2.04.A.15.b.10).a. Ensure the AC POWER indicator flashes at a rate of 4 Hz during the minimum flash interval as described in Subsection 925.2.04.A.15.b.10).b. Ensure that the indicator illuminates when the AC Line voltage level is restored above the brownout level. Ensure the indicator extinguishes when the AC Line voltage is less than 80 Vac.

ii. VDC FAILED

Ensure the VDC FAILED indicator illuminates when a 24VDC fault condition is detected. This indicator remains extinguished if the monitor has not been triggered by a 24VDC fault.

iii. WDT ERROR

Ensure the WDT ERROR indicator illuminates when a controller Watchdog fault is detected. Ensure the WDT Error indicator flashes ON once every 2 seconds if the WD Enable switch on the monitor is placed in the OFF position to disable Watchdog monitoring, or the AC Line voltage is below the Watchdog disable level.

iv. CONFLICT

Ensure that the CONFLICT indicator illuminates when a conflicting signal fault is detected.

v. DIAGNOSTIC

Ensure the DIAGNOSTIC indicator illuminates when one of the following faults is detected: Internal Watchdog fault, Memory Test fault, or Internal power supply fault. This indicator is intended to inform the service technician of a monitor hardware or firmware failure.

vi. RED FAIL

Ensure the RED FAIL indicator illuminates when an absence of signal is detected on a channel(s). Ensure the RED FAIL indicator flashes ON once every two seconds if the RED ENABLE input is not active, or a Special Function input is active, or the EE input is active.

vii. DUAL IND

Ensure the Dual IND. indicator illuminates when a GY-Dual or GYR-Dual Indication fault is detected on a channel(s).

viii. SEQUENCE

Ensure the Sequence indicator illuminates when the minimum Yellow Clearance time has not been met on a channel(s).

ix. PCA

Ensure the PCA indicator illuminates if the Program Card is absent or not properly seated.

If the unit is in the Diagnostic Display mode, ensure the PCA indicator flashes ON (once, twice, or three times) to indicate the fault event number being displayed. See Subsection 925.2.04.A.15.c.

x. RP DETECT

Ensure the RP DETECT indicator illuminates when the unit has detected a Conflict, Red Fail, or Dual Indication fault as a result of recurring pulse field inputs.

xi. CHANNEL STATUS

Ensure that during normal operation the 48 Channel Status indicators display all active signals (Red, Green, and Yellow).

In the fault mode, ensure that the Channel Status indicators display all signals active at the time of the fault for six seconds and then indicate the channels involved in the fault for 2 seconds.

b) Front Panel Control - Reset Button

i. Provide a momentary SPST Control switch labeled RESET on the unit front panel to reset the monitor circuitry to a non-failed state. Position the switch on the front panel such that the switch can be operated while gripping the front panel handle. Ensure that a reset command issued from either the front panel button or External Reset input is a one-time reset input to prevent the unit from constant reset due to a switch failure or constant external input, and causes all LED indicators to illuminate for 300 ms.

ii. The Reset button also provides control of the Diagnostic Display mode. For a complete description of Diagnostic Display operation, see Subsection 925.2.04.A.15.c.

c) Serial Communications Connector

Use this connector to provide EIA-232 serial communications. Ensure that it is a high quality 9 pin metal shell D subminiature type with female contacts. Refer to Table 925-2 for Pin assignments.

Table 925-2 Serial Communications Connector

Pin	Function
1	DCD*
2	TX DATA
3	RX DATA
4	DTR (Data Terminal Ready)
5	SIGNAL GROUND
6	DSR
7	DSR*
8	CTS*
9	NC
* Provide Jumper options to allow the connection of Pin #4 to be made with Pin #7, and the connection of Pin #8 to be made with Pin #1.	

3) Electronics

a) RMS Voltage Sampling

Use high speed sampling techniques to determine the true RMS value of the AC field inputs. Sample each AC input at least 32 times per cycle. Ensure that the RMS voltage measurement is insensitive to phase, frequency, and waveform distortion.

b) Internal MPU Watchdog

Use a microprocessor for all timing and control functions. Verify continuing operation of the microprocessor by an independent monitor circuit, that forces the Output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within 300 ms.

If the microprocessor should resume operation, ensure the Signal Monitor continues to operate. Ensure that this monitoring circuit is also configurable to latch in the fault state. Ensure the unit requires a power-up cycle to reset the circuit once it is triggered.

c) Sockets

In the interest of reliability, ensure that only the PROM memory device for the microprocessor firmware is socket mounted. Ensure that the PROM memory socket is a precision screw machine type socket with a gold contact finish providing a reliable gas tight seal. Low insertion force sockets or sockets with "wiper" type contacts are not acceptable.

d) Internal Power Supply

Use a built-in, high-efficiency switching power supply to generate all required internal voltages. Ensure that all supply voltages regulated. Failure of the internal power supply to provide proper operating voltages shall force the output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the DIAGNOSTIC indicator. Provide a user replaceable slow blow fuse for the AC Line input. Ensure the unit is operational over the AC Line voltage range of 75 Vac to 135 Vac.

e) EIA-232 Interface

Ensure the EIA-232 port interface electronics is electrically isolated from all monitor electronics except chassis ground.

f) Configuration Parameters

Select user-programmed configuration settings using PCB mounted switches or jumpers. Designs requiring a Personal Computer (PC) to program or verify the configuration parameters are not acceptable. Ensure that user-programmed configuration settings that are transferred to memory are stored in a programmable read-only memory (PROM or EEPROM). Designs using a battery to maintain configuration data are not acceptable.

g) Field Terminal Inputs

Ensure that all 120 Vac field terminal inputs provide an input impedance of 150K 50K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater and a voltage rating exceeding 350 volts.

h) Component Specifications

Ensure that all electrical components used in the Signal Monitor are rated by the component manufacturer to operate beyond the full unit operating temperature range of –29 ^{o}F to 165 ^{o}F(-34 ^{o}C to +74 ^{o}C).

i) Printed Circuit Boards

Ensure that all printed circuit boards meet the requirements of the *California Traffic Signal Control Equipment Specifications*, January 1989, plus the following requirements to enhance reliability:

i. All plated-through holes and exposed circuit traces are plated with solder.

ii. Both sides of the printed circuit board are covered with a solder mask material.

iii. The circuit reference designation for all components and the polarity of all capacitors and diodes are clearly marked adjacent to the component. Ensure that Pin #1 for all integrated circuit packages is designated on both sides of all printed circuit boards.

iv. All electrical mating surfaces are gold plated.

v. All printed circuit board assemblies are coated on both sides with a clear moisture-proof and fungus-proof sealant.

vi. All components and wire harnesses are mounted to the PCB using plated holes. "Piggy back" connections or jumper wires are not acceptable.

15. Model 208 Monitor Unit

Provide Model 208 Monitor Unit in accordance with CALTRANS TEES and the following. Provide monitor that is on the CALTRANS QPL and provides the pin assignment as shown in Table 925-3.

The Model 208 Monitor Unit shall reliably sense and cause a relay output contact (FAILED STATE) when monitoring the following:

- A Watchdog Timer (WDT) Timeout Condition
- Cabinet +24 VDC Power Supply below specified threshold

a. WDT Monitor Requirements

b. WDT Circuitry shall be provided to monitor a controller unit output line state routed to the monitor unit at its assigned pin. The WDT Circuitry shall sense any line state change and the time between the last change. No state change for 1.5 ± 0.1 seconds shall cause a FAILED state. The timer shall reset at each state change in a NON FAILED state.

1) Only the Unit Reset or a WDT inactive due to the voltage sense shall reset the WDT from a FAILED state.

2) A FAILED state caused by the WDT shall illuminate a front panel indicator light label “WDT ERROR”. The indicator shall remain ON until Unit Reset Issuance.

3) The WDT Circuitry shall sense the incoming VAC Line and when the voltage falls below 98 ± 2VAC for 50 ± 17 ms shall inhibit the WDT Function. When the WDT Circuitry sensed the incoming VAC Line rise above 103 ± 2VAC for 50 ± 2ms the WDT shall become active. A hysteresis between the Voltage Inhibit and the Voltage Active Setting shall be a minimum of 3 Volts.

c. Power Supply Monitor Requirements

1) The monitor unit shall sense the Cabinet +24 VDC Power Supply Output Voltage.

2) Voltages sensed at +18 VDC or below for a duration of 500 ms or longer shall cause a FAILDED state.

3) Voltages sensed at+22 VDC or above shall NOT cause a FAILED state.

4) Voltages sensed below +22 VDC for a duration of 200 ms or less shall NOT cause a FAILED state.

5) All timing and voltages conditions other than those specified above may or may not cause a FAILED state.

6) A FAILED state caused by sensing the power supply shall illuminate a front panel indicator light labeled “VDC FAILED”. The indicator shall remain ON until Unit Reset.

7) Only Unit Reset shall reset the power supply sense circuitry from a FAILED state.

d. FAILED State Output Circuits

1) An electro-mechanical relay shall be provided to switch an output circuit during a FAILED state. The relay coil shall be energized in a NON FAILED State.

2) The relay contacts shall be rated for a minimum of 3 amperes at 120 VAC and 100,000 operations. Contact opening /closing time shall be 30 ms or less.

e. Monitor Unit Reset

1) A momentary SPST CONTROL switch labeled “RESET” shall be provided on the unit front panel to reset the monitor unit circuitry to a NON FAILED state. The switch shall be so positioned on the front panel that the switch can be operated while gripping the front panel handle.

2) The unit shall be provided with provision to drive an external NE@H light through a 56K Ohm, ½ Watt Series resistor (resident on unit).

3) The PDA Type 3 WDT Reset Input shall not be sensed by the unit

4) The output relay CONTACT FOR FAILED STATE shall be OPEN.

Table 925-3 Pin Assignments For Model 208 Monitor Unit	
PIN	**FUNCTION**
1/44	DC Ground
2/43	WDT Ext. Reset
5/40	WDT IN
10/35	+24 VDC
15/30	AC-
17/28	Normally Open, Circ. #2
19/26	AC+
20/25	Normally Closed, Circ. #1
21/24	Circ. Common #1 & #2
22/23	WDT Lamp (External)
NOTE: Card connector keyed between pins 2 & 3, and pins 11 & 12.	

16. Model 242 DC Isolator

    Provide Model 242 DC Isolators that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section. Provide isolators that:

    - Allow the 242 isolator input signal polarity to easily be inverted without the use of tools. Acceptable methods are removable jumpers or dip switches. Unacceptable methods are soldering or desoldering a diode or resistor.
    - Output is OFF for input voltages greater than 12 volts;
    - Output is ON for voltages of less than 8 volts that have a duration of at least 5 to 25 ms (optional 2-7 ms);
    - Minimum output pulse width is 100 ms with a valid input (can be disabled);
    - Output is optically isolated open collector NPN transistor;
    - Capable of sinking 50 ma when on;
    - Can register a new input within 25 ms of the old signal going away; and
    - Output clamped on power up and down
    - Compatible with 2070 controllers and latest version of CALTRANS TEES including errata

17. Model 200 Switchpack

    Provide Model 200 Switchpacks that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

18. Model 204 Flasher Unit

    Provide Model 204 Flasher Units that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

19. Flash Transfer Relay

    Provide Flash Transfer Relays that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

20. Cabinet Model 332A

    Table 925-5 Required Surge Arrestors for Model 332A Cabinet.

    Supply Model 332A (lower input panel) cabinets, with housing Type 1B, and all components as described in these Specifications.

    Supply cabinets having two input files which conform to the CALTRANS Specifications and configured to accept two 2070 controllers in the top portion of the cabinet. Ensure the cabinet has two shelves provided for controller(s).

    Configure the cabinet for dial up communications. Mount a two (2) circuit Buchanan connector on the right side panel (from rear door).

    Mount a phone jack with a RJ11 connector above or to the right of the Buchanan terminal block.

    Wire the phone jack to the Buchanan and to the Terminal Block (TB0) in accordance with Figure 925-2.

    A manual jack shall be installed on the police panel. The jack shall intermate with a three circuit 1/4 inch (6.35 mm) diameter phone plug. The tip and ring (middle) circuits of the jack shall-be connected to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground shall be connected to the interval advance input of the controller unit.

    A Manual ON- OFF Switch shall be provided on the police panel which grounds the Manual Control Enable (C1 Pin 53) input to the controller whenever the switch is in the ON position.

    A manual pushbutton with cord shall be provided. The cord shall have a minimum length of 3 feet (0.9 m). It shall have a 1/4 inch (6.35 mm) diameter, three circuit plug connected to one end and a manual pushbutton enclosed in a hand held enclosure at the other end. A complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval which is active except the vehicular yellow and all red clearance intervals. Cycling the push-button during the vehicular yellow or all red clearance intervals shall not terminate the timing of those intervals.

21. Cabinet Model 332A with Auxiliary Output File)

    Ensure that this unit meets the requirements of Subsection 925.2.04.A.20 above, except that the cabinet is configured with an Auxiliary Output File. Additionally, the field wiring terminals may be mounted on the rear of the input file.

22. Cabinet Model 336S (Base Mount)

    This unit meets the CALTRANS Specification with the addition of approximately 6 additional inches (150 mm) of cabinet height exclusive of the "M" base adapter. Configure the internal component layout so that the additional space is available in the bottom area of the cabinet cage. Ensure that the field wiring input panels and surge protection conform to Table 925-6 Model 336S Default Input File Assignment Detail and Table 925-7 Required Surge Arrestors for Model 336S Cabinet.

    Ensure that the C1 connector harness is provided with pins for all 104 inputs and outputs from the controller.

    A manual jack shall be installed on the police panel. The jack shall intermate with a three circuit 1/4 inch (6.35 mm) diameter phone plug. The tip and ring (middle) circuits of the jack shall-be connected to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground shall be connected to the interval advance input of the controller unit.

    A Manual ON- Off Switch shall be provided on the police panel which grounds the Manual Control Enable (C1 Pin 53) input to the controller whenever the switch is in the ON position

    A manual pushbutton with cord shall be provided. The cord shall have a minimum length of 3 feet (0.9 m). It shall have a 1/4 inch (6.35 mm) diameter, three circuit plug connected to one end and a manual pushbutton enclosed in a hand held enclosure at the other end. A complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval which is active except the vehicular yellow and all red clearance intervals. Cycling the push-button during the vehicular yellow or all red clearance intervals shall not terminate the timing of those intervals.

23. Cabinet Model 336S (Pole Mount)

    Ensure that this unit meets the requirements of Subsection 925.2.04.A.22 above, except that the cabinet is configured for pole mounting as specified in the General Requirements for Type 170 Cabinet Assemblies.

24. Cabinet Model 336S (Base Mount with Auxiliary Output File)

    Ensure that this unit meets the requirements of Subsection 925.2.04.A.22 above, except that the cabinet is configured with an Auxiliary Output File. Additionally, the field wiring terminals may be mounted on the rear of the input file.

25. Cabinet Model 337

    The Model 337 cabinet is a compact cabinet with an output capacity of four vehicle phases plus two pedestrian phases; the dimensions not to exceed 17 inches (425 mm) deep x 20 inches (500 mm) wide x 35 inches (875 mm) high and its shipping weight not to exceed 175 pounds (80 kg).

    Supply the cabinet assembly with capacity for 11, two-channel slots in the input file.

    Ensure that the pin assignments of the C1 connector are compatible with the 2070 controller as applicable according to the required number of input/outputs.

    Ensure that the 337 cabinet uses standard Type 170 input and output file units.

    Equip the cabinet with a C2 connector harness with field terminals protected with surge protectors for communication inputs as specified under communications inputs.

    Ensure that the cabinet has two full-size doors to allow complete access from the front or back of the cabinet. Design the rack assembly to mount in CALTRANS standard rails to allow for a Model 204 flasher.

    Provide a receptacle to accept the plug in power distribution assembly card guides and edge connectors for the input file card guides to support the conflict monitor, and load switches and flash transfer relays.

Due to the compact design of this cabinet assembly, the Department of Transportation may accept a non-standard type of power distribution assembly (PDA).

26. Cabinet Model 334 with Auxiliary Output File for Ramp Metering Operations

The Controller Cabinet shall comply with the CALTRANS Traffic Signal Equipment Specifications (1989), Model 334 Cabinet Specifications (Chapter 6). **DO NOT** use the February 1993 Amendments for Specifications for the Model 334C Cabinet. Do use the Specification Clarifications dated December 20, 1993.

Provide Cabinet configured as shown in Figure 925-1.

Provide Detector Test Switch Panel. Before providing cabinet submit Detector Switch Test panel design and mounting location for approval. Panel shall include one switch for each of the 13 detector inputs.

a. The Detector Test Switch Panel shall be mounted in the cabinet on the rails. The panel shall be fabricated from brushed aluminum.

b. Each switch will be labeled as to function. The label shall be silk-screened on the test panel and be at least ¼ inch in height.

c. A three position switch shall be provided for each detector input. The switch shall function as follows:

- Down (Momentary) - Call is placed into the controller on the appropriate input in parallel with field input
- Up (Lock) – Call is placed into the controller on the appropriate input in parallel with field input.
- Center (Lock)– Normal Operation field output of detector is connected to the controller unit.

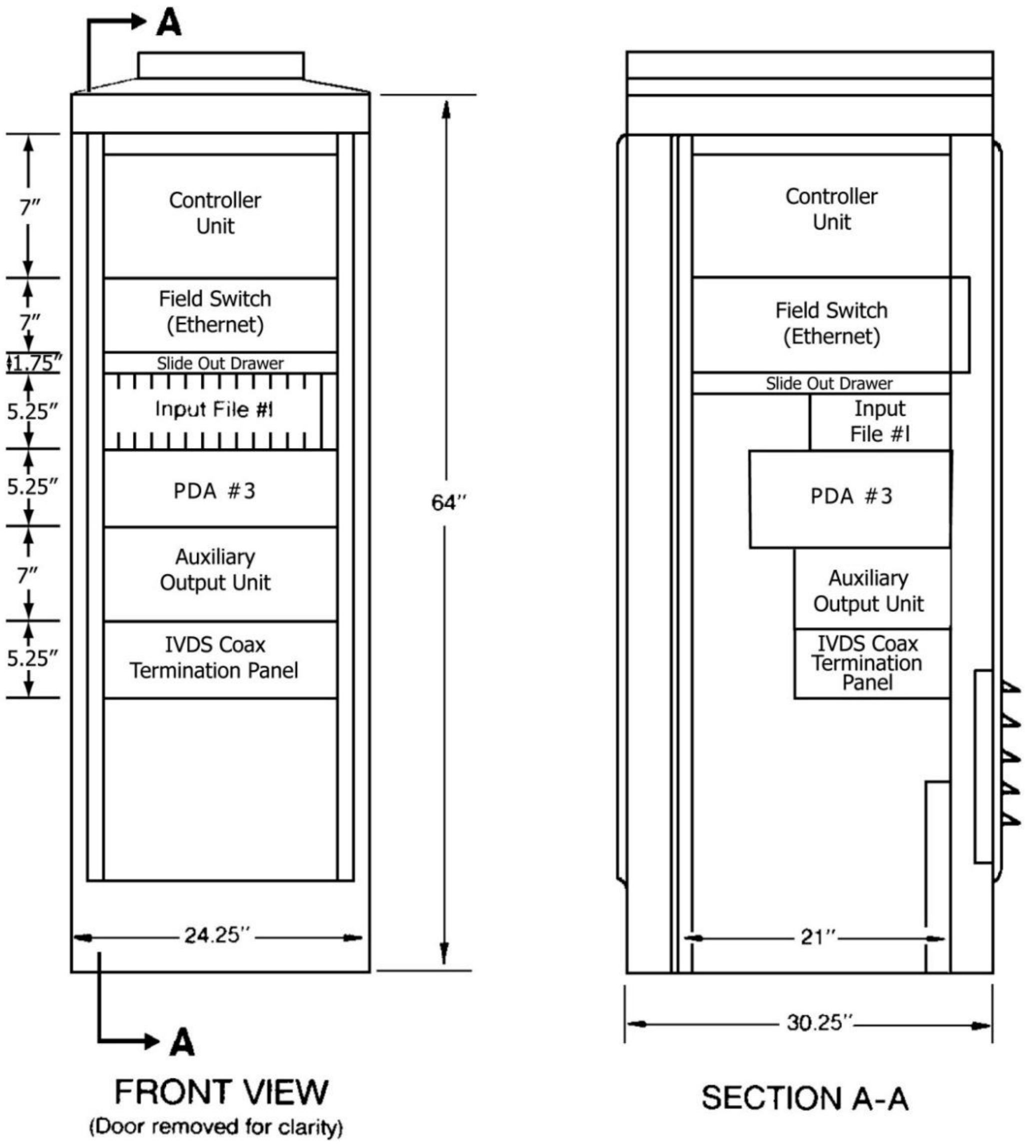


Figure 925-1 Typical 334 Cabinet Configuration

B. Fabrication

Refer to Subsection 925.2.06.A.1 for controller cabinet minimum fabrication Specifications.

C. Acceptance

Refer to Subsection 925.2.01.A for compliance with CALTRANS QPL.

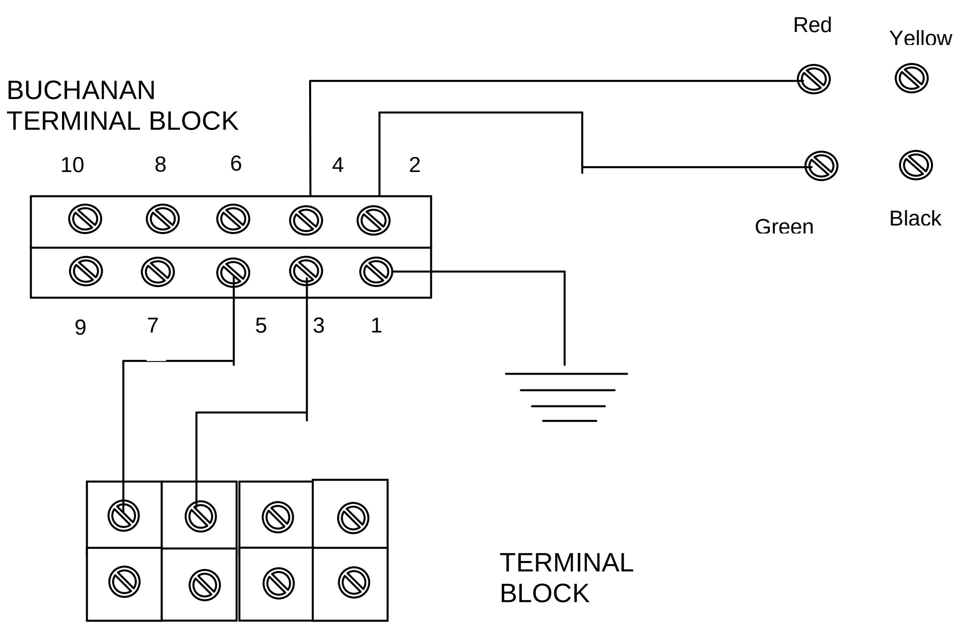
D. Materials Warranty

Refer Subsection 925.2.01.D for Materials Warranties.

Table 925 – 4 Model 332 Default Input Files Assignment Detail

Upper Input File (I)	**Slot**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
	Type		**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**			**DC**	**DC**	**DC**
	Channel 1	**C1 Pin**	56	39	63	47	58	41	65	49	60		80	67	68	81
		Function	Ph1	Ph2	Ph2	Ph2 CALL	Ph3	Ph4	Ph4	Ph4 CALL	Ph1		INT ADV	Ph2 PED	Ph6 PED	FLASH
		Field Term	TB-2 1,2	TB-2 5,6	TB-2 9,10	TB-4 1,2	TB-4 5,6	TB-4 9,10	TB-6 1,2	TB-6 5,6	TB- 6 9,10		NC	TB- 8 4,6	TB- 8 7,9	NC
	Channel 2	**C1 Pin**	56	43	76	47	58	45	78	49	62		53	69	70	82
		Function	Ph1	Ph2	Ph2	Ph2 CALL	Ph3	Ph4	Ph4	Ph4 CALL	Ph3		MCE	Ph4 PED	Ph8 PED	STOP TIME
		Field Term	TB-2 3,4	TB-2 7,8	TB-2 11,12	TB-4 3,4	TB-4 7,8	TB-4 11,12	TB-6 3,4	TB-6 7,8	TB-6 11,12		NC	TB-8 5,6	TB-8 8,9	NC
Lower Input File (J)	**Slot**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
	Type		**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**			**TBA**	**TBA**	**DC**
	Channel 1	**C1 Pin**	55	40	64	48	57	42	66	50	59		54	71	72	51
		Function	Ph5	Ph6	Ph6	Ph6 CALL	Ph7	Ph8	Ph8	Ph8 CALL	Ph5			EVA	EVB	R/R
		Field Term	TB-3 1,2	TB-3 5,6	TB-3 9,10	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-7 1,2	TB-7 5,6	TB- 7 9,10			TB- 9 4,6	TB- 9 7,9	TB- 9 10,12
	Channel 2	**C1 Pin**	55	44	77	48	57	46	79	50	61		75	73	74	52
		Function	Ph5	Ph6	Ph6	Ph6 CALL	Ph7	Ph8	Ph8	Ph8 CALL	Ph7			EVC	EVD	
		Field Term	TB-3 3,4	TB-3 7,8	TB-3 11,12	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-7 3,4	TB-7 7,8	TB-7 11,12			TB-9 5,6	TB-9 8,9	TB- 9 11,12

Table 925-5 Required Surge Arrestors for Model 332 Cabinet		
Field Terminal Block	**Terminals**	**Required Arrestor**
TB-8	1-12	Section 925.2.04.A.13.f
TB-9	10-12	Section 925.2.04.A.13.f
TB-9	4-9	Terminal Block only Section 925.2.04.A.13.f
TB-2, TB-3, TB-4, TB-5, TB-6, TB-7	1-12	Section 925.2.04.A.13.c



Note: For a typical signal installation, the Model 332 cabinet is the design standard.

Figure 925-2—Wiring Diagram for Dial-up Communications

Table 925-6 Model 336S Default Input File Assignment Detail

Slot		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Type		Det	Det	Det	Det	Det	Det	Det	Det	DC	TBA	TBA	DC	DC	DC
Channel 1	C1 Pin	56	39	58	41	55	40	57	42	51	71	72	67	68	81
	Function	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	Ph7	Ph8	SE1	EVA	EVB	Ph2 PED	Ph6 PED	FLASH
	Field Term	TB-7 1,2	TB-7 5,6	TB-7 9,10	TB-8 1,2	TB-8 5,6	TB-8 9,10	TB-9 1,2	TB-9 5,6	TB-5 1,2	TB- 5 5,6	TB- 5 9,10	TB- 4 1,2	TB- 4 5,6	NC
Channel 2	C1 Pin	47	43	49	45	48	44	50	46	52	73	74	69	70	82
	Function	Ph2 CALL	Ph2	Ph4 CALL	Ph4	Ph6 CALL	Ph6	Ph8 CALL	Ph8	R/R	EVC	EVD	Ph4 PED	Ph8 PED	STOP TIME
	Field Term	TB-7 3,4	TB-7 7,8	TB-7 11,12	TB-8 3,4	TB-8 7,8	TB-8 11,12	TB-9 3,4	TB-9 7,8	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-4 3,4	TB-4 7,8	NC

Table 925-7 Required Surge Arrestors for Model 336S Cabinet

Field Terminal Block	Terminals	Required Arrestor
TB-4	1-12	Section 925.2.04.A.13.f
TB-5	1-4	Section 925.2.04.A.13.f
TB-5	5-12	Terminal Block only Section 925.2.04.A.13.f
TB-7, TB-8, TB-9	1-12	Section 925.2.04.A.13.c

Table 925-8 Model 334 Default Input File Assignment Detail

Slot		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Type		Det	Det	Det	Det	Det	Det	Det	Det	Det	Det	Det	TBA	TBA	TBA
Channel 1	C1 Pin	46	50	49	55	51	57	59	61	81	79	53	41	43	45
	Function	L1 D1	L2 D2	L1 Q1	L3 Q3	L1 MLA	L2 MLA	L3 MLA	L4 MLA		L3 D3				
	Field Term	TB-2 1,2	TB-2 5,6	TB-2 9,10	TB-3 1,2	TB-3 5,6	TB-3 9,10	TB-4 1,2	TB-4 5,6	TB-4 9,10	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-6 1,2	TB-6 5,6
Channel 2	C1 Pin	39	47	48	56	52	58	60	62	80	82	54	40	42	44

	Function	L1 P1	L2 P2	L2 Q2		L1 MLB	L2 MLB	L3 MLB	L4 MLB		L3 P3				
	Field Term	TB-2 3,4	TB-2 7,8	TB-2 11,12	TB-3 3,4	TB-3 7,8	TB-3 11,12	TB-4 3,4	TB-4 7,8	TB-4 11,12	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-6 3,4	TB-6 7,8

Table 925-9 Required Surge Arrestors for Model 334 Cabinet

Field Terminal Block	Terminals	Required Arrestor
TB-2, TB-3, TB-4	1-12	Section 925.2.04.A.13.c
TB-5	1-4	Section 925.2.04.A.13.c

Table 925 - 10 Model 334 PDA Type 3 Output File

	SP 1					SP 2					SP 3				
	C1 Pin	**Out #**	**Conn**	**Func**	**Field Term**	**C1 Pin**	**Out #**	**Conn**	**Func**	**Field Term**	**C1 Pin**	**Out #**	**Conn**	**Func**	**Field Term**
SP R	2	0	C6-1	Warn 1	T4-7	4	2	C6-3	Lane 1 R	T4-4	7	5	C6-6	Lane 2 R	T4-1
SP Y	37	34	C6-9		T4-8	5	3	C6-4	Lane 1 Y	T4-5	8	6	C6-7	Lane 2 Y	T4-2
SP G	3	1	C6-2	Warn 2	T4-9	6	4	C6-5	Lane 1 G	T4-6	9	7	C6-8	Lane 2 G	T4-3

Table 925 - 11 Model 334 Auxiliary Output File

	SP 9					SP 10					SP 11				
	C1 Pin	Out #	Conn	Func	Field Term	C1 Pin	Ou t #	Conn	Func	Field Term	C1 Pin	Out #	Conn	Func	Field Term
SP R	97	53	C5-14	Lane 3 R	A124	94	50	C5-11	Not used	A121	91	48	C5-9	Not used	A114
SP Y	98	54	C5-15	Lane 3 Y	A125	95	51	C5-12	Not used	A122	101	37	C5-18	Not used	A115
SP G	99	55	C5-16	Lane 3 G	A126	96	52	C5-13	Not used	A123	93	49	C5-10	Not used	A116

	SP 12					SP 13					SP 14				
	C1 Pin	Out #	Conn	Func	Field Term	C1 Pin	Ou t #	Conn	Func	Field Term	C1 Pin	Out #	Conn	Func	Field Term
SP R	88	45	C5-6	Not used	A111	85	42	C5-3	Not used	A104	83	40	C5-1	Not used	A101
SP Y	89	46	C5-7	Not used	A112	86	43	C5-4	Not used	A105	100	36	C5-17	Not used	A102
SP G	90	47	C5-8	Not used	A113	87	44	C5-5	Not used	A106	84	41	C5-2	Not used	A103

925.2.05 Type ITS Cabinet Assemblies

A. Requirements

Ensure that the cabinet assembly meets the requirements of the CALTRANS Specifications as described in this document. In addition to the CALTRANS Specifications, ensure that the cabinet assembly conforms to the requirements listed below, which take precedence over conflicting CALTRANS Specifications.

1. Cabinet configuration:

   Supply cabinets in accordance with the following information and table 925-12.

   a. Cabinet Traffic Signal Application - Series 340
      - 340 - 4 Door Cabinet with “P” Base Ground Mount
      - 342 - 2 Door Cabinet with “170” Base (332) Ground Mount
      - 346 - 2 Door Cabinet with ”170” Base (336S), Adaptor Mount

   b. Cabinet Traffic Management Application - Series 350
      - 354 - 2 Door Cabinet with “170” Base (332) Ground Mount
      - 356 - 2 Door Cabinet with “170” Base (336S) Adaptor Mount

Table 925-12 ITS Cabinet Configurations					
Items	ITS Cabinet Versions				
	340	342	346	354	356
	Qty	Qty	Qty	Qty	Qty
Housing # 1/ Cage #1		1		1	
Housing # 2/Cage #2			1		1
Housing #3/Two Cage #1	1				
“J” Panel Cage #1	4	2		2	
“J” Panel Cage #2			2		2
Service Panel Assembly with AC -/EG Bus	1	1	1	1	1
Raw/Clean AC power Assembly	1	1	1	1	1
Raw Clean AC power Extension	1				
AC Clean Module Assembly	1				
DC Power/Comm Assembly	2	1	1	1	1
DC Power/Comm Extension	2	1		1	1
Cabinet Shelf Assembly	2	1	1	1	1
Input Assembly	3	2	1	1	1
Six Pack Output Assembly	1			1	1
Fourteen Pack output Assembly	1	1	1		
PDA ITS Assembly	1	1	1	1	1
Control/Serial Bus harness	8	6	4	4	4
Serial Bus 3 Harness	3	1	1	1	1

NOTE: Input Assembly shall include a Model 218 SIU. Output Assembly shall include a Model 218 SIU, Model 214 AMU and Model 205 Transfer Relays. The PDA ITS (Traffic Signal Application) shall include two Model 204 Flasher Units, Model 212 CMU and two Model 216 Power Supply Units and attached harnesses. The PDA ITS (Traffic Management System Application) shall include Model 212 CMU and two Model 216 Power Supply Units and attached harnesses.

c. Model 340 Cabinet:

Field termination panels

9 – Flash Transfer Relays

2 – Model 204 Flashers

Specific Equipment Layout and other cabinet devices determined on a project specific basis

d. Model 342 Cabinet:

1-Model 242 DC Isolator

6- Flash Transfer Relays

2-Model 204 Flashers

e. Model 346 Cabinet

1-Model 242 DC Isolator

6-Flash Transfer Relays

2-Model 204 Flasher

1-"M" Base Adapter installed (Base Mount Cabinets Only)

1-Aluminum Cover Plate for Cabinet Bottom (Pole Mount Cabinets Only)

f. Model 354 Cabinet:

Specific Equipment Layout and additional cabinet equipment determined on a project specific basis.

g. Model 356 Cabinet

Specific Equipment Layout and additional cabinet equipment determined on a project specific basis.

1-"M" Base Adapter installed (Base Mount Cabinets Only)

1-Aluminum Cover Plate for Cabinet Bottom (Pole Mount Cabinets Only)

NOTE: Include above components in cabinet at time of delivery.

Other auxiliary cabinet components such as controllers, load switches, etc. will be ordered as separate items.

2. Finish

Use cabinets that have a bare aluminum finish (see Subsection 925.2.06.A.1 for controller-cabinet minimum fabrication specifications).

3. Locks

Equip the main cabinet door with locks that accept No. 2 Corbin keys. Provide two sets of keys with each cabinet. One set of keys is defined as one – No. 2 key and one - police panel key.

4. Power

Equip the cabinet assemblies with an ITS power distribution assembly to generate AC and DC power for the electronic components, except the DC power for the controller units.

5. Mounting

Equip the cabinets for pole or base mounting, as specified in the Plans.

a. Base Mount

Supply Model 346 and 356 cabinets, when specified as base mount, with a “M” base-mounting adapter installed.

b. Pole Mount

Supply Model 346 and 356 cabinets, when specified as pole mount, with two exterior pole mounting brackets that allow for mounting on steel, concrete, and timber poles.

Ensure that the bracket mounting holes are properly reinforced with metal plates of adequate size and strength, welded longitudinally across the inside depth of the cabinet.

Ensure that the exterior-mounting bracket is shipped installed on the cabinet housing. Additionally, provide an aluminum plate, which covers the bottom cabinet opening.

6. Cabinet Light

Include in each cabinet one fluorescent strip lighting fixture mounted inside the top front portion of the cabinet. Do not use a screw in type fluorescent lamp.

The fixture includes a cool white lamp, covered, and operated by a normal power factor, UL listed ballast.

Install a door-actuated switch to turn on the cabinet light when either door is opened.

7. Cabinet Interlock

Do not install the interlock circuit, as detailed in the CALTRANS Specifications.

8. Cabinet Drawer

Equip each Model 340, 342, 346, 352 and 356 cabinet with an aluminum storage compartment mounted in the rack assembly with the approximate following dimensions: 16 inches (400 mm) wide, 14 inches (350 mm) long, and 1.75 inches (44 mm) deep.

Mount this compartment directly under the Type 2070 controller. Provide a drawer with telescoping drawer guides to allow full extension from the rack assembly.

When extended, the storage compartment opens to provide storage space for cabinet documentation and other miscellaneous items.

Ensure that the storage compartment be of adequate construction to support a weight of 25 pounds (12 kg) when extended.

Provide a top for the storage compartment that has a non-slip plastic laminate attached, which covers a minimum of 90% of the surface area of the top.

9. Test Program

Supply each cabinet with a diagnostic test program, which verifies the operation of the cabinet. Ensure that the program can test cabinet wiring related to the output file, input file, and police panel and flash switches. In addition, ensure that the program can check the operation of the SIU, AMU and CMU by generating all possible conflicts, in sequence,

10. Surge Protection

Equip each cabinet with devices to protect the control equipment from surges and over voltages.

Design the surge protector panels to allow for adequate space for a wire connection and surge protector replacement without the removal of terminal blocks or panels. Provide surge protectors for the input sections as detailed below and as shown in the Input Terminal and Surge Arrestor Detail.

Supply surge protectors that meet the following Specifications.

a. AC Service Input

Include a surge protection unit for each cabinet on the AC service input that meets or exceeds the following requirements:

- Provide a hybrid type power line surge protection device on a service panel which plugs into a 12 pin Beau Connector which mounts on a service panel.

  Install the protector between the applied line voltage and earth ground. Use a surge protector capable of reducing the effect of lightning transient voltages applied to the AC line that conforms to the following:

Peak surge current for an 8 x 20 ms waveform:	20,000A for 20 occurrences
Clamp voltage @ 20,000A	280V max
Maximum continuous operating current:	@ 120V / 60 Hz 10A
Series Inductance:	AC Line/AC Neutral - 200 microhenries
Response time:	Voltage never exceeds 280V during surge
Spike suppression for +/- 700 V spike:	+/- 40 V deviation from sine wave at all phases angles between 0 and 180 degrees.

- Provide a protector with the following terminals:
  - Main Line (AC line first stage terminal)
  - Main Neutral (AC neutral input terminal)
  - Equipment Line In (AC line second stage input terminal, 10A)

    - Equipment Line Out (AC line second stage output terminal, 10A)
    - Equipment neutral out (neutral terminal to protected equipment)
    - GND (Earth connection)
- Supply a protector that is epoxy encapsulated in a flame-retardant material.
- Configure the Equipment Line Out to provide power to the Type 2070 and to the 24 V power supply.

b. Inductive Loop Detector Inputs

Protect each inductive loop detector channel input by an external surge protection device that meets or exceeds the following requirements:

- A three-terminal device, two (2) of which are connected across the signal inputs of the detector with the third connected to the chassis ground to protect against common mode damage.
- Instantly clamps differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array appears as a low capacitance to the detector.
- Clamps common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.
- Withstand 25-100A surge current occurrences of a 10 x 700 µs waveform.
- Have the following clamp characteristics:

Maximum break over voltage:	170 V
Maximum on-stage clamping voltage:	3V
Response Time:	<5 ns
Off-stage leakage current:	<10 µA
Capacitance:	less than 220 pf

- Ensure that the unit also meets the following minimum requirements:

Peak surge current:	6 times
Differential mode:	400 A (8 x 20 ms)
Common mode:	1,000 A (8 x 20 ms)
Estimated occurrences:	500 @ 200 A
Response time:	40 ns
Input capacitance:	35 pF typical
Temperature:	-40° F to +185° F (-40º C to 85º C)
Mounting:	No. 10-32 x 3/8-inch (No. 5 x 10 mm) bolt
Clamp voltage	
@400 A diff. Mode:	30 V max.
@1,000 A comm. Mode:	30 V max.

c. Signal Load Switches (Switchpacks)

Provide the output of the switchpack in the output file with transient protection via the nine position transient protection device in the output file. Protect switchpacks from surges on the AC output lines.

Ensure that the transient protectors meet or exceed these requirements:

- Steady state sinusoidal voltage (RMS) rating at 50 to 60 Hz of at least 150 V at 77 ºF (25 °C)
- Steady state applied DC voltage rating of at least 200 V at 77 ºF (25 °C)

- Transient energy rating is of at least 80 J for a single impulse of 10/1,000 µs current waveform at 77 ºF (25 °C)
- Peak current rating of 6,500 A for a single impulse of 8/20 µs waveform with the rated continuous voltage applied
- Varistor voltage of at least 212 V at 1.0mA of DC current applied for the duration of 20 µs to 5s
- Clamping voltage of at least 395 V with an applied 8/20 µs impulse of 100 A
- Typical capacitance at a frequency of 0.1 to 1.0 MHz of 1600 pF
- Two-terminal device, one of which is connected to the AC output of the signal load switch on the output file terminals (backside of the field terminals) with the other connected to AC neutral

d. Communication Inputs

Protect low voltage communications input as it enters the cabinet with a solid-state surge protection unit that meets or exceeds these requirements:

- Dual pair (4-wire) module with a printed circuit board connector, double sided and gold plated for reliability
- Ability to mate with and be installed in a 10-circuit Buchanan connector Part Number PCBIB10S or Tyco Part Number 2-1437410-3 or equivalent
- Usable as two independent signal pairs
- The data circuits pass through the protection in a serial fashion
- C2 connector of the 2070 controller that terminates on the line side of the unit
- Communication field wires for this local side that terminate on the line side of the unit
- Ground terminals connected to power ground
- Ensure that the unit meets the following minimum requirements:

Peak surge current:	10 kA (8 x 20 µs wave shape)
	500A (10 x 700 µs wave shape)
Occurrences @ peak:	50 typical
Response time:	<1ns
Voltage Clamp:	8V line to line
Series Resistance:	24 Ω total
Temperature	-40 oF (-40º C) to +185º F (85º F)
Primary protector:	3 element gas tube 5kA, (8 x 20µs wave shape), per side
Secondary protector:	Silicon avalance, 1.5 kW minimum

e. Low Voltage DC Inputs

Provide an external surge protection device for each low voltage DC input channel which meets the same requirements as the communication inputs with the following exception of the Voltage clamp, which shall be 30 V line-to-line.

11. Type 212 ITS Cabinet Monitor Unit

a. Introduction

Supply each cabinet with Type 212 ITS Cabinet Monitor Unit (CMU). Ensure the Type 212 CMU meets the CALTRANS TEES Specifications and functions as a unit with the a Type 214 Auxiliary Monitor Unit to provide the following monitoring functions: Cabinet Power Supplies,; Conflicting Channel Monitor, Serial Bus1 and 3 Error; Message 62; Diagnostic Error; Multiple Channel Inputs; Lack of Signal Inputs; Yellow Clearance; Yellow plus Red Clearance; Police and Power Distribution Switch Monitor; door Switches and Main Contactor Status; Circuit Breakers;

Flash Unit Output Status; and AC Line Level Sense. Ensure the Unit supplied is listed on the most recent California Department of Transportation Qualified Products List (QPL).

b. Configuration

Supply Type 212 CMU capable of monitoring up to 28 physical load switch channels (RYG) plus 4 virtual channels for a total of 32 channels.

c. Programming

Ensure complete programming of the Type 212 CMU is by an interchangeable Datakey nonvolatile memory device. The Datakey shall store all of the configuration parameters. Ensure the programming of the datakey can easily be accomplished by a PC and provide datakey and programming device with the delivery of the first unit ordered. Orders of multiple ITS cabinets require delivery or 1 programming device with PC software for every 10 cabinets.

d. Logging

Ensure the Type 212 CMU maintains a non volatile event log recording. The complete intersection status as well as previous fault events, AC Line events, configuration changes, monitor resets, cabinet temperature and true RMS voltages for all field inputs. A real time clock time shall stamp each log event with the time and date.

Ensure a Signal Sequence History Log is stored in nonvolatile memory. The information stored in the signal sequence log shall provide graphic displays of up to 30 seconds of signal status prior to the fault trigger event with 50 ms resolution.

The Type 212 CMU shall be provided with PC Software that allows a review of status, event log review and archival.

12. Type 214 ITS Auxiliary Monitor Unit

a. Introduction

Supply each ITS cabinet output assembly with a Type 214 ITS Auxiliary Monitor Unit (AMU). Ensure the Type 214 CMU meets the CALTRANS TEES Specifications and functions with the a Type 212 Cabinet Monitor Unit to provide cabinet monitoring functions to perform the following monitoring functions: Cabinet Power Supplies, Conflicting Channel Monitor, Serial Bus 1 and 3 Error; Message 62; Diagnostic Error; Multiple Channel Inputs; Lack of Signal Inputs; Yellow Clearance; Yellow plus Red Clearance; Police and Power Distribution Switch Monitor; door Switches and Main Contactor Status; Circuit Breakers; Flash Unit Output Status; and AC Line Level Sense. Ensure the Unit supplied is listed on the most recent California Department of Transportation Qualified Products List (QPL). The Type 214 AMU shall provide the field signal sensing.

b. Current Monitoring

Supply Type 214 AMU capable of operating in a 14 channel mode or a 6 channel mode. Ensure the address select is correct for the output assembly in which the Model 214 AMU is installed.

c. Diagnostics

Ensure the Type 214 AMU has self diagnostic tests that execute continuously to provide for correct operation to properly monitor the current for use with LED signal heads.

13. Type 218 ITS Serial Interface Unit

a. Introduction

Supply each input and output assembly with a Type 218 ITS Serial Interface Unit (SIU). Ensure the Type 218 ITS SIU supplied meets the CALTRANS TEES Specifications. Ensure the Unit supplied is listed on the most recent California Department of Transportation Qualified Products List (QPL). The Type 218 ITS SIU shall provide the interface between the 2070 controller and the input and output files.

b. Configuration

Supply Type 218 SIU capable of operating in all input and output modes. Provide a Model 218 SIU that is configured correctly for the input or output file for which it is supplied.

c. Programming

Ensure programming of the Type 218 SIU is programmed by assembly mounted address jumpers and that no other setup is required.

d. Diagnostics

Ensure the Type 218 SIU supplied has a complete set of internal diagnostics self-tests run continuously to monitor critical components of the unit. Provide unit with a front panel LED indicator that can be used to report the current Input/Output assembly address assignment of the unit for cabinet configuration verification. Ensure unite has a diagnostic EIA-232 port on the front panel to interface with the SIU 218 functions.

14. Model 242 DC Isolator

Provide Model 242 DC Isolators that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section. Provide isolators that:

- Allow 242 isolator input signal polarity to easily be inverted without the use of tools. Acceptable methods are removable jumpers or dip switches. Unacceptable methods are soldering or desoldering a diode or resistor.
- Output is OFF for input voltages greater than 12 volts;
- Output is ON for voltages of less than 8 volts that have a duration of at least 5 to 25 ms (optional 2-7 ms);
- Minimum output pulse width is 100 ms with a valid input (can be disabled);
- Output is optically isolated open collector NPN transistor;
- Capable of sinking 50 ma when on;
- Can register a new input within 25 ms of the old signal going away; and
- Output clamped on power up and down

15. Model 200 Switchpack

Provide Model 200 Switchpacks that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

16. Model 204 Flasher Unit

Provide Model 204 Flasher Units that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

17. Flash Transfer Relay

Provide Flash Transfer Relays that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

18. Cabinet Model 342

Provide Cabinet Model 342 that meets the CALTRANS Specification with the addition of surge protection as detailed in Table 925-13 Model 342 ITS Cabinet Default Input Files Assignment Detail, Table 925-14 Required Surge Arrestors for Model 342 ITS Cabinet, and Table 925-15 Model 342 & 346 ITS Cabinet Default Output File Assignment Detail.

Supply Model 342 with lower input panel cabinets, with housing Type 1, and all components as described in these Specifications.

Supply cabinets having two input files which conform to the CALTRANS Specifications and configured to accept two 2070 controllers in the top portion of the cabinet.

Configure the cabinet for dial up communications. Mount a two (2) circuit Buchanan connector on the right side panel (from rear door).

Mount a phone jack with a RJ11 connector above or to the right of the Buchanan terminal block.

Wire the phone jack to the Buchanan and to the Terminal Block (TB0) in accordance with Figure 925-3.

19. Cabinet Model 346 (Base Mount)

    This unit meets the CALTRANS Specification with the addition of approximately 6 additional inches (150 mm) of cabinet height exclusive of the "M" base adapter. Configure the internal component layout so that the additional space is available in the bottom area of the cabinet cage. Ensure that the field wiring input panels and surge protection conform to Table 925-16 Model 346 ITS Cabinet Default Input File Assignment Detail, Table 925-17 Required Surge Arrestors for Model 346 Cabinet, and Table 925-15 Model 342 & 346 Default ITS Cabinet Default Output File Assignment.

20. Cabinet Model 346 (Pole Mount)

    Ensure that this unit meets the requirements of Subsection 925.2.04.A.19 above, except that the cabinet is configured for pole mounting as specified in the General Requirements for Type ITS Cabinet Assemblies.

21. Cabinet Model 340

    The Model 340 cabinet configuration will be determined by the special provisions of the project.

    Ensure that the input and output port assignments are compatible with the 2070 controller as applicable according to the required number of input/outputs. Ensure that the 340 cabinet uses standard ITS cabinet input and output file units.

    Equip the cabinet with a C2 connector harness with field terminals protected with surge protectors for communication inputs as specified under communications inputs.

    Ensure that the cabinet has four full-size doors to allow complete access from the front or back of the cabinet. Design the rack assembly to mount in CALTRANS standard rails to allow for a Model 204 flasher.

    Provide a receptacle to accept the plug in power distribution assembly card guides and edge connectors for the input file card guides to support the conflict monitor, and load switches and flash transfer relays.

B. Fabrication

Refer to Subsection 925.2.07.A.1 for controller cabinet minimum fabrication Specifications.

C. Acceptance

Refer to Subsection 925.2.02.A for compliance with CALTRANS QPL.

D. Materials Warranty

Refer Subsection 925.2.01.D for Materials Warranties.

Table 925 – 13 Model 342 ITS Cabinet Default Input Files Assignment Detail

Input File	Chan	Item	File Slot 1	2	3	4	5	6	7	8	9	10	11	12
		SIU Pin	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
		SIU Byte,Bit	2,6	3,0	3.2	3,4	3,6	4,0	4,2	4,4	4,6	5,0	5,2	5,4
		SIU Input #	7	9	11	13	15	17	19	21	23	25	27	29
	Upper	***2070 Input #***	17	0	28	8	22	6	43	25	51	32	12	38
		2070 Port	3.2	1.1	4.5	2.1	3.7	1.7	6.4	4.2	7.4	5.1	2.5	5.7
		Function	Ph 1 Det	Ph 2 Det	Ph 2 Det	Ph 2 Det	Ph 3 Det	Ph 4 Det	Ph 4 Det	Sp Det 1	Sp Det 5	Pd 2 Det	Pre 1	Pre 5
		Field Term	TB-2 1,2	TB-2 5,6	TB-2 9,10	TB-4 1,2	TB-4 5,6	TB-4 9,10	TB-6 1,2	TB-6 5,6	TB-6 9,10	TB-8 4,6	TB-9 10,12	TB-9 5,6
		SIU Pin	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
		SIU Byte,Bit	2,7	3,1	3,3	3,5	3,7	4.1	4,3	4,5	4,7	5,1	5,3	5,5
		SIU Input #	8	10	12	14	16	18	20	22	24	26	28	30
1	***Lower***	***2070 Input #***	21	4	41	19	2	30	10	53	52	34	13	39
		2070 Port	3.6	1.5	6.2	3.4	1.3	4.7	2.3	7.6	7.5	5.3	2.6	5.8
		Function	Ph 1 Det	Ph 2 Det	Ph 2 Det	Ph 3 Det	Ph 4 Det	Ph 4 Det	Ph 4 Det	Sp Det 2	Sp Det 6	Pd 4 Det	Pre 2	Pre 6
		Field Term	TB-2 3,4	TB-2 7,8	TB-2 11,12	TB-4 3,4	TB-4 7,8	TB-4 11,12	TB-6 3,4	TB-6 3,4	TB-6 11,12	TB-8 5,6	TB-9 11,12	TB-9 8,9
		SIU Pin	B25	A26	B26	A27								
		SIU Byte,Bit	8,7	9,0	9,1	9,2								
	Opto	***SIU Input #***	Opto In 1	Opto In 2	Opto In 3	Opto In 4								
	Inputs	***2070 Input #***	46	14	47	45								
		2070 Port	6.7	2.7	6.6	6.8								
		Function	Flsh Sen	MCE	Int Adv	S T								
		SIU Pin	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
		SIU Byte,Bit	2,6	3,0	3.2	3,4	3,6	4,0	4,2	4,4	4,6	5,0	5,2	5,4

		SIU Input #	7	9	11	13	15	17	19	21	23	25	27	29
	Upper	***2070 Input #***	16	1	29	9	18	7	44	54	49	33	36	15
		2070 Port	3.1	1.2	4.6	2.2	3.3	1.8	6.5	7.7	7.2	5.2	5.5	2.8
		Function	Ph 5 Det	Ph 6 Det	Ph 6 Det	Ph 6 Det	Ph 7 Det	Ph 8 Det	Ph 8 Det	Sp Det 3	Sp Det 7	Pd 6 Det	Pre 3	Spare 1
		Field Term	TB-3 1,2	TB-3 5,6	TB-3 9,10	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-7 1,2	TB-7 5,6	TB-7 9,10	TB-8 7,9	TB-9 4,6	TB-8 1,3
		SIU Pin	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
		SIU Byte,Bit	2,7	3,1	3,3	3,5	3,7	4.1	4,3	4,5	4,7	5,1	5,3	5,5
		SIU Input #	8	10	12	14	16	18	20	22	24	26	28	30
2	***Lower***	***2070 Input #***	20	5	42	18	3	31	11	55	50	35	37	40
		2070 Port	3.5	1.6	6.3	3.3	1.4	4.8	2.4	7.8	7.3	5.4	5.6	6.1
		Function	Ph 5 Det	Ph 6 Det	Ph 6 Det	Ph 7 Det	Ph 8 Det	Ph 8 Det	Ph 8 Det	Sp Det 4	Sp Det 8	Pd 8 Det	Pre 4	Spare 2
		Field Term	TB-3 3,4	TB-3 7,8	TB-3 11,12	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-7 3,4	TB-7 7,8	TB-7 11,12	TB-8-8,9	TB-9 7,9	TB-8 2,3
		SIU Pin	B25	A26	B26	A27								
		SIU Byte,Bit	8,7	9,0	9,1	9,2								
	Opto	***SIU Input #***	Opto In 1	Opto In 2	Opto In 3	Opto In 4								
	Inputs	***2070 Input #***	NA	NA	NA	NA								
		2070 Port												
		Function												

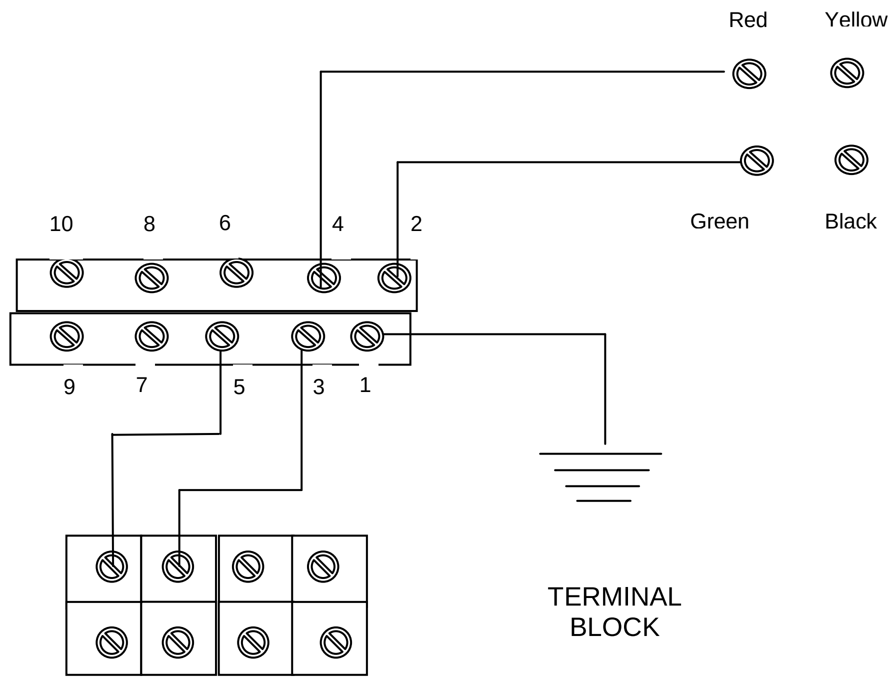
Table 925 – 14 Required Surge Arrestors for Model 342 ITS Cabinet

Field Terminal Block	Terminals	Required Arrestors for Model 342 Cabinet
TB - 8	1-12	Section 925.2.05.A.10.f
TB - 9	10-12	Section 925.2.05.A.10.f
TB - 9	4-9	Section 925.2.05.A.10.f
TB - 2, TB - 3, TB - 4, TB - 5, TB - 6, TB - 7	1-12	Section 925.2.05.A.10.c

Table 925 - 15 Model 342 & 346 ITS Cabinet Default Output File Assignment Detail

Item	Switch Pack													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SIU Pin	A2	B3	A5	B6	A8	B9	A11	B12	A14	B15	A17	B18	A20	B21
SIU Byte, Bit	2,0	2,3	2,6	3,1	3,4	3,7	4,2	4,5	5,0	5,3	5,6	6,1	6,4	6,7
SIU Output #	1	4	7	10	13	16	19	22	25	28	31	34	37	40
2070 Output #	13	10	8	5	2	0	29	26	24	21	18	16	53	50
2070 Output Port	2.6	2.3	2.1	1.6	1.3	1.1	4.6	4.3	4.1	3.6	3.3	3.1	7.6	7.3
AMU Pin	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29
AMU Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Field Term	TR-1 1,2	TR-2 1,2	TR-3 1,2	TR-4 1,2	TR-5 1,2	TR-6 1,2	TR-7 1,2	TR-8 1,2	TR-9 1,2	TR-10 1,2	TR-11 1,2	TR-12 1,2	TR-13 1,2	TR-14 1,2
Function	Ph 1 Rd	Ph 2 Rd	Pd 2 DW	Ph 3 Rd	Ph 4 Rd	Pd 4 DW	Ph 5 Rd	Ph 6 Rd	Pd 6 DW	Ph 7 Rd	Ph 8 Rd	Pd 8 DW	Ov A Rd	Ov B Rd
SIU Pin	B2	A4	B5	A7	B8	A10	B11	A13	B14	A16	B17	A19	B20	A22
SIU Byte, Bit	2,1	2,4	2,7	3,2	3,5	4,0	4,3	4,6	5,1	5,4	5,7	6,2	6,5	7,0
SIU Output #	2	5	8	11	14	17	20	23	26	29	32	35	38	41
2070 Output #	14	11	32	6	3	34	30	27	33	22	19	35	54	51
2070 Output Port	2.7	2.4	5.1	1.7	1.4	5.3	4.7	4.4	5.2	3.7	3.4	5.4	7.7	7.4
AMU Pin	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27	B28	B29
AMU Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Field Term	TR-1 3,4	TR-2 3,4	TR-3 3,4	TR-4 3,4	TR-5 3,4	TR-6 3,4	TR-7 3,4	TR-8 3,4	TR-9 3,4	TR-10 3,4	TR-11 3,4	TR-12 3,4	TR-13 3,4	TR-14 3,4
Function	Ph 1 Yel	Ph 2 Yel	Pd 2 PC	Ph 3 Yel	Ph 4 Yel	Pd 4 PC	Ph 5 Yel	Ph 6 Yel	Pd 6 PC	Ph 7 Yel	Ph 8 Yel	Pd 8 PC	Ov A Yel	Ov B Yel
SIU Pin	A3	B4	A6	B7	A9	B10	A12	B13	A15	B16	A18	B19	A21	B22
SIU Byte, Bit	2,2	2,5	3,0	3,3	3,6	4,1	4,4	4,7	5,2	5,5	6,0	6,3	6,6	7,1
SIU Output #	3	6	9	12	15	18	21	24	27	30	33	36	39	42
2070 Output #	15	12	9	7	4	1	31	28	25	23	20	17	55	52
2070 Output Port	2.8	2.5	2.2	1.8	1.5	1.2	4.8	4.5	4.2	3.8	3.5	3.2	7.8	7.5
AMU Pin	A16	A17	A18	A19	A20	C21	C22	C23	A24	A25	A26	A27	A28	A29

AMU Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Field Term	TR-1 5,6	TR-2 5,6	TR-3 5,6	TR-4 5,6	TR-5 5,6	TR-6 5,6	TR-7 5,6	TR-8 5,6	TR-9 5,6	TR-10 5,6	TR-115,6	TR-12 5,6	TR-13 5,6	TR-14 5,6
Function	Ph 1 Grn	Ph 2 Grn	Pd 2 W	Ph 3 Grn	Ph 4 Grn	Pd 4 W	Ph 5 Grn	Ph 6 Grn	Pd 6 W	Ph 7 Grn	Ph 8 Grn	Pd 8 W	O A Grn	O B Grn



Note: For a typical signal installation, the Model 342 cabinet is the design standard.

Figure 925-3—Wiring Diagram for Dial-up Communications

Table 925 – 16 Model 346 ITS Cabinet Default Input Files Assignment Detail

Input File	Channel	Item	File Slot 1	2	3	4	5	6	7	8	9	10	11	12
1	Upper	**SIU Pin**	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
		SIU Port	2,6	3,0	3.2	3,4	3,6	4,0	4,2	4,4	4,6	5,0	5,2	5,4
		SIU In #	7	9	11	13	15	17	19	21	23	25	27	29
		2070 In #	17	0	19	2	16	1	18	3	12	36	32	33
		2070 Port	3.2	1.1	3.4	1.3	3.1	1.2	3.3	1.4	2.5	5.5	5.1	5.2
		Function	Ph 1 Det	Ph 2 Det	Ph 3 Det	Ph 4 Det	Ph 5 Det	Ph 6 Det	Ph 7 Det	Ph 8 Det	Pre 1	Pre 3	Pd 2 Det	Pd 6 Det
		Fld Term	T-7 1,2	T-7 5,6	T-7 9,10	T-8 1,2	T-8 5,6	T-8 9,10	T-9 1,2	T-9 5,6	T-5 1,2	T-5 5,6	T-4 1,2	T-4 5,6
	Lower	**SIU Pin**	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19
		SIU Port	2,7	3,1	3,3	3,5	3,7	4.1	4,3	4,5	4,7	5,1	5,3	5,5
		SIU In #	8	10	12	14	16	18	20	22	24	26	28	30
		2070 In #	8	4	10	6	9	5	11	7	13	37	34	35
		2070 Port	2.1	1.5	2.3	1.7	2.2	1.6	2.4	1.8	2.6	5.6	5.3	5.4
		Function	Ph 2 Det	Ph 2 Det	Ph 4 Det	Ph 4 Det	Ph 5 Det	Ph 6 Det	Ph 7 Det	Ph 8 Det	Pre 2	Pre 4	Pd 4 Det	Pd 8 Det
		Fld Term	T-7 3,4	T-7 7,8	T-7 11,12	T-8 3,4	T-8 7,8	T-8 11,12	T-9 3,4	T-9 7,8	T-5 3,4	T-5 7,8	T-4 3,4	T-4 7,8
	Opto	**SIU Pin**	B25	A26	B26	A27								
		SIU Port	8,7	9,0	9,1	9,2								
		SIU In #	Opto In 1	Opto In 2	Opto In 3	Opto In 4								
		2070 In #	46	14	47	45								
		2070 Port	6.7	2.7	6.6	6.8								
		Function	Flsh Sen	MCE	Int Adv	S T								

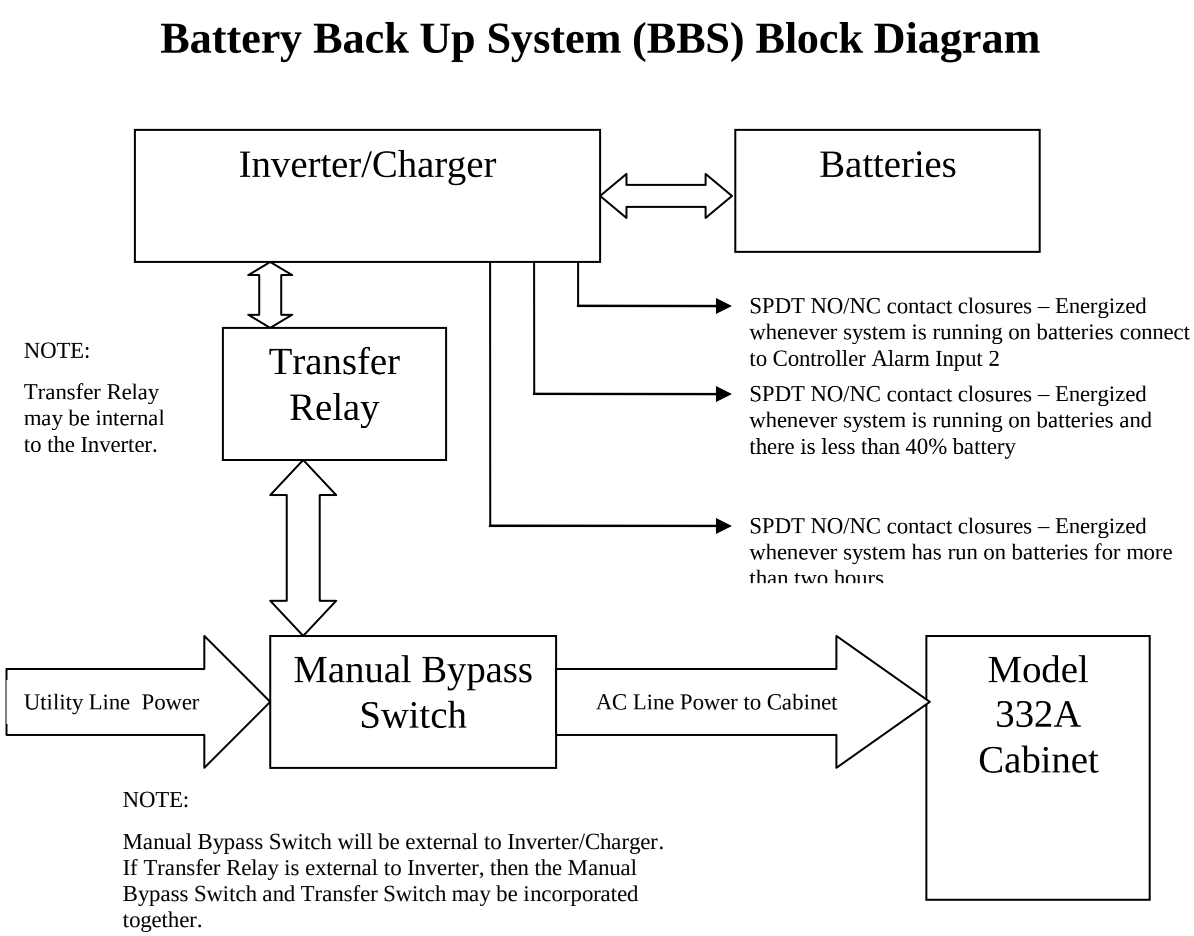
Table 925 – 17 Required Surge Arrestors for Model 346 ITS Cabinet		
Field Terminal Block	**Terminals**	**Required Arrestors for Model 346 Cabinet**
TB – 4	1-12	Section 925.2.05.A.10.f
TB - 5	1-4	Section 925.2.05.A.10.f
TB - 5	5-12	TERMINAL BLOCK Only Section 925.2.05.A.10.f
TB - 7, TB - 8, TB – 9	1-12	Section 925.2.05.A.10.c

925.2.06 Battery Backup System

A. **Requirements**

This specification is for establishing the minimum requirements for a complete emergency battery backup system for use with Light Emitting Diode Traffic Signal Modules at intersections with 332 cabinets. The Battery Backup System (BBS) shall include, but not be limited to the following: Inverter/Charger, Power Transfer Relay, Batteries, a separate manually operated non-electric Bypass Switch and all necessary hardware and interconnect wiring. The BBS shall be capable of providing power for full run-time operation for an “LED –only” intersection (all colors: red, yellow, green and pedestrian heads) or flashing mode operation and intersection Red LED’s. The BBS shall be designed for outdoor applications, in accordance with the CALTRANS TEES.

Figure 925-4 Battery Backup Block Diagram



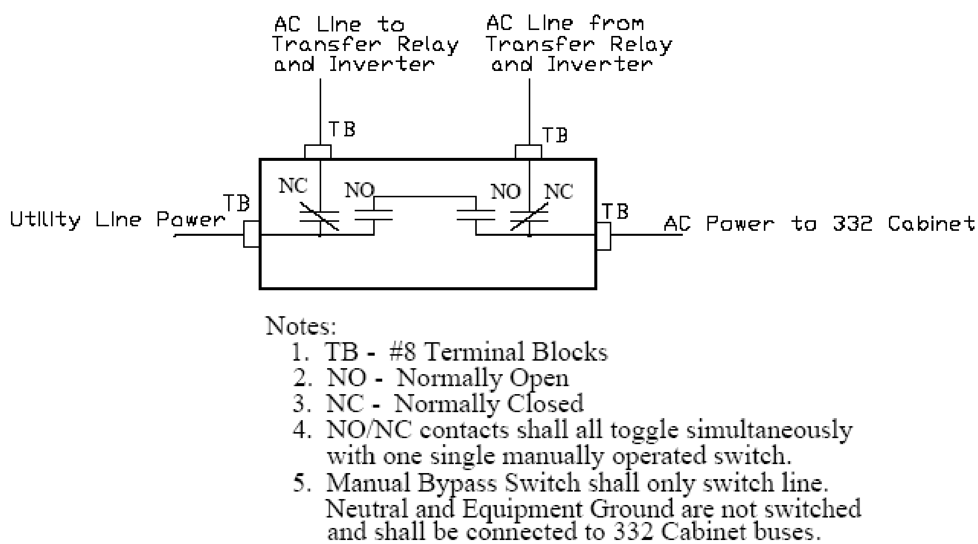
1. Operation:

   a. The BBS shall provide a minimum two (2) hours of full run-time operation for an “LED-only” intersection (minimum 700W/1000VA active output capacity, with 80% minimum inverter efficiency).

b. The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 65 milliseconds. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

c. The BBS shall include a Manual Bypass Switch which provides capability to transfer the power service to disable the BBS and operate only from the power service provided. The Manual Bypass Switch shall be as shown in Figure 925-5.

Figure 925 – 5 Manual Bypass Switch (Shown in normal BBS Mode)



d. The BBS shall provide the user with 3-sets of normally open (NO) and normally closed (NC) single-pole double-throw (SPDT) dry relay contact closures, available on a panel-mounted terminal block, rated at a minimum 120V/1A, and labeled so as to identify each contact. For typical configuration, see Figure 925-6.

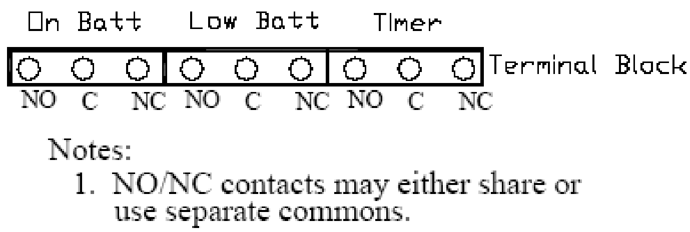
1) The first set of NO and NC contact closures shall be energized whenever the unit switches to battery power. Contact shall be labeled or marked “On Batt.”

2) The second set of NO and NC contact closures shall be energized whenever the battery approaches approximately 40% of remaining useful capacity. Contact shall be labeled or marked “Low Batt.”

3) The third set of NO and NC contact closures shall be energized two hours after the unit switches to battery power. Contact shall be labeled or marked “Timer.”

4) Relay contact activation shall be annunciated on the front panel via a visual indication. This can be either discreet LED, or part of LCD screen, etc.

Figure 925 – 6 Relay Contacts (NO/NC) available on panel-mounted terminal block (typ)



e. Operating temperature for both the inverter/charger, power transfer relay and manual bypass switch shall be –37 °C (-35F) to +74 °C (+165 F).

f. Both the Power Transfer Relay and Manual Bypass Switch shall be rated at 240VAC/30 amps, minimum

g. The BBS shall use a temperature-compensated battery charging system. The charging system shall compensate over a range of 2.5 – 4.0 mV/ °C (5-8 F) per cell. The temperature sensor shall be external to the inverter/charger unit. The temperature sensor shall come with 3 meters (10 feet) of wire.

h. Batteries shall not be recharged when battery temperature exceeds 50 °C (122 F) ± 3 °C (6 F).

i. BBS shall bypass the utility line power whenever the utility line voltage is outside of the following voltage range: 100VAC to 130VAC (± 2VAC).

j. When utilizing battery power, the BBS output voltage shall be between 110 VAC and 125 VAC, pure sine wave output, ? 3% THD, 60Hz ± 3Hz.

k. BBS shall be compatible with CALTRANS Model 332A Cabinets, Model 170E Controllers, Model 2070 Controllers and cabinet components for full time operation.

l. In cases of low (below 98VAC) or absent utility line power, when the utility line power has been restored at above 105 VAC ± 2 VAC for more than 30 seconds, the BBS shall transfer from battery backed inverter mode back to utility line mode.

m. In cases of high utility line power (above 132VAC), when the utility line power has been restored at below 125VAC ± 2 VAC for more than 30 seconds, the BBS shall transfer from battery backed inverter mode back to utility line mode.

n. BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service.

o. In the event of inverter/charger failure, battery failure or complete battery discharge, the power transfer relay shall revert to the NC (and de-energized) state, where utility line power is connected to the cabinet.

p. Recharge time for the battery, from “protective low-cutoff” to 80% or more of full battery charge capacity, shall not exceed twenty (20) hours.

2. Mounting/Configuration

NOTE: All references made to EIA rail or EIA 19” (482.6mm) rack shall conform to Electronic Industries Standards EIA-310-B, Racks, Panels, and Associated Equipment, with 10-32 “Universal Spacing” threaded holes.

a. General

1) Inverter/Charger Unit shall be shelf-mounted or rack-mounted on a standard EIA 19” rack. If the inverter/charger is mounted inside the 332A Cabinet (Configuration 1), a shelf shall be provided that supports the weight of the unit.

2) Power Transfer Relay and Manual Bypass Switch shall be mounted on EIA rail.

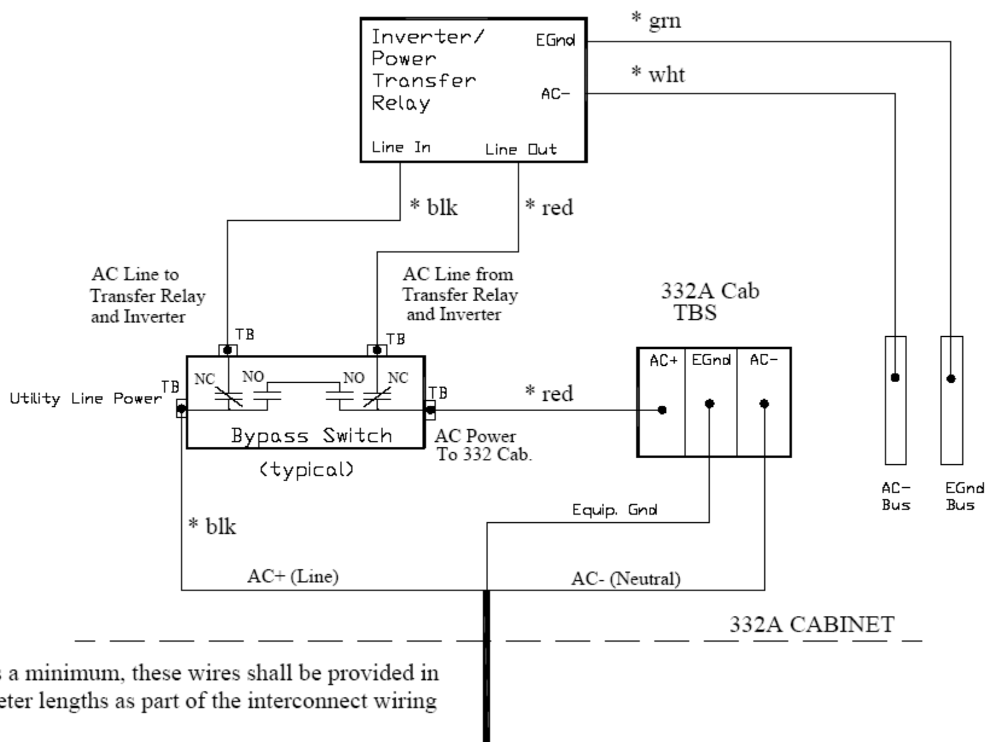
3) All interconnect wiring shall be provided between Power Transfer Relay, Bypass Switch and Cabinet Terminal Service Block and shall be no less than 3 meters (9’10”) of UL Style 1015 CSA TEW with the following characteristics:

- AWG Rating: 10 AWG
- Stranding: 105 strands of 30 AWG tinned copper
- Rating: 600 V, 105 °C, PVC Insulation

4) Relay contact wiring provided for each set of NO/NC relay contact closure terminals shall be a minimum of 3 meters (10 feet) of UL Style 1015 CSA TEW 18 AWG wire, same ratings as above, except 16 strands of 30 AWG tinned copper. Wiring shall be of adequate length for particular installation.

5) Figure 925-7 provides clarification as to how BBS Power Transfer Relay and Manual Bypass Switch are interconnected with Model 332A Cabinets in order to ensure interchangeability between all BBS manufacturers.

Figure 925- 7 BBS Utility Power Connection Diagram



* As a minimum, these wires shall be provided in 3-meter lengths as part of the interconnect wiring kit.

6) All necessary hardware for mounting (shelf angles, rack, etc) shall be included in the bid price of the BBS. All bolts/fasteners and washers shall meet the following requirements:

- Screw type: Pan Head Phillips machine screw
- Size and Thread pitch: 10-32
- Material: 18-8 stainless steel (Type 316 stainless steel is acceptable as an alternate)

- Washer: Use one flat washer (18-8 stainless steel) under the head of each 10-32 screw (provided that the screws are properly tightened, lock washers are unnecessary.)
- Number of screws per hinge bracket: Minimum of six (6) screws per hinge bracket with one screw near each end.

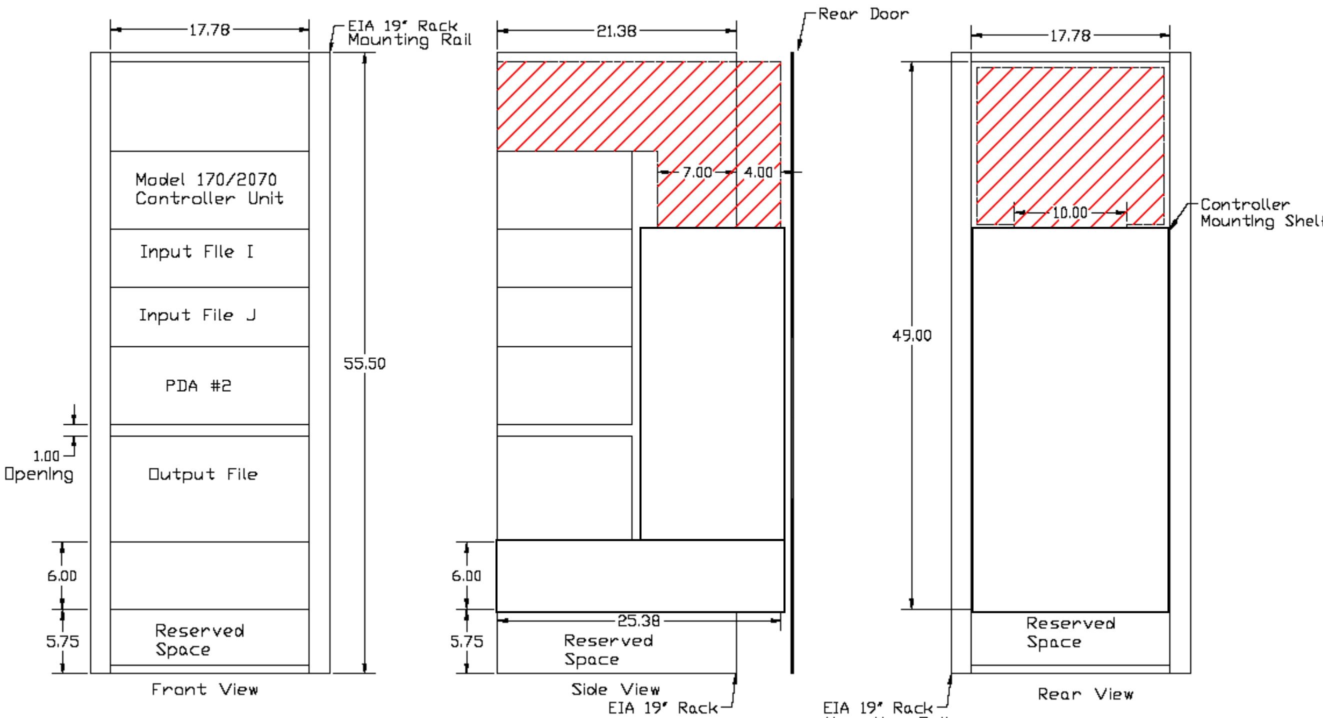
7) There shall be two (2) basic BBS mounting options:

a) Configuration 1 – The BBS (Inverter/Charger, Bypass Switch and Transfer Relay only) installed inside the 332A Cabinet, with the batteries installed in the externally mounted cabinet. See Figure 925-8 for location of inverter in 332A cabinet.

b) Configuration 2 – The entire BBS, including batteries, installed inside the externally mounted cabinet.

Figure 925-8 BBS Mounting Diagram

For a typical Model 332A Cabinet



Notes:
Area inside of dashed lines represents available mounting locations for BBS.
Prescribed available mounting areas are approximate.
All dimensions shown are in inches.

8) External Cabinet

a) The External Cabinet shall be used for housing batteries and/or BBS, which includes inverter/charger unit, power transfer relay, manually operated bypass switch, any other control panels, and all wiring and harnesses.

b) The same Inverter/Charger, Power Transfer Relay and manually operated Bypass Switch that fits inside a typical fully equipped CALTRANS Model 332A Cabinet shall also be able to fit inside the externally mounted cabinet.

c) The External Cabinet shall be a NEMA 3R rated cabinet conforming to TEES, August 16, 2002 Chapter 7, Section 2-Housings for the construction and finish of the cabinet. The specific finish of the external cabinet shall match the finish of the 332A cabinet. Anti-Graffiti paint shall not be used. Two separate mounting installations shall be used. Refer to the project plans for the appropriate mounting installation.

i. Mounting Installation Type A shall be typically used for installing at locations with existing 332 cabinet. This cabinet mounting installation shall attach the exterbnal cabinet to the side of the 332 cabinet in the relationship as shown in figure 925-9. Type A mounting installation shall use fasteners that meet the following requirements:

- (Total of 8 bolts per cabinet with 2 flat washers per bolt and 1 K-lock nut per bolt)
- Cabinet mounting bolts shall be:
  - 18-8 Stainless Steel Hex Head (Fully Threaded)
  - 3/8" – 16 X 1"
- Washers shall be:
  - Designed for 3/8" bolt
  - 18-8 Stainless Steel 1" OD round flat type
- K-lock washer shall be:
  - 18-8 Stainless Steel, Hex Nut Assembled with Free-Spinning Tooth Washer
  - 3/8" – 16 Screw size

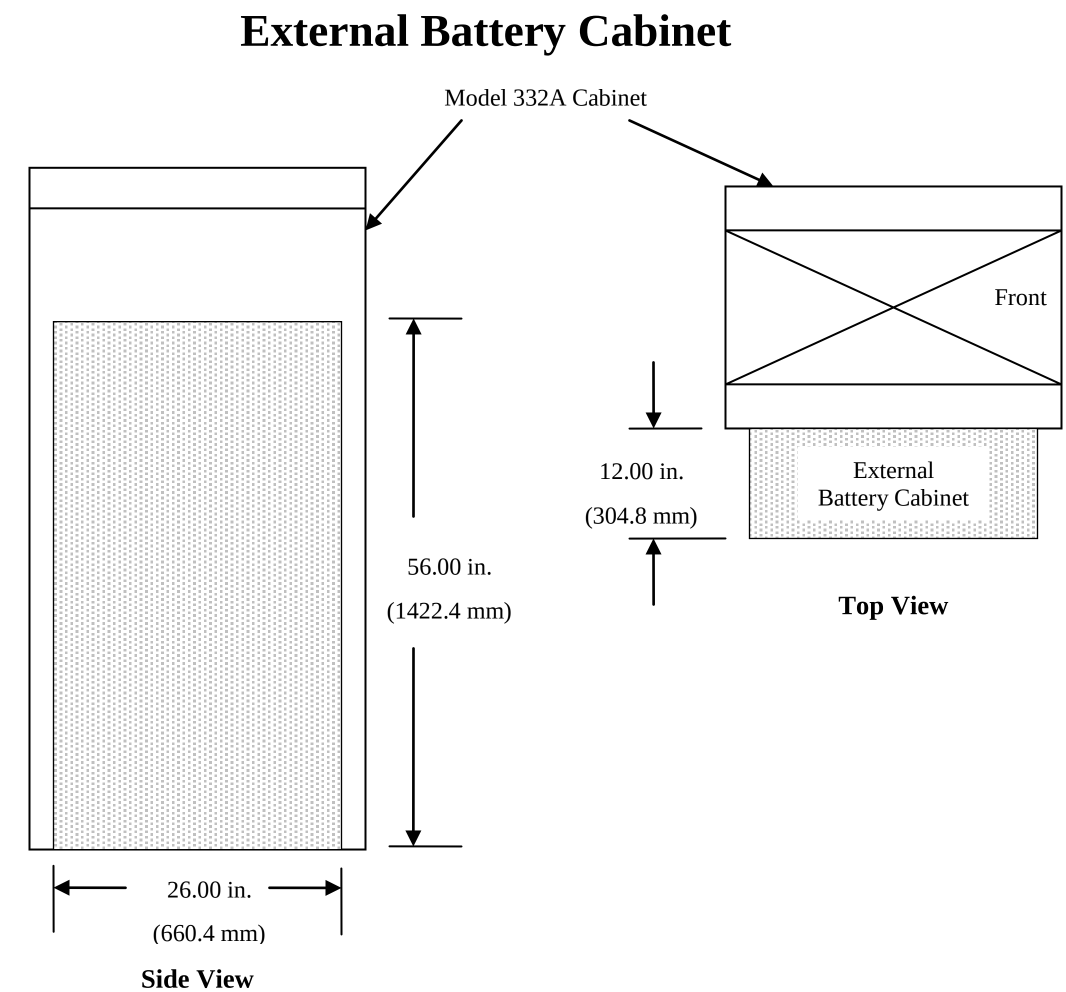
External Cabinet to 332A Cabinet couplings shall provide a conduit for power connections between the 332A Cabinet and External Cabinet. The couplings shall consist of three parts and meet the following requirements:

- 2" Nylon Insulated, Steel Chase Nipple
- 2" Sealing, Steel Locknut
- 2" Nylon Insulated, Steel Bushing

The external cabinet shall come provided with all bolts, washers, nuts and cabinet-cabinet coupler fittings provided, necessary for mounting the external cabinet to the 332A Cabinet.

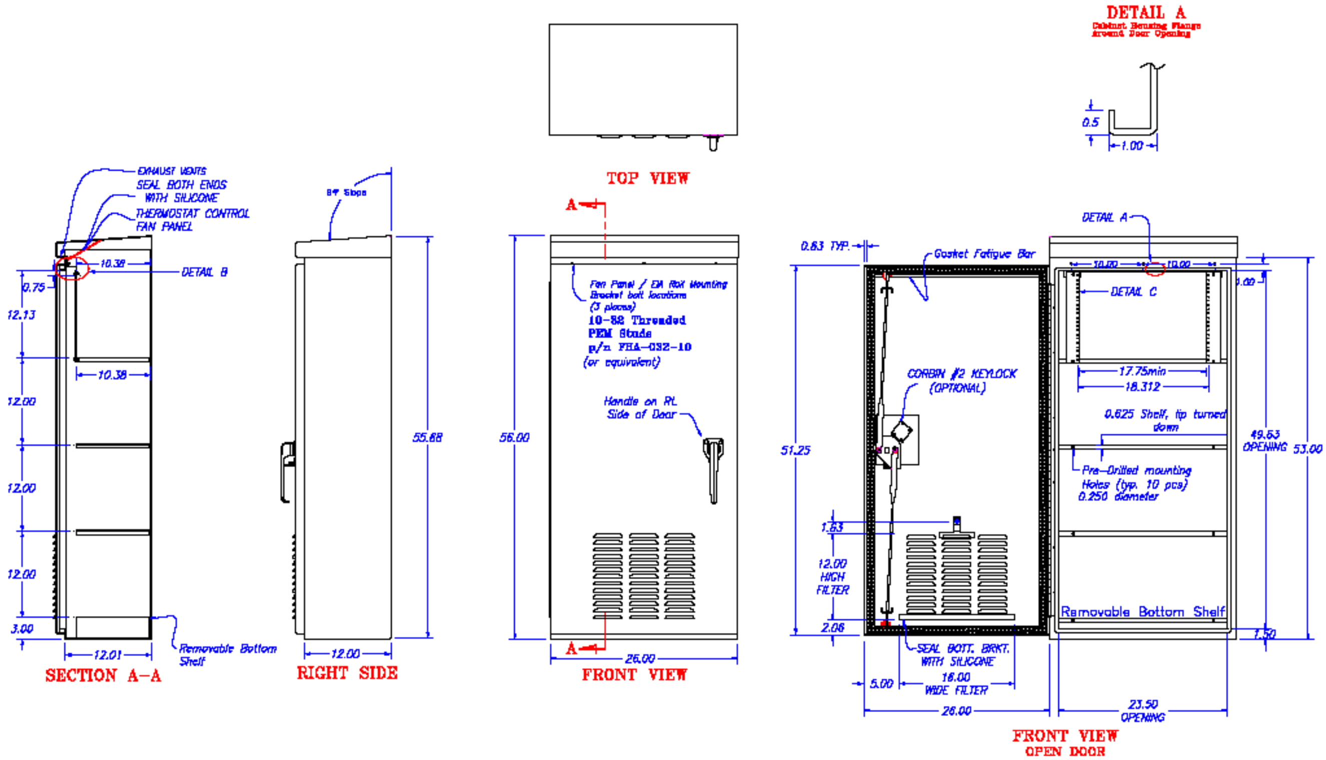
ii. Mounting Installation Type B shall be typically used for locations where a new traffic controller cabinet and foundation are being installed. This cabinet installation shall provide the external battery cabinet as a base mount cabinet on the same foundation as the 332 cabinet. Connections between the cabinets shall be through conduit in the cabinet base. The external cabinet shall be installed in the same relationship as shown in figure 925-9 to the 332 cabinet. The external cabinet shall be installed so that it is centered on the 30 inch left side of the 332 cabinet.

Figure 925-9 External BBS Cabinet Details



d) The specific dimensions and details of the external battery cabinet shall be as shown in Figures 925-10 through 925-12.

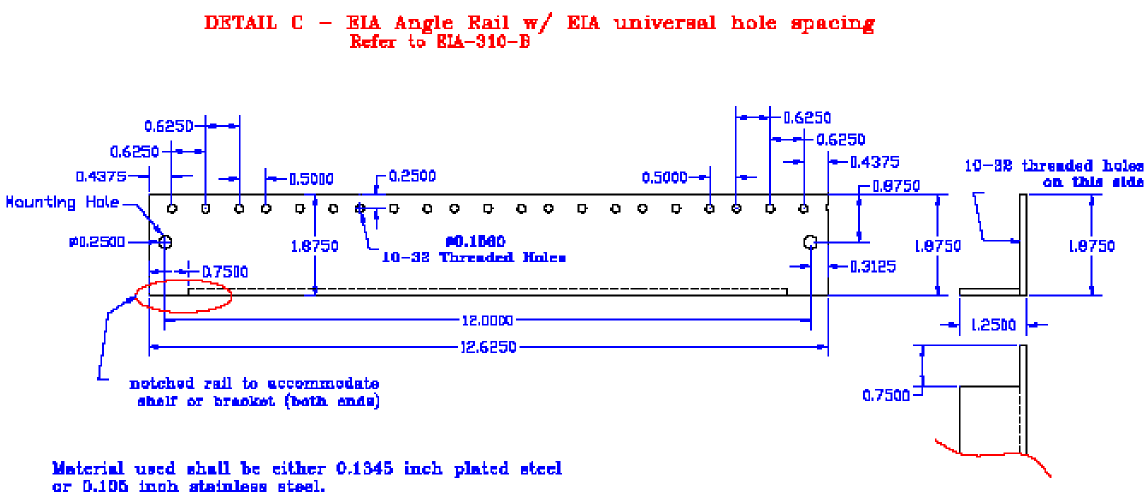
Figure 925-10 External BBS Cabinet Details



e) Four shelves shall be provided. There shall be a minimum of 304.8mm (12”) clearance between shelves. Each shelf shall be a minimum of 263.65mm (10.38”) X 635.0mm (25”), and capable of supporting a minimum of 57kg (125 lbs.). Shelf edges shall be turned down on all four sides for support and to provide a flat top surface. Shelves shall be predrilled with EIA rail mounting holes. Shelves shall provide a vertical “passageway” for wring in the rear of the cabinet on both the left and right.

f) The bottom shelf shall be capable of being removed.

Figure 925-11 EIA Rail for Mounting Inverter or PTR inside External BBS Cabinet



g) The external cabinet shall be ventilated through the use of louvered vents, filter, and one thermostatically controlled fan as per TEES Chapter 7 Section 2-Housings.

h) External cabinet fan shall be AC operated from the same line output of the Manual Bypass Switch that supplies power to the 332 Cabinet. A 2-position terminal block shall be provided on the fan panel, along with 3 meters (10 feet) of connected hookup wire.

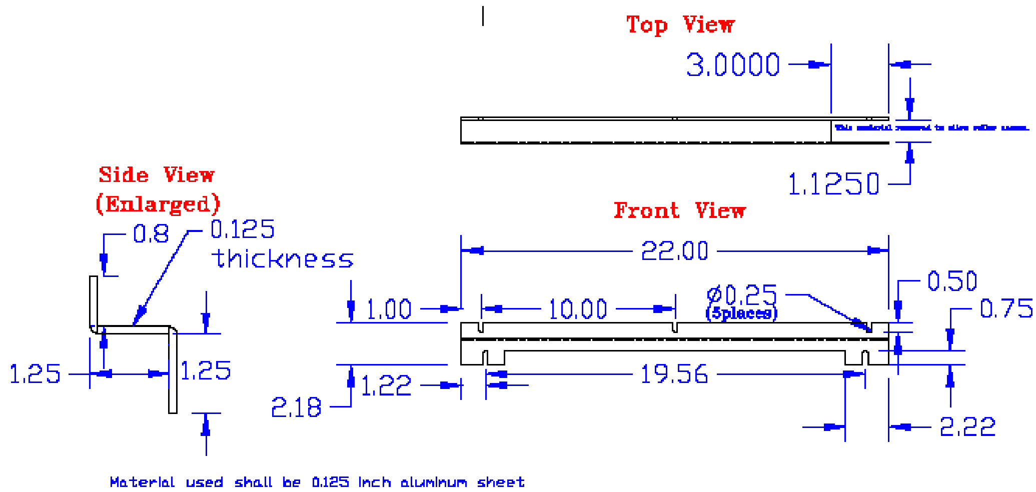
i) The door shall be attached to the cabinet through the use of either a continuous stainless steel piano hinge or four, two-bolts per leaf, hinges as per TEES Chapter 7 Section 2. The door shall use a padlock clasp or latch and lock mechanisms as described in the TEES, in order to lock the door.

j) Two EIA angle rails, per Detail C, Figure 925 – 11, along with all necessary mounting hardware (4 sets of 10-32 bolts and nuts with captive washers) shall be provided with the external cabinet (not installed). Rails shall be symmetric to allow for installation on either right or left sides of the cabinet. Mounting holes and bracket shall allow for EIA rail installation at any location in the external cabinet. The EIA mounting angle nominal thickness shall be either 0.1345 inch (3.4163mm) plated steel or 0.105 inch (2.667mm) stainless steel.

k) EIA rail mounting bracket shall be of continuous, one-piece design bolted into the cabinet to provide adequate support for rail-mounted equipment. See Figure 925 – 12.

l) Pressed in, flush-head threaded screw posts shall be inserted into the front face of the cabinet enclosure top sill. These threaded posts shall be used to mount both the fan panel and the EIA rail-mounting bracket. The screw posts shall be #10-32 thread size stud 0.625 inches in length. Refer to Figure 925 – 10, front views for mounting detail.

Figure 925-12 EIA Rail Mounting Bracket for Mounting EIA Rails inside External BBS Cabinet



3. Maintenance, Displays, Controls and Diagnostics

    a. The BBS shall include a display and /or meter to indicate current battery charge status and conditions.

        1) The BBS shall provide voltmeter standard probe input-jacks (+) and (-) to read the exact battery voltage drop at the inverter input.

        2) The BBS shall include a 0 to 100% battery capacity LED indicator.

    b. The BBS shall have lightning surge protection compliant with IEEE/ANSI C.62.41.

    c. The BBS shall be equipped with an integral system to prevent battery from destructive discharge and overcharge.

    d. The BBS and batteries shall be easily replaced with all needed hardware and shall not require any special tools for installation.

    e. The BBS shall include a front-panel event counter display to indicate the number of times the BBS was activated and a front-panel hour meter to display the total number of hours the unit has operated on battery power. Both meters shall have push button resets.

    f. Manufacturer shall include a set of equipment lists, operation and maintenance manuals, and board-level schematic and wiring diagrams of the BBS, and the battery data sheets. Manual shall conform to TEES August 16, 2002, Chapter 1, Section 1.2.4.2.

4. Battery System

    a. Individual batteries shall be:

        1) Voltage rating: 12V type

        2) Group size: 24 maximum

        3) Batteries shall be easily replaced and commercially available off the shelf.

    b. Batteries used for BBS shall consist of 4 to 8 batteries with a cumulative minimum rated capacity of 240 amp-hours.

    c. Batteries shall be deep cycle, sealed prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/ Valve Regulated Lead Acid).

d. Batteries shall be certified by the manufacturer to operate over a temperature range of – 25 °C (-13F) to +74 °C (+165 F).

e. The batteries shall be provided with appropriate interconnect wiring and corrosion-resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.

f. Batteries shall indicate maximum recharge data and recharging cycles.

g. Battery Harness

1) Battery interconnect wiring shall be via two-part modular harness.

2) Part I shall be equipped with red (+) and black (-) 30.48 cm (12 inches) cabling that can be permanently connected to the positive and negative posts of each battery. Each red and black pair shall be terminated into an Anderson Power Pole Connector or AMP Power Series Connector or equivalent style connector.

3) Part II shall be equipped with the mating Power Pole style connector for the batteries and a single, insulated Power Pole style connection to the inverter/charger unit. Harness shall be fully insulated and constructed to allow batteries to be quickly and easily connected in any order to ensure proper polarity and circuit configuration.

4) Power Pole style connectors may be either one-piece or two-piece. If a two-piece connector is used, a locking pin shall be used to prevent the connectors from separating.

5) The length of the battery interconnect harness (Part II) shall be a minimum of 152.4 cm (60 inches) from the Inverter/Charger plug to the first battery in the string. The lateral length of the harness between battery connectors shall be a minimum of 30.48 cm (12 inches).

6) All battery interconnect harness wiring shall be UL Style 1015 CSA TEW or Welding Style Cable or equivalent, all of proper gauge with respect to design current and with sufficient strand count for flexibility and ease of handling.

7) Battery terminals shall be covered and insulated with molded boots so as to prevent accidental shorting.

B. Fabrication

Refer to Subsection 925.2.07.A.1 for controller cabinet minimum fabrication Specifications.

C. Acceptance

General Provisions 101 through 150. Each BBS shall be manufactured in accordance with a manufacturer Quality Assurance (QA) program. The QA program shall include two Quality Assurance procedures: (1) Design QA and (2) Production QA. The Production QA shall include statistically controlled routine tests to ensure minimum performance levels of BBS units built to meet this specification and a documented process of how problems are to be resolved. The manufacturer, or an independent testing lab hired by the manufacturer, shall perform Design Qualification Testing on new BBS system(s) offered, and when any major design change has been implemented on an existing design. A major design change is defined as any modification, material, electrical, physical or theoretical, that changes any performance characteristics of the system, or results in a different circuit configuration. Where a dispute arises in determining if a system is a new design or if the system has had a major design change, the State will make the final determination if Design Qualification Testing is required prior to production consideration.

Production Quality Control tests shall be performed on each new system prior to shipment. Failure to meet this requirements shall be cause for rejection. The manufacturer shall retain test results for seven years. Each BBS shall be given a minimum 100-hour burn-in period to eliminate any premature failures. Each system shall be visually inspected for any exterior physical damage or assembly anomalies. Any defects shall be cause for rejection.

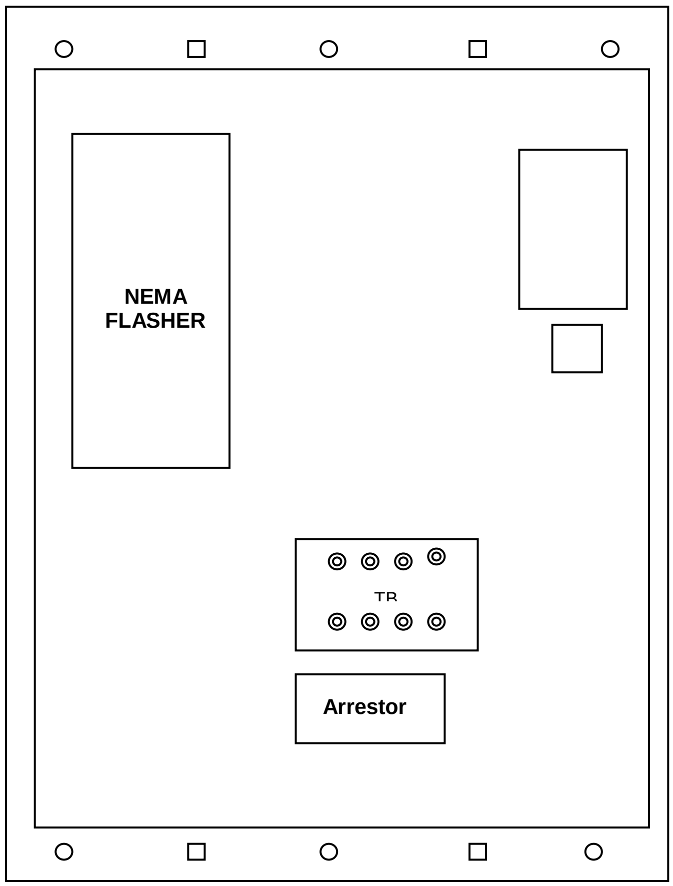
D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties. Manufacturers shall provide a two (2) year factory-repair warranty for parts and labor on the BBS from date of acceptance by the Department. Batteries shall be warranted for full replacement for two (2) years from date of purchase. The warranty shall be included in the total bid price of the BBS.

925.2.07 Flashing Beacon Assembly

A. **Requirements**

This specification is for a flashing signal cabinet, which consists of an aluminum cabinet containing a flasher assembly, Field connection terminal block, surge arrestor and circuit breaker wired in a manner to operate flashing beacons. Refer to Figure 925-13.



NOTE: Front view of cabinet Door Assembly not shown.

No scale

Figure 925-13—Typical Flashing Signal Cabinet Layout

1. Cabinet

Supply a NEMA Type 3R cabinet assembly, manufactured of aluminum with a minimum thickness of 0.125 inches (3 mm).

Ensure that the cabinet exterior has a smooth, uniform “bare” aluminum finish with all joints between adjoining cabinet components (sides and bottom) continuously welded on the outside to prevent the intrusion of moisture and dust.

Ensure that all welds are free of cracks, blow holes and other irregularities.

Supply a cabinet with the following exterior dimensions:

	Minimum	Maximum
Height	14 inches (350 mm)	18 inches (450 mm)
Width	10 inches (250 mm)	14 inches (350 mm)
Depth	7 inches (175 mm)	10 inches (250 mm)

Use a cabinet door that is double flanged on all four sides to prevent the entry of dirt and liquids when the door is open.

Install a one-piece gasket formed around the door opening to insure a weather tight seal when the door is secured.

Attach the door to the cabinet housing by a continuous tamper proof hinge.

Equip each cabinet with a Corbin #2 lock and one key. Police panel type locks are not acceptable.

Install an aluminum back panel in the cabinet, mounted on standoffs, to facilitate mounting of internal components.

Install exterior aluminum mounting brackets, which extend a minimum of 1.75 inches (44 mm) and a maximum of 2.5 inches (63 mm) from the top and bottom of the cabinet.

Use brackets that extend across the full width of the cabinet back on the top and bottom.

Provide these brackets with holes for mounting to a flat surface with screws and vertical slots for banding to steel, concrete or wooden signal poles.

2. Flasher Unit

Supply a standard plug in two circuits NEMA flasher.

Ensure that the flasher is of all solid state construction, meets the requirements of the NEMA Standards and is rated at a minimum of 10 A per circuit.

Ensure that the flasher utilizes zero voltage turn-on and turn-off current and is capable of dimming outputs.

3. Surge Arrestor

Supply a flasher cabinet that incorporates an AC surge arrestor to protect the internal components from lighting and over voltages on the AC service input.

The requirements for the surge arrestor are:

Two Stage Arrestor	
Peak Surge Current	20000 A
Peak Surge Voltage @ 20KA	280 V
Clamp Voltage	280 V @ 20 kA
Continuous AC Voltage	120 V AC RMS
Response Time	<5 nsec
Operating Temp	-40 ºF to 185 ºF (-40 ºC to 85 ºC)

4. Circuit Breaker

Include a 15 A circuit breaker in the cabinet. The circuit breaker shall have the following characteristics.

Thermal Magnetic 1 pole 120/240 VAC at 50/60 Hz 15 A

Interrupting Rating of 10KA at 48 VDC

Wire Size 14 to 2 AWG

35 MM Din Rail mounting

5. Terminal Block

   Include a four position terminal block in the cabinet for making field connections. Properly label all field terminal connections.

6. Construction

   Assemble the flasher assembly, terminal block, surge arrestor and circuit breaker in the cabinet as shown on the attached drawing.

   Wire all components together as a working unit, thus requiring only field connections to and from the AC power and flashing beacons.

B. Fabrication

Refer to Subsection 925.2.07.A.1 for controller cabinet minimum fabrication specifications.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.08 Flashing Signal Cabinet With Time Clock

A. **Requirements**

This specification is for a flashing signal cabinet with time clock which consists of an aluminum cabinet containing a flasher assembly, time clock, field connection terminal block, surge arrestor and circuit breaker wired in a manner to operate school flashing beacons. Refer to Figure 925-14.

1. Cabinet

   Supply a NEMA Type 3R cabinet assembly that is manufactured of aluminum with a minimum thickness of 0.125 inches (3 mm).

   Ensure that the cabinet exterior has a smooth, uniform natural aluminum finish, and that all joints between adjoining cabinet components (sides and bottom) are continuously welded on the outside to prevent the intrusion of moisture and dust.

   Ensure that all welds are free of cracks, blow holes and other irregularities.

   The exterior dimensions of the cabinet are as follows:

	Minimum	Maximum
Height	14 inches (350 mm)	18 inches (450 mm)
Width	10 inches (250 mm)	14 inches (350 mm)
Depth	12 inches (300 mm)	16 inches (400mm)

   Supply a cabinet door that is double flanged on all four sides to prevent the entry of dirt and liquids when the door is open.

   Use a one-piece gasket that is formed around the door opening to insure a weather tight seal when the door is secured.

   Attach the door to the cabinet housing with a continuous tamper proof hinge.

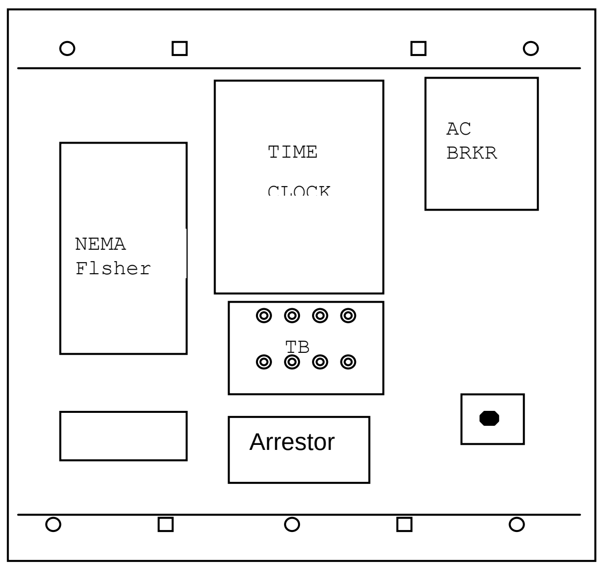
   Provide each cabinet with a Corbin #2 lock and one key. Police panel type locks are not acceptable.

Supply each cabinet with an aluminum back panel mounted on standoffs to facilitate mounting of internal components.

Supply cabinets with exterior aluminum mounting brackets, which extend a minimum of 1.75 inches (44 mm) and a maximum of 2.5 inches (63 mm) from the top and bottom of the cabinet.

Use brackets that extend across the full width of the cabinet back on the top and bottom.

Provide these brackets with holes for mounting to a flat surface with screws and vertical slots for banding to steel, concrete or wooden signal poles.



Note: Front view of cabinet Door Assembly not shown. **No scale.**

Figure 925-14—Typical Flashing Cabinet with Time Clock Cabinet Layout

2. Flasher Unit

Supply a standard plug in, two circuits NEMA flasher.

Ensure that the flasher is of all solid state construction, meets the requirements of the NEMA Standards and is rated at a minimum of 10 A per circuit.

Ensure that the flasher utilizes zero voltage turn-on and turn-off current and be capable of dimming outputs.

3. Time Switch

Supply a time switch that meets the requirements of Subsection 925.2.09 of this specification.

4. Surge Arrestor

Supply flasher cabinets that incorporate an AC surge arrestor to protect the internal components from lighting and over voltages on the AC service input.

The requirements of the surge arrestor are as follows:

Two Stage Arrestor	
Peak Surge Current	20000 A
Peak Surge Voltage @ 20KA	280 V
Clamp Voltage	280 V @ 20 kA
Continuous AC Voltage	120 V AC RMS
Response Time	<5 nsec
Operating Temp	-40 ºF to 185 ºF (-40 ºC to 85 ºC)

5. Circuit Breaker

Include a 15 A circuit breaker in each cabinet. The circuit breaker shall have the following characteristics.

- Thermal Magnetic 1 pole 120/240 VAC at 50/60 Hz 15 A
- Interrupting Rating of 10KA at 48 VDC
- Wire Size 14 to 2 AWG
- 35 MM Din Rail mounting

6. Terminal Block

Include a four position terminal block in each cabinet for making field connections. Properly label all field terminal connections.

7. Construction

Assemble the flasher assembly, terminal block, surge arrestor and circuit breaker in the cabinet as shown on the attached drawing.

Wire all components together as a working unit, thus requiring only field connections of the AC power and flashing beacons.

B. Fabrication

Refer to Subsection 925.2..07.A.1 for controller cabinet minimum fabrication Specifications.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.09 Time Clock

A. **Requirements**

Supply time clocks that are single circuit, calendar programmable, solid state, fully self-contained units (RTC AP 21 or Eltec NTC 17E or equivalent) that meet the following Specifications:

1. Alphanumeric liquid crystal display.
2. Automatic daylight savings time and leap year compensation. Changes in the daylight savings time program made through the keypad do not require hardware modification.
3. Minimum twenty-four (24) hour capacitive back up. Battery back up is not acceptable.
4. Keypad entry programming without the use of any external devices such as a PC, external programming unit, another time switch, etc.
5. Operate on 95 to 135 V AC, 60 Hz line current.
6. SPDT relay output rated at 15 A.
7. Maximum size of 4.25 inches (110 mm) wide, 8.25 inches (210 mm) high and 2 inches (50 mm) deep.
8. A programming manual is to be included with each unit.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.10 Self Tuning Loop Detector

A. **Requirements**

This specification sets forth the minimum acceptable design, operational and functional performance requirements for multi-channel, inductive loop vehicle detection systems.

1. General Requirements
   a. Mounting

      Ensure that the unit is configured for rack mount insertion into a NEMA (TS l or TS 2) card rack and/or CALTRANS Type 2070 cabinet input file.

   b. Environmental

      Ensure that the unit is in full compliance with the environmental tests, transient tests and size requirements of NEMA standard TS-l Section 15, TS-2 Section 6.5 and the California Type 2070 Specifications.

      Provide documentation from an independent laboratory, which certifies that the unit is in compliance with the above Specifications.

c. LED Indicator

Ensure that each channel includes two high visibility LED indicators; one for the detect state and the second to indicate the status of the fault monitor.

d. Phase Indicator

Ensure that each channel has an erasable write-on pad to aid in identification of the associated phase or function.

2. Operational Requirements

a. Tuning

Supply units that are fully digital and self-tuning.

Ensure that each channel of the unit can automatically tune to any loop and lead in combination within two (2) seconds of application of power or when a reset signal is received.

Ensure that the tuning circuit is designed so that drift, caused by environmental changes or changes in applied power, does not cause false actuations.

b. Scanning

Supply units that sequentially scan each channel (only one channel energized at any given time) to eliminate crosstalk from multiple loops in adjacent lanes and/or allow overlapped loops for directional control and/or allow use of multi-conductor homerun cable when connected to the same detector unit.

c. Sensitivity Setting

Ensure that each channel is equipped with front panel selectable sensitivity settings in presence and pulse modes.

d. Frequency

Supply units that have a minimum of three switch selectable operating frequencies.

e. Inductance Range

Ensure that each channel can tune to an inductive load from 50 to 2000 microhenries with a Q factor > 5.

f. Grounded Loops

Ensure that each channel can continue to operate with poor quality loop systems (Q>2) including those that have a single point short to ground.

g. Fault Monitoring

Supply units that constantly monitor the operation of each channel.

Ensure that the unit detects shorted loops, open circuit loops or sudden changes in inductance (>25% of nominal).

Ensure that each type of fault is indicated on a fault LED by a unique sequence of flashes until the fault is rectified.

Ensure that while the channel is in the fault condition, the channel output remains in the detect state.

When the fault is rectified, the fault LED continues to emit the sequence signifying the last fault detected, but the detect LED and output returns to normal operation.

h. Failsafe Output

Ensure that each channel output generates a continuous solid state output to the controller when power to the detector is removed.

i. Operational Modes

Supply units with each channel selectable for either pulse or presence modes and that meet the following requirements:

- Pulse Mode

  This setting provides a single output pulse (125 ms +/- 25) in response to a vehicle entering the loop. If a vehicle remains in the sensing zone in excess of two (2) seconds, the unit "tunes out" said vehicle. The channel is then capable of detecting another vehicle entering the same detection zone.

- Presence Mode

  The presence hold time is a minimum of four (4) minutes for small vehicles (motorcycles) and a minimum of sixty (60) minutes for automobiles.

  Ensure that the unit tunes out of continuous peak hour traffic over long or multiple small loops as long as there is vehicle motion in the sensing zone every ten (10) minutes.

j. Resets

Ensure that the channels are manually resettable by removing the power momentarily.

Ensure that the channels reset remotely when the voltage on Pin C falls below 8 V DC for a period > l5µs, and that the unit resumes normal operation within four (4) seconds after the application of power or after a reset signal of l5µs.

k. Field Tuning

Ensure that field adjustments to the operation of the detector do not require the use of a meter, circuit changes, special software or any substitutions, modifications or additions to the unit.

3. Performance Requirements

If testing should be required, provide the Department with a test unit and/or software within ten (10) calendar days of the request.

Should the unit fail to meet the design and/or performance requirements of this specification, the unit will be rejected.

Ensure that the units meet the following requirements:

a. Capable of detecting passage, holding presence and accurately counting all types of licensed motor vehicles when connected in various loop configurations and lead-in combinations without detecting vehicles in adjacent lanes.

- Typical Loop Configurations with Lead-in of 5 feet (1.5 m) to 1,500 feet (1000 m) are:
- 6 feet x 6 feet (1.8 m x 1.8 m)
- 6 feet x 20 feet (1.8 m x 6 m)
- 6 feet x 40 feet [(1.8 m x 12 m) standard or quadrupole]

b. Capable of responding to an inductance change of 0.02% and sense vehicles at speeds of up to 80 mph (130 km/h).

c. Not detect vehicles, moving or stopped, at distances greater than three feet for any loop perimeter.

d. Detect all vehicles over multiple turn and/or multiple loops that may he connected in series, parallel or series/parallel with homerun lengths from <5 feet (1.5 m) to > 1,500 feet (1,000 m).

4. Optional Features

In addition to the requirements listed in the previous sections, the units may be requested with any combination of the following optional features:

a. Option 1- Timing Features - Delay & Extension

When this option is specified, ensure that the unit incorporates the following features:

1) Delay Timing: Minimum selectable delay time of 1 to 30 seconds in minimum 1-second increments for each channel.

2) Extension Timing: Minimum selectable extension time of 0.5 to 10 seconds in minimum 0.5-second increments for each channel.

b. Option 2 - Advanced Features

When the option for advanced features is specified, supply units that incorporate the following advanced features:

1) Serial Port Interface

When the serial port interface is specified, equip the detector with a front and rear panel RS 232 port for the transmission of data. Provide Windows 95 compatible software for interfacing with the detector.

2) PC Interface

Ensure that PC software, when connected directly to the unit through the front panel RS 232 port, provides a screen to display the following loop system operating characteristics, on a per channel basis, for system setup, data collection and diagnostics.

- Loop Status
- Loop Inductance (μH)
- Loop Frequency (kHz)
- Inductance Change (nH)
- Last Fault: Open, Shorted, >25% ΔL
- Fault Occurrence: Date & Time
- Vehicle Count

3) Speed, Volume & Occupancy

The software, when connected directly to the unit, is capable of collecting and storing speed, volume and occupancy data from each detector channel.

The software allows assignment of loop-to-loop distances to enable accurate speed and vehicle length measurements.

The speed volume and occupancy information is uploaded and stored in the vendor-supplied software.

Upon request, supply the necessary information/protocols to allow the Department to write custom software to retrieve speed, volume and occupancy data.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.11 Loop Sealant

A. **Requirements**

Furnish and install loop sealant according to Subsection 833.2.09, “Polyurethane Sealant for Inductive Loops”. For a list of sources, see QPL 75.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.12 Vehicle Signal Heads

A. **Requirements**

Supply vehicle signal heads that are 12 inches (300 mm) in diameter for traffic signal control applications. For ramp metering systems supply both 12 inches (300 mm) and 8 inches (200 mm) as per the Plans.

Ensure that the 8 inch (200mm) or 12 inch (300 mm) polycarbonate vehicle signal heads meet the current ITE specification on Vehicle Traffic Control Signal Heads with the following modifications and / or clarifications:

1. Unless otherwise approved by the Engineer or as noted on the Plans, supply signal heads with the following exterior color scheme:
   - Signal Housing - Highway Yellow.
   - Front Face including Doors and Visors: Flat Black
2. Provide housing and housing door that are one piece injection molded ultraviolet and heat stabliized polycarbonate resin with the color impregnated in the material.
3. Terminate the wiring from each signal section in the top section of the head assembly. Ensure that the cable jacket is a minimum of 6 inches inside the signal head assembly.
4. Provide the appropriate Vehicle Signal LED Signal in each section either Circular or Arrow Module.
5. Provide an effective seal with the LED module to make the assembly weather tight.
6. Mount one aluminum reinforcing support plate in the top of the red section of each three, four or five-section signal head for the installation of mounting hardware.
7. Install a support plate between each section of all signal heads. Place these plates such that there is a plate in the bottom of and/or top of any sections where sections adjoin to another section.
8. Provide Signal Heads that use stainless steel hardware and are weather tight. Ensure signal heads that are supplied are sealed for mounting in all possible configurations.
9. Provide Signal Heads that have housing door that “positively” latches using two eyebolts and wing nuts. Ensure the Signal door has hinge lugs molded on one side and two latch jaws are molded on the other side.
10. Provide signal heads that provide a positive method of holding the lens such that the lens does not rotate. Ensure the lens is weather tight. Lens clips which do not apply firm pressure to the lens gasket to avoid rotation are not acceptable.

B. Fabrication

Refer to ITE Standards for material composition and finish Specifications.

C. Acceptance

Refer to ITE Standards for material composition, finish Specifications, and wind loading requirements.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.13 Pedestrian Signal Head

A. **Requirements**

Provide each section with a visor encompassing the top and sides of the signal face of a size and shape adequate to shield the lens from external lighted sources.

An acceptable option is a “Z-crate” or louver type visor for mounting over the Pedestrian signal face.

Construct the housing of one piece cast aluminum alloy with two integrally hinge lugs, screw slots and openings at each end. Construct the door of one piece cast aluminum alloy with two hinge lugs cast on top of the door and two latch points cast on the bottom. Provide hinge pins of stainless steel to attach the door to the housing and two eye bolts and wing nuts on the other side of the door.

Ensure that the door is provided with a neoprene gasket capable of making a weather resistant, dustproof seal when closed. Supply Pedestrian signal heads with a black face and a yellow body, unless otherwise specified on the Plans.

Ensure that Pedestrian indications are distinguishable to the Pedestrian both day and night and at all distances from 10 feet (3 m) to the full width of the areas to be crossed.

Use symbols that are 12 inches (300 mm) high. Use only internal illumination.

Ensure that when illuminated, the “HAND” symbol is Portland Orange and the “PERSON” symbol is Lunar White, meeting the ITE Standards. Ensure that an opaque material obscures all areas of the face or lens, except for the message. Ensure that when not illuminated, the symbols are not to be distinguishable by Pedestrians at the far end of the crosswalk they control.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.14 Optically Programmed Signal Head

A. **Requirements**

Supply signal heads that permit the visibility zone of the indication to be determined optically and require no hoods or louvers.

The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis.

Ensure that no indication results from external illumination and that one light unit does not illuminate a second. The components of the optical system include the lamp, lamp collar, optical limiter-diffuser, and objective lens.

Ensure that the optical system accommodates projection of diverse, selected indications to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer.

Ensure that the projected indication conforms to ITE transmittance and chromaticity Standards.

1. Construction

   a. Provide an LED Lamp Module that is a direct replacement for the incandescent lamp. Ensure the Lamp modules are on the latest CALTRANS QPL for LED Programmed Visibility Modules. Ensure the unit provided operates over the voltage range of 80 to 135 VAC and the tempoerature range of -40 C (-40 F) to 74 C (165 F). Provide modules that conform to the applicable portions of section 925.2.15. Ensure the unit provides a minimum luuminous intensity of 500 candela and does not exceed 18 watts at 25 C (77 F).

      Couple the lamp to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

   b. Supply an optical limiter with an accessible imaging surface at focus on the optical axis for objects 900 to 1,200 feet (270 to 360 m) distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone.

      Ensure that the optical limiter is provided with positive indexing means and is composed of heat-resistant glass.

   c. Ensure that the objective lens is a high-resolution planar incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or approved equal.

      Supply a lens that is symmetrical in outline and that may be rotated to any 90-degree orientation about the optical axis without displacing the primary image.

2. Mounting

   a. Supply signals that mount to standard 1.5 inch (38 mm) fittings as a single section, as a multiple section face, or in combination with other signals.

      Provide signal sections with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting.

      Ensure that terminal connections permit external adjustment about the mounting axis in 5-degree increments.

   b. Ensure that the signal is mountable with ordinary tools and capable of being serviced with no tools.

      Supply attachments such as back plates or adapters that conform and readily fasten to existing mounting surfaces without affecting water and light integrity of the signal. Supply heads with tri-studs for mounting.

3. Electrical

   Supply lamp fixtures that comprise a separately accessible housing and integral lamp support indexed ceramic socket and self-aligning, quick release lamp retainer.

   Ensure that electrical connection between case and lamp housing can be accomplished with an interlock assembly, which disconnects lamp holder when opened. Include a covered terminal block for clip or screw attachment of lead wires for each signal section.

   Use concealed No. 18 AWG, stranded and coded wires to interconnect all sections to permit field connection within any section.

4. Photo Controls

   Ensure that each signal includes integral means for regulating its intensity between limits as a function of the individual background illumination.

   Ensure that lamp intensity is not less than 97% of uncontrolled intensity at 10 750 lux, and reduces to 15 + 2% of maximum at less than 10.75 lux.

   Ensure that response is proportional and essentially instantaneous to any detectable increase of illumination from darkness to 10 750 lux, and damped for any decrease from 10 750 lux.

   Ensure that the intensity controller is comprised of an integrated, directional light sensing and regulating device interposed between lamp and line wires.

Ensure that it is compatible with 60 Hz input and responsive within the range 105 to 135 V AC.

Output may be phase controlled, but ensure that the device provides nominal terminal impedance of 1,200 W open circuit and a corresponding holding current.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.15 LED Signal Modules

A. **Requirements**

This specification covers Type 1 Light Emitting Diode (LED) red, green and yellow modules for vehicle signals for both Circular and Arrow indications. It also covers LED Pedestrian “HAND & PERSON” signal modules.

1. General Requirements All Modules

Ensure that Type 1 LED signal module include a LED circuit board with LEDs and required circuit components, 36 inch (900 mm) 16 AWG wire leads with strain relief and spade terminals, a rigid housing, and a one piece neoprene gasket.

Supply Type 1 LED signal modules that are watertight when mounted in the traffic signal housing.

Submit life data on the LEDs from the LED Signal Module manufacturer to calculate the expected useful life.

Supply modules with permanent markings of date of manufacture and date of installation.

Ensure that the Type 1 LED signal modules utilize the same mounting hardware that is used to secure the incandescent lens and gasket assembly.

2. Optical All Modules

Provide test data from an independent laboratory to verify that the performance of the product meets current ITE requirements.

Ensure that the individual LEDs are wired such that a catastrophic failure of one LED will result in the loss of not more than 5% of the signal module light output.

The failure of a single LED in a string or cluster of LED’s causes loss of light from only that LED, not the entire string or indication.

Provide control circuitry that prevents the current flow through the LEDs in the “off” state to avoid any false indications as may be perceived by the human eye during daytime and nighttime hours.

Ensure that the LED signal module is operationally compatible with existing or new supplied conflict monitors (NEMA TS-1, NEMA TS-2, Model 210, Model 2010, ITS Cabinet CMU and AMU).

Ensure that the LED Signal Module is operationally compatible with existing or new supplied load switches.

3. Electrical All Modules

Supply LED signal modules that operate over the temperature range of –40 ºF to 165 ºF (-40 °C to 74 ºC).

Ensure that the power factor is 90% or greater, at nominal rated voltage, at 77 ºF (25 °C), after 60 minutes of operation. Provide modules that do not exceed the maximum power consumption as shown in Table 925-18.

Table 925-18 Maximum Power Consumption (in Watts) at 25 C (77 F) & 74 C (165 F)						
Vehicle Indications	**Red**		**Yellow**		**Green**	
Temperature	**25 C**	**74 C**	**25 C**	**74 C**	**25 C**	**74 C**
12 Inch (300 mm) Circular	11	17	22	25	15	15
8 Inch (200 mm) Circular	8	13	13	16	12	12
12 Inch (300 mm) Arrow	9	12	10	12	11	11
Pedestrian Indications	**Hand**				**Man**	
Temperature	**25 C**	**74 C**	**25 C**	**74 C**	**25 C**	**74 C**
12 Inch (300 mm)	10	12			9	12

Ensure that the total harmonic distortion (THD) is less than 20% at rated voltage, at 77 ºF (25 °C) and that all LED traffic signal modules are in compliance with FCC noise regulations.

Ensure that the LED signal modules operate on line voltage, 120 V AC nominal, and are able to operate over the voltage range of 80 V AC to 135 V AC. Power Supply must be integral to the module.

Provide transient voltage suppression rated at 1,500 W for 1 millisecond and fusing with a maximum rating of 2 A to minimize the effect and repair cost of an extreme over voltage situation or other failure mode.

Ensure the lens of the modules that are polymeric and are not frosted have a surface coating to provide front surface abrasion resistance. Ensure the Red and Yellow section module lens are tinted to correspond with the wavelength (chromaticity) of the LED. Ensure Green Section modules are clear.

Ensure the modules allow a reduction of the intensity of the light output in response to an input from the traffic signal controller. Ensure the minimum light output when dimmed is not less than 30% of the minimum maintained luminous intensity as defined in the applicable Signal Head Module.

4. Circular Signal Modules

Supply LED Circular Signal Modules that fit in standard incandescent vehicle traffic signal housings and meet the Performance Specification of the ITE Vehicle Traffic Control Signal Heads: LED Circular Signal Supplement. In case of conflict, this specification shall govern. Before delivery of any modules supply certification that module is to be in compliance with these specifications. In addition substantiating documentation must be supplied from an independent test laboratory to show the product has passed design qualification testing in accordance with section 6.4 of the ITE Vehicle Traffic Control Signal Heads: LED Circular Signal Supplement. Ensure the report includes a Minimum Maintained Luminous Intensity chart for the module being provided that uses the same horizontal and vertical angles as shown in Table 1 of the ITE Vehicle Traffic Control Signal Heads: LED Circular Signal Supplement. Ensure all modules are provided with a signed copy of the production and test and inspection as detailed in section 6.3 of the ITE Vehicle Traffic Control Signal Heads: LED Circular Signal Supplement.

Supply lenses for that are made of ultraviolet stabilized polycarbonate. Ensure that the external lens surface is smooth, with no raised features, to, minimize the collection of dirt, diesel smoke, and other particulate contaminates, and to facilitate periodic cleaning.

Ensure that Circular Signal Modules have prominent and permanent markings to designate the proper orientation of the signal module in the traffic signal housing. This marking should be an up arrow or the word “UP” or “TOP”.

Ensure Circular Signal Module meets the photometric requirements as indicated and described in the ITE VTCSH LED Circular Signal Supplement.

Supply Red and Yellow LEDs that utilize AllnGap technology, either AS (Absorbing Substrate or TS (Transparent Substrate) and do not exhibit degradation of more than 30% of their initial light intensity following accelerated life testing (operating at 185 F (85 C) and 85% humidity, for 1000 hours). AlGaAs technology is not acceptable.

Supply Green LEDs that utilize gallium nitride technology.

5. Vehicle Arrow Signal Modules

Supply LED Arrow Signal Modules that fit in standard incandescent vehicle traffic signal housings and meet the Performance specification of ITE Vehicle Traffic Control Signal- LED Vehicle Arrow Traffic Signal Supplement.

Ensure that Arrow Signal Modules provided are omni directional and marked as OD so that they may be rotated at any angle. Ensure the Arrow modules Photometrics support the luminous intensity as indicated in table 925-19.

Before delivery of any modules supply certification that module is to be in compliance with these specifications. In addition substantiating documentation must be supplied from an independent test laboratory to show the product has passed design qualification testing in accordance with section 6.4 of the ITE Vehicle Traffic Control Signal Heads: LED Circular Signal Supplement.

Ensure the report includes a Minimum Maintained Luminous Intensity chart for the module being provided that uses the same horizontal and vertical angles as shown in Table 1 of the ITE Vehicle Traffic Control Signal Heads: LED Vehicle Arrow Traffic Signal Supplement. Ensure all modules are provided with a signed copy of the production and test and inspection as detailed in section 6.3 of the ITE Vehicle Traffic Control Signal Heads: LED Vehicle Arrow Traffic Signal Supplement.

Supply lenses for that are made of ultraviolet stabilized polycarbonate. Ensure that the external lens surface is smooth, with no raised features, to, minimize the collection of dirt, diesel smoke, and other particulate contaminates, and to facilitate periodic cleaning. Supply Red and Yellow LEDs that utilize AllnGap technology, either AS (Absorbing Substrate or TS (Transparent Substrate) and do not exhibit degradation of more than 30% of their initial light intensity following accelerated life testing (operating at 185 F (85 C) and 85% humidity, for 1000 hours). AlGaAs technology is not acceptable.

Supply Green LEDs that utilize gallium nitride technology.

Supply LED Arrow Signal Modules that fit in standard incandescent vehicle traffic signal housings and meet the "ITE Vehicle Traffic Control Signal Heads Part 3: Light Emitting Diode (LED) Vehicle Traffic Signal Modules". Use Table 925- 19 for all references to minimum maintained Intensity values. Ensure the LED arrow modules meet the required luminous intensity as shown in Table 925-19.

Table 925 - 19 Minimum Maintained Luminous Intensity Values for Arrow LED Indications									
Angle					Angle				
Ver	Hor	12 inch (300 mm)			Ver	Hor	12 inch (300 mm)		
+	+ or -	Red	Yellow	Green	-	+ or -	Red	Yellow	Green
2.5	2.5	56.8	141.6	73.9	2.5	2.5	56.8	141.6	73.9
	7.5	47	117.1	61.1		7.5	47	117.1	61.1
	12.5	32.1	80.1	41.8		12.5	32.1	80.1	41.8
	17.5	18.2	45.3	23.7		17.5	18.2	45.3	23.7
	22.5	8.5	21.2	11.1		22.5	8.5	21.2	11.1
	27.5	3.3	8.2	4.3		27.5	3.3	8.2	4.3
7.5	2.5	47	117.1	61.1	7.5	2.5	47	117.1	61.1
	7.5	38.9	97	50.6		7.5	38.9	97	50.6
	12.5	26.7	66.5	34.7		12.5	26.7	66.5	34.7
	17.5	15.1	37.7	19.7		17.5	15.1	37.7	19.7
	22.5	7.1	17.7	9.2		22.5	7.1	17.7	9.2
	27.5	2.8	6.9	3.6		27.5	2.8	6.9	3.6
12.5	2.5	32.1	80.1	41.8	12.5	2.5	32.1	80.1	41.8
	7.5	26.7	66.5	34.7		7.5	26.7	66.5	34.7
	12.5	18.3	45.7	23.9		12.5	18.3	45.7	23.9
	17.5	10.5	26.1	13.6		17.5	10.5	26.1	13.6
	22.5	5.0	12.4	6.4		22.5	5.0	12.4	6.4
	27.5	-	-	-		27.5	-	-	-
17.5	2.5	18.2	45.3	23.7	17.5	2.5	18.2	45.3	23.7
	7.5	15.1	37.7	19.7		7.5	15.1	37.7	19.7
	12.5	10.5	26.1	13.6		12.5	10.5	26.1	13.6
	17.5	6.0	15.0	7.8		17.5	6.0	15.0	7.8
	22.5	2.9	7.2	3.8		22.5	2.9	7.2	3.8
	27.5	-	-	-		27.5	-	-	-

Table 925 - 19 Minimum Maintained Luminous Intensity Values for Arrow LED Indications									
Angle					Angle				
Ver	Hor	12 inch (300 mm)			Ver	Hor	12 inch (300 mm)		
+	+ or -	Red	Yellow	Green	-	+ or -	Red	Yellow	Green
22.5	2.5	8.5	21.2	11.1	22.5	2.5	8.5	21.2	11.1
	7.5	7.1	17.7	9.2		7.5	7.1	17.7	9.2
	12.5	5.0	12.4	6.4		12.5	5.0	12.4	6.4
	17.5	2.9	7.2	2.8		17.5	2.9	7.2	2.8
	22.5	-	-	-		22.5	-	-	-
	27.5	-	-	-		27.5	-	-	-
27.5	2.5	3.3	8.2	4.3	27.5	2.5	3.3	8.2	4.3
	7.5	2.8	6.9	3.6		7.5	2.8	6.9	3.6
	12.5	-	-	-		12.5	-	-	-
	17.5	-	-	-		17.5	-	-	-
	22.5	-	-	-		22.5	-	-	-
	27.5	-	-	-		27.5	-	-	-

6. Pedestrian Signal Modules

Supply LED Pedestrian Traffic Signal Modules that fit in standard pedestrian one section signal head manufactured in accordance with the ITE Pedestrian Traffic Control Signal Indications (PTCSI) housings and meet the ITE Pedestrian Traffic Signal Modules specification.

Ensure that the Pedestrian Indications for the “Hand” and “Man” are filled in so as to provide a solid indication. Do not supply Pedestrian Indications for the Hand and Man that are “outlines”.

Ensure that Pedestrian Signal Modules have prominent and permanent markings to designate the proper orientation of the signal module in the pedestrian signal housing. This marking should be an up arrow or the word “UP” or “TOP”.

Ensure Pedestrian Signal Module meets the photometric requirements as indicated and described in the ITE PTCSI LED Pedestrian Traffic Signal Module Specification.

Supply Portland Orange LEDs that utilize AllnGap technology, either AS (Absorbing Substrate or TS (Transparent Substrate) and do not exhibit degradation of more than 30% of their initial light intensity following accelerated life testing (operating at 185 F (85 C) and 85% humidity, for 1000 hours). AlGaAs technology is not acceptable.

Supply White LEDs that utilize InGaN technology.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Ensure that LED traffic signal modules and LED Pedestrian modules are performance warranted to be in compliance with the minimum intensity values as shown in Table 925-19. Provide independent laboratory test results indicating that LED indications satisfy the minimum intensity Standards for LED traffic signal modules, measured at 120 V AC and 165 ºF (74 °C), for a period of five (5) years.

Ensure that the manufacturer's name, part number, date code, and electrical characteristics of the LED signal module is visible on the assembly, and that each LED signal module is identified for warranty purposes.

925.2.16 LED Pedestrian and Countdown Signal Module

A. **Requirements**

This specification covers LED traffic signal module designed as a retrofit replacement for the message bearing surface of nominal 16" x 18" traffic signal housing built to the PTSCI Standard. The message bearing surface of the module consists of an overlapping "Hand" and "Man" Symbols with a numerical display of numbers from 00 to 99.

1. General Requirements

   Ensure that the unit supplied meets the applicable portions of section 925.15 of this specification.

   Ensure that the message numbers "00" to "99" are a minimum of 7 inches in height and consist of two rows of LEDs.

   Ensure the module fits in the Pedestrian Signal Housing without modification to the housing and requires no special tools for installation.

   Supply LED signal modules that are watertight when mounted in the traffic signal housing.

   Supply life data from the LED Signal Module manufacturer to calculate the expected useful life

   Supply modules with permanent markings for date of manufacture and date of installation.

2. Optical

   Provide test data from an independent laboratory to verify that the performance of the product meets current ITE requirements.

   Ensure that the individual LEDs are wired such that a catastrophic failure of one LED will result in the loss of not more than 5% of the signal module light output.

   The failure of a single LED in a string causes loss of light from only that LED, not the entire string or indication.

   Provide control circuitry that prevents the current flow through the LEDs in the "off" state to avoid any false indications as may be perceived by the human eye during daytime and nighttime hours.

   Ensure that the LED signal module is operationally compatible with existing or new supplied conflict monitors (NEMA TS-1, NEMA TS-2, Model 210, Model 2010, ITS Cabinet CMU and AMU.

   Ensure that the LED Signal Module is operationally compatible with existing or new supplied load switches.

   Ensure that the intensity of the LED signal module does not vary by more than 10% over the allowable voltage range as specified in the electrical section below.

   Ensure that the LED signal modules maintain not less than 90% of the required intensity, as defined by the ITE intensity Standards for LED traffic signal modules.

   Ensure that each module provides an average luminous of at least 3750 candela per square meter of lighting surface for the "Hand" and 5300 candela per square meter for the Man symbol.

   Ensure this over the temperature range of –40 ºF to 165 ºF (–40 °C to + 74 °C) at 120 V AC, when new and after four (4) years of field installation.

   Provide an exterior lens which is uniform and frosted to reduce sun phantom effect.

3. Electrical

Supply LED signal modules that operate over the temperature range of –40 ºF to 165 ºF (-40 °C to 74 ºC).

Ensure that the power factor is 90% or greater, at nominal rated voltage, at 77 ºF (25 °C), after 60 minutes of operation.

Ensure that the total harmonic distortion (THD) is less than 20% at rated voltage, at 77 ºF (25 °C) and that all LED traffic signal modules are in compliance with FCC noise regulations.

Ensure that the LED signal modules operate on line voltage, 120 V AC nominal, and are able to operate over the voltage range of 80 V AC to 135 V AC.

Provide transient voltage suppression rated at 1,500 W for 1 millisecond and fusing with a maximum rating of 2 A to minimize the effect and repair cost of an extreme over voltage situation or other failure mode.

Ensure the modules allow a reduction of the intensity of the light output in response to an input from the traffic signal controller. Ensure the minimum light output when dimmed is not less than 30% of the minimum maintained luminous intensity as defined in the applicable ITE Signal Head Module.

4. Operation

Supply LED Modules which start counting when the flashing “Don Walk” Indication starts and will countdown to “0” when the steady “Don’t Walk” signal turns on. Ensure that the unit maintains a consistent countdown during a short power failure (i.e. Traffic Controller does not restart). Ensure that if Traffic Controller restarts that the countdown timer display is turned off until one full pedestrian clearance Cycle is timed. Ensure that the unit will turn off the counter if the steady Don’t Walk Display starts while the countdown timer is displaying a number other than 00.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Ensure that LED traffic signal modules and LED Pedestrian modules are performance warranted to be in compliance with the latest ITE and CALTRANS minimum intensity Standards for LED traffic signal modules, measured at 120 V AC and 165 ºF (74 °C), for a period of five (5) years.

Ensure that the manufacturer’s name, part number, date code, and electrical characteristics of the LED signal module is visible on the assembly, and that each LED signal module is identified for warranty purposes.

925.2.17 Blank-Out Signs

A. **Requirements**

Ensure that each sign provides a clearly visible and definable legend for 500 feet with ample safety factors.

Provide hardware to mount the sign on standard 1.5 inch (38 mm) pipe brackets or to mount directly to signal mast arms or span wire or as outlined in the Plans.

Ensure LED blankout signs conform to the requirements of section 9252.15 for LED modules and optical requirements

Supply blank-out signs face 30 inches x 36 inches (750 mm x 900 mm) that are capable of displaying one message at a time in one direction.

1. Case

Use a case formed from aluminum extrusion F1-6-E and a special aluminum door frame angle.

For Alloy 6063-T5, ensure that the wall is at least 0.075 inches thick and the corners and joints are at least 0.080 inches (2 mm) thick.

Use filler arc for all welding. Ensure all hinges and fastening hardware, nuts, bolts, fasteners on the housing and internal components are stainless steel.

Use a BR-type take-apart door hinge and draw bolt. Furnish one P-15 1.5 inch (38 mm) hub on the top surface.

Prime the entire case with zinc chromate, bake the inside with two coats of non-yellowing white, and paint the outside with two coats of highway yellow.

2. Electrical

   Ensure that all blankout signs are LED and conform to current ITE Standards. Supply all signs with the necessary mounting hardware to provide for mounting as shown on the Plans. Provide mounting for one way or two way configurations.

   Obtain approval for messages and letter dimensions from the Engineer.

3. Sun Phantom Screen

   Attach to each sign a heavy-duty aluminum louver-type sun phantom screen covering the entire sign face. Slant the louvers down enough to eliminate the sun glare without obstructing the view of the sign face.

4. Painting

   Paint the signal surfaces, inside and out, with two coats of oven-baked enamel in addition to the primer coat. Paint the non-illuminated portions of the signal face black. Paint the housings, brackets, fittings, and etc. highway yellow.

5. Lens

   Use a fabricated, three-section Plexiglas lens clear face, with or without legend, which can accept a silk-screened legend on the first surface. Provide a thickness of at least 0.31 inches (8 mm).

6. Legend

   Acceptable legends are as follows:

   - NO LEFT TURN
   - NO RIGHT TURN
   - SIGNAL AHEAD
   - NO TURNS

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.18 Lane-Use Control Signal

A. **Requirements**

Ensure that all signals are LED and conform to current ITE Standards. Supply all signals with the necessary mounting hardware to provide for mounting as shown on the Plans. Provide mounting for one way or two way configurations.

1. General Requirements

   a. Weight

   Ensure that one-way units weigh not more than 50 pounds (23 kg) and two-way units weigh not more than 60 pounds (27 kg), regardless of messages.

   b. Color

   Ensure that the color of lane-use control signal indications is clearly visible for 0.25 mile (0.38 km) at all times under normal atmospheric conditions. Provide lane-use control signals with a visibility angle of a minimum of 60 degrees.

   c. Housing

   Ensure that the housing of each signal is polycarbonate or a one-piece corrosion resistant aluminum alloy die casting or equal and meets current related ASTM Specifications.

   Ensure that all configurations are balanced to provide a plumb hanging unit. Ensure that all components are readily and easily accessible from the open door.

   d. Housing door

   Ensure that the housing door is one-piece corrosion resistant aluminum or polycarbonate and meets current related ASTM Specifications.

   Provide two substantial door hinges with stainless steel hinge pins. Ensure hinges are on the left side of each section with a latch boss on the right side.

   Provide stainless steel dual eye bolt latches or similar approved devices to securely close and latch the housing door. Equip the housing or door with a continuous molded neoprene gasket to make the interior of the unit dustproof and waterproof.

   e. Wiring

   Provide each signal housing with a complete terminal board. Ensure that one side of terminal strip accommodates socket leads and the other side accommodates field wires. Ensure that the terminal board provides totally separate wiring of each symbol.

   Ensure each lamp is separately wired to a terminal block located in each housing. Provide each lamp holder socket with color-coded leads.

   For combination symbols, color-code socket leads separately to distinguish between red “X”, yellow “X” or downward arrow symbols. Provide leads that are No. 14 AWG type THW, 600 V AC, and fixture wire with 194 ºF (90 °C) thermoplastic insulation.

   f. Visors

   Provide visors not less than 12 inches (300 mm) long for multiple unit and 7 inches (175 mm) long for single unit signals for each signal face.

   Ensure that the visors are constructed of sheet aluminum or polycarbonate and encompass the top and sides of each section.

   g. Painting

   Paint all signal surfaces, inside and out, with two coats of oven baked enamel in addition to the primer coat. Paint the insides of the visors flat black.

   The non-illuminated portions of the signal face black or dark gray and all housings, brackets and fittings highway yellow.

h. Hardware and fittings:

Supply all necessary fittings, pipe brackets, hangers, hubs, etc. for the type of mounting specified. Ensure all fittings are aluminum or galvanized coated to prevent rust and corrosion.

i. Sun -phantom screen

Provide each signal face with a screen, which substantially counteracts sun phantom effect.

2. Signal Display

Ensure that the symbols, which are on an opaque black or dark gray background, meet ITE requirements and are blacked out when not illuminated.

3. LED Optical System

a. Ensure that the LEDs supplied for the lane use control signal meet the Specifications for a type module as required in section 925.2.14. Ensure that each separate color indication in a sign face is illuminated by independent LEDs.

b. Ensure that the green arrow indication does not utilize the same termination points as any “X" indication.

c. Ensure that total power required for any single indication does not exceed 250 W.

d. Ensure that all modules are contained behind a water tight signal face or lens assembly.

e. Ensure that the entire optical system is weatherproof and is not vulnerable to extremes in temperature or moisture.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

926.2.19 Pedestrian Push Button Station

A. **Requirements**

Ensure that Pedestrian push buttons are of tamperproof construction and consist of a direct push type button and single momentary contact switch in cast aluminum housing. The pushbutton cover shall also be of cast aluminum. The housing and cover shall be free of voids, pits, dents, molding sand excessive foundry grinding marks. Exterior surface shall be smooth and cosmetically acceptable, free of molding fins, cracks and other exterior blemishes.

Provide housing and cover with an alodine conversion coating so as to provide a proper base for paint adhesion. Finish the housing with baked enamel and paint the push button housing and Pedestrian heads highway yellow (unless otherwise specified by the Engineer).

The assembly shall be capable of being mounted to a flat or curved surface. Ensure the assembly includes the appropriate sign as shown in the Plan Details.

Ensure that any screws or bolts are stainless steel. Provide the unit with a 0.5 inch (13 mm) threaded opening with plug.

Ensure that the assembly is weatherproof and so constructed that when properly installed, it will be impossible to receive an electrical shock under any weather condition.

Ensure that Pedestrian Pushbuttons are integrated with a sign as shown in the standard details. Only provide the 5” by 7” sign unless otherwise indicated in the Plans. .

Ensure the button assembly is configured to have an embossed arrow on the convex surface of the button. The arrow shall be capable of rotating for proper movement direction. Ensure the rotation of the button will not affect the successful operation of the pedestrian detection.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01D for Materials Warranties.

925.2.20 Signal Head Back Plate

A. **Requirements**

Ensure that each back plate is designed to properly shield a traffic signal head from background distractions for better visibility.

Design the back plates to extend beyond the signal head to a minimum of 6 inches (150 mm) on all sides and have all corners rounded with minimum 2 inch (50 mm) radii.

Construct the back plates from aluminum, UV stabilized polycarbonate or, ABS plastic material with a finished color of flat black. If aluminum back plates are provided ensure that each back plate has two coats of “baked on enamel” paint.

Ensure that polycarbonate back plates are at least 0.15 inches (4 mm) thick; ABS back plates are at least 0.05 inches (1 mm) thick and metal back plates are at least 0.05 inches (1 mm) thick.

Design the back plates with predrilled holes to provide for simple attachment to the specified brand, size and configuration of traffic signal head with all mounting hardware included.

Ensure that the back plates do not interfere with the signal mounting hardware. Ensure that the back plates include louvers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.21 Signal Head Visors

A. **Requirements**

Typically, visors are one piece tunnel type and removable unless specified otherwise in the signal Plans.

Ensure that visors are polycarbonate and at least 9 inches (225 mm) deep for 12 inch (300 mm) heads. Special angle visors are full circle with the long side at least 18 inches (450 mm) deep. Ensure that visors provide a positive method of attaching to the door of the signal head that do not allow rotation. An acceptable method is to provide tabs that use stainless steel screws.

Unless otherwise specified by the Engineer, provide black signal head visors.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.22 Signal Head Louvers

A. **Requirements**

Ensure that louvers (with the vanes oriented vertically) are directional with a 7-degree cutoff right of center. Rotating the louver 180 degrees will produce a 7-degree cutoff left of center.

Provide twelve-inch (300 mm) louvers with 5 vanes. Finish all louvered surfaces in flat black. Ensure that programmable louvers are directional with a 7-degree cutoff and that all louver surfaces have a flat black finish.

Ensure that the units can be installed and programmed in accordance with the manufacturer's instruction on visors that are recommended by the manufacturer.

Have the programmable louver display approved by the Engineer prior to placing the signal in stop and go operation.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.23 Hardware For Mast Arm Mounting

A. **Requirements**

Ensure that signal heads are rigidly mounted to the mast arm. Provide mounting hardware that is in accordance with the following:

1. Adjustability

   Ensure the mounting bracket is completely adjustable such that it allows; rotational adjustment about the bracket axis; vertical adjustment; rotational adjustment about the Mast Arm; and rotational adjustment from the vertical plane.

2. Attachment

   Ensure the bracket is provided with Stainless Steel Band to fasten the bracket to the arm. Ensure the bracket is easily adjustable to fit all sizes of round, elliptical or other shaped structure without special tools or equipment.

3. Signal Accomodations

   Ensure the bracket attaches to the signal to assure maximum rigidity by clamping the signal top and bottom. Ensure a standard bracket accommodates all major signal manufacturers signal for 3, 4 and 5 section signal head configurations.

4. Wiring

   All electrical wiring shall be completely concealed with the bracket. The vertical support shall be a gusseted “C” shaped extruded aluminum tube to accommodate the signal cable regardless of vertical positioning of the tube.

5. Materials

   The upper and lower arms shall be cast 319 aluminum or equivalent. The lower arm shall be internally threaded to accommodate the threaded vertical support tube. Ensure the lower arm is furnished with plastic covers which slide and snap into place. Both arms shall have 72 tooth serrations cast into the arm to assure a positive lock with signal housing and shall be secured about their rotational axis with setscrews. Ensure the arms have a tri-bolt arrangement for attachment to the signal housing.

   Ensure the vertical support is gusseted tube extruded from 6063-T6 aluminum. Ensure the tube includes a vinyl closure strip.

   Ensure the mast arm clamp assembly is cast from 713 aluminum alloy or equivalent. Provide an assembly that allows for 360 degrees of rotation with no internal bracing obstructing the center opening. Provide two stainless steel bands that have minimum tensile strength of 100,000 PSI.

   Ensure that each bracket is complete with all necessary bolt, washers, gaskets and miscellaneous items to allow assembly of the signal to the bracket and the bracket to the mast arm. Ensure all aluminum parts have an Aldine finish. All non stainless steel parts shall have a yellow zinc di-chromate or galvanize finish.

This item will be approved upon submittal of catalog cuts. Refer to Standard Detail Drawings for additional information.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01D for Materials Warranties.

925.2.24 Hardware For Signal Head Pole Mounting

A. **Requirements**

Ensure this item consists of hardware adequate for the specific mounting. As a minimum provide the following hardware. 1 ½ inch pipe nipples of die cast aluminum that are a minimum of 12 inches and threaded with 1 ½ inch NPS threads on either end. On the upper and lower arm there shall be a serrated 72 tooth boss with set screw. The upper arm shall have a neoprene gasket to provide weather tight fit. Hub plates for pole mounting shall be provided and they shall be appropriate for the particular mounting (round or flat). Hardware shall die cast aluminum alloy 380 or extruded. All die cast parts shall be cleaned in an alkaline cleaning compound Extruded parts shall have an alodine conversion coating to provide proper base for paint adhesion. The assembly is to be painted federal yellow and baked in an oven. Ensure the assembly is provided with all required hardware. All other hardware shall be stainless steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure that this item consists of hardware as shown in the standard details.

This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.25 Balance Adjuster

A. **Requirements**

Ensure this item consists of hardware that is cast from 316 Stainless Steel or 65-45-12 Ductile Iron or equivalent. Ensure castings are free of voids, pits, dents, molding sand and excessive grinding marks. Exterior surface shall be cosmetically acceptable and free of molding fins, cracks and other exterior blemishes. All hardware shall be supplied and be stainless steel or galvanized.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure this item consists of hardware as shown in the Standard Details. This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.26 Hardware For Mounting 12 Inch (300 mm) Pedestrian Head

A. **Requirements**

Ensure this item meets the same criteria as 925.2.24.A and is in accordance with the Standard Details.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure this item consists of hardware as shown in the Standard Details. This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.27 Pedestal Pole

A. **Requirements**

The Pedestal poles support vehicle signal heads, pedestrian signal heads, and push button. Furnish Pedestal poles according to type and overall length.

Pedestal pole for vehicle display for one lane ramp metering operation shall be constructed to support one 12” signal head and one 8” signal head assembly as shown in the Plans.

Pedestal pole for ramp meter advance warning sign and flashing beacon shall be constructed to meet the sign manufacturer’s structural requirements. Pedestal pole mounting adapter shall rigidly attach to the sign case’s structural bracing. Cable entrance to the sign case shall be through the inside of the pole.

1. Ensure that all poles are made of one continuous piece of bare finish aluminum from top to base connection for the entire height of the pole.

   The shaft, of appropriate shape, may or may not be uniformly tapered from butt to tip. A pole used to support only a traffic signal may be tapered.

2. Fabricate pole caps, when required, of cast material, and secure in place with set-screws.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.28 Pedestal Pole Base

A. **Requirements**

Ensure that all design radii are smooth and intact. Ensure that the exterior surface finish is smooth and cosmetically acceptable by being free of molding fins, cracks and other exterior blemishes.

Fabricate from new aluminum ingot. Do not use scrap materials.

Minimum requirements are as follows:

ALUMINUM ALLOY NO.	319	ELONGATION [% IN 2 IN. (50 mm)]	2.5
TENSILE STRENGTH, KSI (MPa)	34 (234)	BRINELL HARDNESS	85
YEILD STRENGTH, KSI (MPa)	19 (131)	SHEAR STRENGTH, KSI (MPa)	232 (1600)

1. Ensure this item consists of square cast aluminum with bare finish, and has a minimum weight of 21 pounds (9.5 kg). Thread the upper end to receive a 4 inch (100 mm) National Pipe Thread (NPT) pipe shaft.
2. Design the base so that it may be fastened to a foundation with four (4) 0.75 inch (19 mm) anchor bolts located 90 degrees apart on the bottom of the base. Provide slots in the bottom of the base 1.5 inch (38 mm) wide and 2.5 inches (63 mm) long measured along the circumference of the bolt circle, allowing a proper fit even if the bolts are placed slightly off center.
3. Design the base to accommodate bolt circles of a minimum of 12 inches (300 mm) through a maximum of 14.5 inches (363 mm) and anchor bolts with a minimum of 0.63 inches (16 mm) through 1 inch (25 mm) diameter.
4. Design the base with a removable plastic door. Ensure that the door opening is free of burrs and sharp edges and is no less that 8.5 inches (213 mm) square. Attach the door to the base using one socket button head screw to prevent unauthorized entry.
5. Ensure that the base meets or exceeds 1985 AASHTO breakaway requirements. Provide test reports from an FHWA approved independent laboratory certifying that the base has been tested and meets all applicable requirements. In addition, supply a statement of certification from the FHWA stating such tests have been accepted and approved.
6. In order to prove structural soundness, provide a certification from a recognized independent structural laboratory certifying that the base will withstand a bending moment of 10,750 ft-lbs (14 575 N-m).
7. Ensure that the door is injection molded from ABS plastic to deter vandalism and theft, and has the following properties:

TEST	ASTM METHOD	VALUE
Tensile @ Yield [0.13 inches (3 mm)]	D638	6600 psi (45 500 kPa)
Flexural @ Yield	D790	11,000 psi (75 850 kPa)
Rockwell Hardness	D785	101 (R Scale)
Notched Izod	D256	5 ft-lb./in. (0.03 N-m/mm)

8. Ensure that the door exhibits the following properties:

- Has an edge thickness of 0.25 inches (6 mm) and a minimum thickness of 0.156 inches (4 mm)
- Contains flame-retardant material, meeting or exceeding underwriters laboratories UL 94 test H.B
- Gray aluminum tone in color, unless otherwise specified
- Contains ultra-violet inhibitors and stabilizers for protection against UV degradation
- Is injection molded with a smooth front finish
- Has flat and straight surfaces without blisters, buckling or warping; have reinforcing ribs
- Contains two (2) injection molded lugs on the bottom of the door with slots of the proper width and depth to fit the base door opening.

9. Supply the base with a set of four (4) anchor bolts, 0.75 inch (19 mm) diameter by 18 inches (450 mm) in length, material per ASTM A 572A 572M, Galvanized per ASTM A 153/A 153M. Supply (1) hex nut and (1) flat washer with each bolt.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

925.2.29 Pedestal Pole Foundation Anchor Asembly

A. **Requirements**

Provide Foundation Anchor assembly that is 4 inches (100 mm) in diameter by 56 inches (1400 mm) with a single helical blade and a square fixed baseplate with combination underside holt-head retainer and dirt scrappers allowing flush- mount with the ground.

Provide Baseplate that is steel and conforms to ASTM A-36 material. Provide pipe with helical blade that is manufactured from ASTM A-53ERW Grade B Steel. Ensure 4 inch pipe has 2 inch (50 mm) by 3 inch (75mm) entrance hole 18 inches below the steel plate. Ensure the anchor assembly is hot dipped galvanized finish after fabrication and complies with ASTM A-123.

Ensure base plate has four slotted mounting holes to fit bolt circles from 7 ¾ inch (195mm) to 14 ¾ inch (375 mm. Provide 4 slotted mounting hole with a ¾ inch keyhole slot to permit bolt installation and replacement from the top surface without digging under the baseplate.

Ensure assembly is furnished with;

- Quantity of four ¾ inch(20 mm) -10NC x 3 inch(75 mm) square head galvanized ASTM 325 anchor bolts;
- Quantity of four ¾ inch(20 mm) plain flat galvanized washers;
- Quantity of four 3/16 inch(5 mm) thick galvanized plate washers;
- and Quantity of four ¾ inch (20 mm) galvanized hex nuts.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.30 Timber Poles

A. **Requirements**

Ensure that all timber poles meet the requirements of Section 861. Poles must be inspected and tested by the GDOT Office of Materials and Research and hammer stamped by the inspector.

Ensure that all poles have a brand or stamp 10 feet (3 m) from the butt that notes the type wood, date of manufacture, manufacturer, class and length.

Ensure that all timber poles that have guy attachments or support span wire or arms that suspend signal heads over the roadway or sidewalk are Class II.

Poles that support loop lead-in, messenger or communications cable that does not have guy attachments may be Class IV size.

Ensure that all poles meet the requirements in the table below unless otherwise noted on the traffic signal Plans or list of materials.

Class	Nominal Length, ft (m)	Minimum Circumference At 6 feet (2.4 m) from butt, in. (mm)
II	30 (9)	34.0 (850)
II	35 (10.5)	36.5 (913)
II	40 (12)	38.5 (963)
II	45 (13.5)	40.5 (1013)
II	50 (15)	42.0 (1050)
IV	30 (9)	29.5 (738)
IV	35 (10.5)	31.5 (788)
IV	40 (12)	33.5 (838)
IV	45 (13.5)	35.0 (875)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.31 Steel Strain Poles

A. **Requirements**

Ensure that steel strain poles conform to Section 639 and include hardware for span wire attachments, anchor base, and anchor bolts for the purpose of supporting span wire suspended signs and/or signals.

For signal supports, ensure that the opening at the top and bottom of the pole is large enough to allow all wiring into and out of pole. Do not strap conduit to strain pole because of insufficient opening allowances.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.32 Pre-Stressed Concrete Strain Pole

A. **Requirements**

Ensure that Pre-stressed concrete strain poles for overhead signs and signal supports conform to Section 500.

For signal supports, ensure that the opening at the top and bottom of the pole is large enough to allow all wiring into and out of pole. Do not strap conduit to strain pole because of insufficient opening allowances.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.33 Traffic Signal Pull Box

A. **Requirements**

Ensure that traffic signal pull boxes a matched assembly of a box and cover from the same manufacturer.

For all pull boxes except Types 4 and 5, use pull boxes manufactured in a single unit for the full depth required in the size in an open bottom configuration. Do not use stacked pull boxes.

For pull boxes Types 4 and 5, use stacked pull boxes as shown in the Plans, where the top unit is open bottom and the bottom unit is closed bottom manufacture. In the bottom unit provide a drain hole.

Provide pull boxes that are constructed of fiberglass-reinforced composite polymer concrete product or steel wire reinforced Portland cement concrete product with a concrete gray or tan color.

Ensure that pull boxes meet all requirements of ANSI 77 2002 Tier 15. Provide compliance test documentation.

Provide a ¼-inch galvanized wire mesh between the gravel base and the open bottom box or closed bottom box drain hole for all pull box types.

Use Type 1 pull boxes [12 inches x 12 inches (300 mm x 300 mm)] for loop lead-ins. When loop lead-ins and splices and other cables are required, use Type 2 pull boxes [11 inches x 18 inches (275 mm x 450 mm)] or Type 3 pull boxes [17 inches x 30 inches (425 mm x 750 mm)].. Use Type 4, 4S, 5, 5S, 6 and 7 pull boxes for fiber optic cable. Furnish one-piece covers for all pull boxes except Types 5, 5S, and 7.

Furnish two-piece covers for Types 5, 5S, and 7.

Furnish covers with a skid-resistant surface with a minimum coefficient of friction of 0.5 when tested in accordance with ASTM C1028.

Furnish covers with stainless steel hold-down bolts, minimum size 3/8-16.

Furnish covers with the logo “TRAFFIC SIGNAL” for pull box Types 1, 2 and 3, and with other pull box types when installed for traffic signal cabling at a traffic signal.

Unless otherwise shown in the Plans or installed for traffic signal cabling at a traffic signal, furnish covers with the logo "GDOT COMMUNICATIONS" for pull box Types 4, 4S, 5, 5S, 6 and 7.

Furnish pull box Types 4, 5, 6 and 7 with factory-installed cable racks and rack hooks.

Cable racks and rack hooks shall be hot-dipped galvanized steel.

Each cable rack rail shall be minimum 24 inches (600 mm) in length with rack hook mounting holes on the entire length. Install two racks on each of the pull box long side walls. For Type 4 and 5 pull boxes only, each cable rack rail may be comprised of two minimum 12 inch (300 mm) units installed on the stacked box side walls.

Mount cable racks to the side walls using minimum 3/8-16 stainless steel hardware.

Furnish a minimum of four rack hooks, minimum 6 inch length (150 mm), per pull box. Furnish an additional four rack hooks for each through cable stored in the pull box. Furnish an additional two rack hooks for each splice closure stored in the pull box.

Furnish Types 6 and 7 pull boxes with factory-installed non-metallic conduit terminators for Sch. 40 and SDR11 2-inch (53 mm) of the quantity and location as shown in the Plans, or for a different conduit size if shown in the Plans. Terminator bodies shall be manufactured from high-impact polystyrene or approved equivalent.

When joining conduits of dissimilar materials, furnish an airtight and watertight conduit adhesive intended for direct-contact underground use.

Refer to the Standard Detail Drawings and the Traffic Signal Design Manual for further information.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.34 Prefabricated Controller Cabinet Base

A. **Requirements**

Ensure that prefabricated controller cabinet bases are designed to withstand wind loading of 100 mph (160 km/h) with the cabinets as shown in the Plans mounted. Refer to Standard Detail Drawings for further information. Ensure the prefab controller cabinet base has the correct bolt pattern for the cabinet(s) to be installed. Only provide precast polymer concrete products that have been preapproved.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.35 Loop Lead-In Cable

A. **Requirements**

Ensure that loop detector lead-in cable is No. 18 AWG, 3-pair shielded cable that meets IMSA specification #50-2.

Ensure that identification markings are stamped on the jacket.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.36 Loop Detector Wire

A. **Requirements**

Ensure that loop detector wire, meets IMSA specification 51- -3 and is 14 AWG..

Ensure that identification markings are stamped on the cable jacket.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.37 Aerial (Lashed) & Duct Signal Cable

A. **Requirements**

Ensure that aerial (lashed) or duct (conduit) No. 14 AWG, stranded, 7-conductor, with black polyethylene (PE) jacket and 600 V AC rating meets IMSA specification #20-1. Use conductors that are straight, not twisted pairs.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.38 Self-Supporting Twisted Pair Aerial Signal Communications Cable

A. **Requirements**

Ensure that self-supporting, figure eight, aerial signal communications cable, No. 19 AWG, stranded 6-pair conductors is rated at 600 V AC and meet IMSA specification #20-4-1984.

Use conductors that are twisted pairs with copper tape shield under a black PE jacket. Ensure that messenger strand is 0.25 inch (6 mm), 7-strand and conforms to ASTM A 475 Siemens-Martin grade or better with a Class A coating.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.39 Underground Feeder Cable, Type UF

A. **Requirements**

Ensure that underground feeder cable, Type UF w/ground has two (2) conductors with pvc/nylon jacket and a minimum 600 V AC rating per UL #493. Two-conductor, No. 6 AWG wire may be used.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.40 Messenger & Guy Strand (Span Wire)

A. **Requirements**

Ensure that all messenger and guy strand (span wire) conforms to ASTM A 475 Siemens-Martin grade or better with a Class A coating, 7-wire span wire.

Ensure ¼-inch (6 mm) Messenger & guy strand shall be used to support interconnect cable or as tether spans.

Messenger & guy strand 0.31 inch (7 mm) shall be used only where it is essential to match an existing 0.31inch (7 mm) span wire that will not be replaced as part of a new installation.

Ensure all span wire for signal heads, blank out sign, optically programmed heads, lane control signs, standard, aerial or sidewalk guys uses a minimum Messenger & guy strand 0.38 inch (9 mm) as a minimum size.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.41 Power Disconnect Box

A. **Requirements**

Ensure that all power disconnect boxes are NEMA 3R 240 V AC, 60 Amp Phase 1(metal non-fused 2 pole). Ensure the disconnect box is supplied with a padlock keyed as per directions of District Signal Engineer. Provide power disconnect box that is not fused and does not have a circuit breaker. Supply with a service grounding kit.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.42 Cable Ties

A. **Requirements**

Ensure that all cable ties are nylon, ultraviolet resistant black and consist of the following as a minimum:

Nominal Length	8 inches (200 mm)
Width	0.30 inches (7 mm)
Tensile Strength	120 pounds (55 kg)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.43 Lashing Rod

A. **Requirements**

Ensure that all lashing rods are sized in accordance with messenger and cable(s) diameters to be supported. Provide lashing rods that are of the same material as the messenger or guy strand.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.44 Stainless Steel Lashing Wire

A. **Requirements**

Provide lashing wire that is type 316 stainless steel with 0.045 inch (1 mm) diameter.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.45 Guy Insulators

A. **Requirements**

Ensure that all guy insulators are high impact resistant PVC with ultraviolet stabilizers added for retention of color. Ensure that insulators attach to the guy so that they cannot easily be removed. Use guy insulators which are yellow unless otherwise directed.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.46 Universal Closure Kit

A. **Requirements**

Supply a Universal Signal Closure Kit to seal the signal head at either the top or bottom. Ensure that the kit will fit any manufacturer’s signal head (top or bottom) without the use of special tools or modification.

1. Ensure that the gasket is 60-70 durometer neoprene.
2. Ensure that Closure Cap is injection molded ABS plastic. The plastic is to be loaded with UV stabilizers.
3. Ensure that Adapter Bar is made so that it will secure the closure cap and compensate for varying thickness of signal heads.
4. Provide two # 10 (9mm) screws to fit any manufacturer’s signal head. Ensure that one screw is 0.75 inches (19 mm) in length and the second screw is 1 inch (25 mm) in length.
5. Pack each assembly in a clear plastic bag. Mark the bag with the manufacturer’s name and part number. Include the Universal Signal Closure Kit in a package containing the span wire clamp and Tri-Stud wire entrance fitting.
6. Ensure that the Closure Cap is molded to closely match the color of the signal head (Federal Yellow). The adapter bar and screws are to be zinc plated steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.47 Cast Aluminum Span Wire Clamp

A. **Requirements**

Provide Span Wire Clamps that are cast from Aluminum Alloy 713 or equivalent, free of voids, pits, dents, molding sand and excessive foundry grinding marks. Ensure that all design radii are smooth and intact.

Provide an exterior surface finish that is smooth and cosmetically acceptable, free of molding fins, cracks and other exterior blemishes. Ensure that span wire clamps are fabricated from aluminum ingot with minimum requirements as follows:

- ALUMINUM ALLOY No. 713
- YIELD STRENGTH, ksi (MPa) 25 (172)
- TENSILE STRENGTH, ksi (MPa) 35 (240)
- BRINELL HARDNESS 75
- ELONGATING [% in 2 inches (50 mm)] 3

1. Ensure that the Span Wire Clamp can accommodate cables 0.25 inch (6 mm) to 0.63 inch (16 mm) diameter.
2. Ensure that the weight is less than 1.75 pounds (0.8 kg) with hardware.
3. Ensure that the Span Wire Clamp have a minimum overall length of 7 inches (175 mm).
4. Ensure that the Span Wire Clamp have a centerline dimension from cable to clevis pin of 2 inches (50 mm) [+/- 0.5 inches (13 mm)].
5. Ensure that the Span Wire Clamp have a cast aluminum cable bar to protect the cable when tightening the U-bolts.
6. Ensure that the Span Wire Clamp have a mounting opening of 0.75 inches (19 mm) [+/- 0.03 inches (0.8 mm)].
7. Ensure that the Span Wire Clamp have 0.5 inch (13 mm) - 13 NPT U-bolts with 0.5 inch (13 mm) lock washers and nuts.
8. Ensure that the clevis pin are 0.63 inch (16 mm) diameter with a length of 2.25 inches (56 mm) and secured with a hump back stainless steel cotter pin.
9. Ensure that the Clamp and Cable Bar have an Alodine 1200 conversion coating to help resists oxidation.
10. Ensure that the Clevis Pin and hardware are galvanized per ASTM 123/A 123M or stainless steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.48 Cast Aluminum Tri-Stud Span Wire Entrance Fitting

A. **Requirements**

Ensure that the Tri-Stud Span Wire Entrance Fittings are cast from Aluminum Alloy 713 or equivalent, free of voids, pits, dents, molding sand and excessive foundry grinding marks.

Ensure that the all design radii are smooth and intact. Ensure that the exterior surface finish is smooth and cosmetically acceptable, free of molding fin, cracks and other exterior blemishes.

Ensure that the material is fabricated from aluminum ingot with minimum requirements as follows:

- ALUMINUM ALLOY No. 713
- YIELD STRENGTH, ksi (MPa) 25 (172)
- TENSILE STRENGTH, ksi (MPa) 35 (240)
- BRINELL HARDNESS 75
- ELONGATION [% in 2 inches (50 mm)] 3

1. Ensure that the Tri-Stud Span Wire Entrance fitting has a mounting support at the top of the wire entrance 0.69 inches (17 mm) thick [+/- 0.07 inches (1.5 mm)].
2. Ensure that the Tri-Stud Span Wire Entrance fitting weight is not less than 1.75 pounds (0.8 kg) with hardware.
3. Ensure that the mounting support has at least six (6) clevis openings for adjustment with suspension bracing between every two (2) openings.
4. Ensure that the Tri-Stud Span Wire Entrance has a minimum of 0.5 inch (13 mm) diameter throughout for wire access and that wire access is free of burrs and casting webs.
5. Ensure that the Wire Entrance opening is recessed and has a neoprene grommet with sealed membrane sections.
6. Ensure that the signal head attachment end is serrated and has a minimum of 3-signal head centering bosses extending 0.19 inches (5 mm) from the serrations.
7. Ensure that the serrations have a 72-tooth design to match the signal head.
8. Ensure that three (3) stainless steel studs are cast into the wire entrance fitting. Ensure that the studs are 0.31 inches (7 mm) and extend 1.5 inches (38 mm) [+/- 0.13 inches (4 mm)] beyond the serrations. Provide each Tri-Stud span wire entrance fitting with a Tri-Stud hardware kit.
9. Ensure that the Tri-Stud Span Wire Entrance Fitting has an alodine conversion coating to provide a proper base for paint adhesion. Ensure that the assembly is painted federal yellow and baked in a drying oven after painting.
10. Ensure that the all Hardware is galvanized or stainless steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.49 Bull Rings

A. **Requirements**

Provide bull rings that are galvanized weldless steel 0.63 inch (16 mm) diameter. Submit catalog cuts for approval.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.50 Ramp Meter Enforcement Device

A. **Requirements**

For each metered lane, provide one ramp meter enforcement device mounted on the back of one signal per lane and wired directly to the red signal display, (Refer to 647.3.05.L). This installation shall include a Red 44 LED Array (allnGaP), Pixel housing, 6061 aluminum powder coated swivel bracket, 2 inch lens, with an aluminum hood. Mounted and adjusted as per the Plans.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.51 Advance Warning Flasher Blank-Out Sign

A. **Requirements**

The Advance Warning Flasher blank-out sign shall display the message “PREPARE TO STOP” and shall have the dimensions shown in the Plans. The advance warning flasher blank-out sign assembly shall consist of:

- The legend color shall be double stroke red LED Letters
- The LED shall conform to the Federal color Standards.
- The formed letters shall conform to the United States Department of Transportation's Standard Alphabet.
- Two yellow 12 inches (300 mm) traffic signal heads (flashing Beacons) shall be mounted on each end of the sign as shown in the Plans.
- The Yellow Flashing Beacon will be designed using the 925.2.06 Flashing Beacon Assembly, 925.2.15 LED Signal Modules, and 925.2.11 Vehicle Signal Heads requirements. The Yellow Flashing Beacon shall alternate. The flashing beacon cabinet assembly shall be located outside attached to the sign pedestal pole. The surge arrestor in the flashing beacon cabinet assembly shall protect the blank-out sign and the flasher unit/flashing beacons. Provide a non-fused disconnect switch instead of the circuit breaker required in 925.2.06, wired to disconnect all power to the advance warning flasher assembly.
- The sign shall be equipped with a photo-cell for dimming of the sign legend. Dimming shall be as per the manufacturers Specifications.
- The assembly shall be capable of continuous operation over a temperature range of -37 °C (-34 F) to +74 °C (165 F). The advance warning flasher blank-out sign assembly housing shall consist of:

- The entire front face of the sign shall be protected by a sheet of polycarbonate mounted in the cast door frame. Lens material shall be 3 millimeter thick clear polycarbonate with vandal resistant properties.
- The sign shall include a 2.5 millimeter thick aluminum weatherproof housing and door with internal structural frame.
- The interior of the unit shall be painted with a flat black enamel to eliminate internal reflection and two coats of yellow standard color No. 13538 baking enamel for exterior surfaces.
- The signal shall completely blank-out when not energized.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

925.2.52 Vinyl Electrical Tape

A. **Requirements**

Ensure electrical tape used is flame retardant, cold and weather resistant. Provide tape that is rated for 600 volts and for use between 0 F (-18 C) and 176 F (80 C).

Ensure tape is 0.0085inches (0.2 mm) thick and meets the requirements of UL 510 and Mil-I-24391.

Provide tape that remains flexible with abrasion resistance.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to Subsection 925.2.01.D for Materials Warranties.

November 18, 2005

Section 934—Rapid Setting Patching Materials for Portland Cement Concrete

Delete Section 934 and substitute the following:

934.1 General Description

This section includes the requirements for rapid setting patching materials used in Portland cement concrete.

934.1.01 Related References

A. **Standard Specifications**

Section 886—Epoxy Resin Adhesives

B. Referenced Documents

AASHTO	ASTM
T 97 T 260	C 31/C31M C 109/C 109M C 140 C 666

Federal Hazardous Products Labeling Act

QPL 27

934.2 Materials

934.2.01 Rapid Setting Patching Materials

A. **Requirements**

1. Use rapid setting patching materials that have the following characteristics:
   - Are nonmetallic.
   - Have a color similar to Portland cement concrete.
   - Can be mixed and placed like concrete.
   - Have accelerated hardening characteristics.
   - Yield a permanent patch in concrete that can withstand traffic within 2 hours.

   For a list of sources, see QPL-27.
2. Type I

   Use Type I to patch reinforced or nonreinforced horizontal Portland cement concrete surfaces.
3. Type II

   Use Type II to patch only nonreinforced horizontal Portland cement concrete surfaces.
4. Type III

   Use Type III to patch reinforced vertical or overhead Portland cement concrete surfaces.
5. Classify Type I, Type II, and Type III as follows:
   a. Class A, Premixed: Use these materials as received by adding water or an activator solution, according to the manufacturer's instructions.

   NOTE: DO NOT add extra aggregate to Class A patching material without approval from the Office of Materials and Research.

   b. Class B, Non-Premixed: These materials contain no aggregate. Add aggregate (fine and/or coarse) according to the manufacturer's recommendations.
6. Type IV

   Use hot applied elastomeric patching material to patch nonreinforced horizontal Portland cement concrete surfaces.

7. Type V

   Use two-component cross linked resins to patch nonreinforced horizontal Portland cement concrete surfaces.

8. Physical Requirements

   Ensure that Type I, Type II, and Type III rapid setting patching materials meet these requirements when tested with the required test methods.

Requirement	Measurement
Flow of Mortar, Type I and Type II Type III	100% minimum 80% to 100%
Flexural Strength, Minimum	500 psi (3.5 MPa) in 24 hours
Compression Strength, Minimum	
2 hours	1,200 psi (8.5 MPa)
24 hours	3,000 psi (20 MPa)
7 days (moisture cure)	4,000 psi (27.5 MPa)
Absorption, Maximum	10%
Shear Bond, Minimum	200 psi (1.5 MPa) in 24 hours
Freeze Thaw Durability Factor	75% of the reference concrete after 300 freeze-thaw cycles
Total Chlorides	
Type I and Type III Type II	0.6 lb/yd^3 (0.4 kg/m^3) maximum No limits

9. Submittals

   For the Freeze-Thaw test, submit to the Department a certification from the manufacturer showing results of durability tests conducted by an independent professional testing laboratory.

   Conduct the tests according to ASTM C 666. Express the durability as a durability factor.

B. Fabrication

1. Packaging

   a. Package this material in strong, moisture-proof paper bags or other suitable containers that can withstand shipping, normal handling, and storage without breaking.

   b. Clearly label each container of the components of a patching system with the following information:

      - Component designation, if two components.
      - Manufacturer’s batch number.
      - Mixing ratio and directions.
      - Potential hazards and precautions displayed according to the Federal Hazardous Products Labeling Act.

C. Acceptance

1. Follow the mixing instructions of the manufacturer to create test specimens.
2. Air-cure all test specimens except for the 7-day moisture cure cubes.
3. Test Types I, II, and III using the following methods:

Test	Method
Flow of mortar	ASTM C 230
Flexural strength	AASHTO T 97
Compressive strength	ASTM C 109/C 109M or C 31/C 31M, whichever is applicable
Absorption	ASTM C 140
Shear bond strength	See Subsection 934.2.01.C, “Acceptance”, Step 4
Rapid freeze thaw	ASTM C 666
Total chlorides	AASHTO T 260

4. Shear Bond Strength
   a. Place a Type II epoxy resin adhesive meeting the requirements of Section 886 on the surface of a cured mortar bar 16 x 3 x 3 in (400 x 75 x 75 mm).
   b. Cast a 16 x 2 x 0.5 in (400 x 50 x 13 mm) rapid-setting material patch in the center of the mortar base.
   c. Air-cure the test sample for 24 hours.
   d. Saw the mortar bar base and the cured rapid setting material patch into 2 in (50 mm) segments for testing.
   e. Use a holding device and plunger to apply a load at a rate of 0.05 in (1.3 mm) per minute to the patch until the patch fails.
   f. Read the load in pounds (newtons) on the plunger.
   g. Calculate the shear bond strength in pounds per square inch by dividing the load in pounds by the interfacial area of the patch in square inches. Calculate the metric equivalent for shear bond strength in MPa by dividing the load in newtons by gravitational acceleration ($9.81\ m/s^2$).
5. The Department will conduct one year field evaluations for each Type IV and Type V patching material.
6. The Department will reject a patching system that meets all the requirements of this Specification, but does not work as required in actual use.

D. Materials Warranty

Ensure that the material has a minimum storage life of at least 1 year under conditions of 40° to 90° F (4° to 32° C) and maximum relative humidity of 90 percent.

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January 20, 2006

Section 941—Macro-Synthetic Fibers for Concrete Reinforcement

941.1 General Description

This section includes the requirements for manufacturing macro-synthetic fibers which are permitted as reinforcement in lieu of steel reinforcement in the following selected precast concrete products:

- Precast concrete manhole riser sections
- Precast concrete flared end sections

941.1.01 Related References

A. **Standard Specifications**

Section 866–Precast Concrete Catch Basin, Drop Inlet, and Manhole Units

B. Referenced Documents

ASTM C 1116

ASTM C 1399

ASTM D 3822

QPL 86

GDOT Standard 1120

941.2 Materials

For a list of sources, see QPL 86.

941.2.01 Macro-Synthetic Fibers for Concrete Reinforcement

A. **Requirements**

1. Ensure that macro-synthetic fibers are manufactured from virgin polyolefins (polypropylene and polyethylene) and comply with ASTM C 1116.4.1.3. Fibers manufactured from materials other than polyolefins must show documentary evidence confirming their long term resistance to deterioration when in contact with the moisture and alkalies present in cement paste and/or the substances present in air-entraining and chemical admixtures.
2. The minimum fiber length required is 1.50 in (38 mm).
3. Ensure that macro-synthetic fibers have an aspect ratio (length divided by the equivalent diameter of the fiber) between 45 and 150.

B. Acceptance

1. Ensure that macro-synthetic fibers have a minimum tensile strength of 40 ksi (276 MPa) when tested in accordance with ASTM D 3822.
2. Minimum dosage rate in pounds of fibers per cubic yard is established by determining a minimum average residual strength of no less than 150 psi (1034 kPa) when tested in accordance with ASTM C 1399. In all cases, ensure a minimum fiber dosage rate of 5 lbs/yd3 (2.9 kg/m3) and a maximum fiber dosage rate of 10 lbs/yd^3 (5.9 kg/m^3).
3. Ensure that macro-synthetic fibers have a minimum modulus of elasticity of 400 ksi (2758 MPa) when tested in accordance with ASTM D 3822.
4. The fiber manufacturer is required to obtain independently performed test results that confirm the requirements listed herein and submit those for approval by the Engineer.
5. Approved fibers are listed on the Department’s Qualified Products List 86 (QPL-86), "Macro-Synthetic Fibers for Concrete Reinforcement".

C. Materials Warranty

General Provisions 101 through 150.