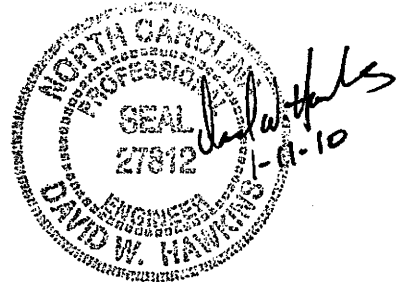


PROJECT SPECIAL PROVISIONS (PSP)
STRUCTURES



TERMS AND DEFINITIONS

(SPECIAL)

Unless noted otherwise, the following terms and their associated definitions are applicable throughout these Project Special Provisions:

Terms

Definitions

Railway, Railway Company,
Railroad, Railroad Company

Norfolk Southern Corporation

Railroad Engineer

The authorized representative of the Railway.

AREMA

American Railway Engineering and
Maintenance-of-Way Association.

NCDOT, Department,
Department of Transportation

North Carolina Department of Transportation.

Standard Specifications,
Specifications

NCDOT Standard Specifications for Roads and
Structures, January 2002.

Engineer, Department's Engineer
Project Engineer, Highway Engineer

The authorized representative of the NCDOT.

Inspector, Department's Inspector

The authorized inspector of the NCDOT.

PORTLAND CEMENT

(SPECIAL)

Portland Cement shall meet the requirements of the Standard Specifications for the type specified for the work. In addition, in order to minimize alkali content, the total percentage of sodium oxide (Na₂O) present plus 0.658 times the total percentage of potassium oxide (K₂O) present shall not exceed 0.60 percent. The Contractor shall furnish the Engineer with two (2) copies of certified mill test reports from the manufacturer stating that all cement meets the above requirements.

Flyash may be substituted for cement in the amounts shown in Section 1024-1(A) of the Standard Specifications provided that the minimum cement requirement as shown on the Plans has been satisfied. In no case shall the substitution of flyash or other admixtures approved by the Engineer be in lieu of the minimum cement requirements.

FINE AND COARSE AGGREGATE**(SPECIAL)**

The fine and coarse aggregates used in all concrete on the railway structure shall be non-reactive in accordance with the "Method of Test for Potential Reactivity of Aggregates (Chemical Method)", ASTM Designation C289-81. The Contractor shall furnish the Engineer two (2) copies of the above test reports certifying that the fine and coarse aggregates are non-reactive and will not cause an alkali reaction.

FALSEWORK AND FORMWORK**(7-18-06)****1.0 DESCRIPTION**

Use this Special Provision as a guide to develop temporary works submittals required by the Standard Specifications or other provisions; no additional submittals are required herein. Such temporary works include, but are not limited to, falsework and formwork.

Falsework is any temporary construction used to support the permanent structure until it becomes self-supporting. Formwork is the temporary structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Access scaffolding is a temporary structure that functions as a work platform that supports construction personnel, materials, and tools, but is not intended to support the structure. Scaffolding systems that are used to temporarily support permanent structures (as opposed to functioning as work platforms) are considered to be falsework under the definitions given. Shoring is a component of falsework such as horizontal, vertical, or inclined support members. Where the term "temporary works" is used, it includes all of the temporary facilities used in bridge construction that do not become part of the permanent structure.

Design and construct safe and adequate temporary works that will support all loads imposed and provide the necessary rigidity to achieve the lines and grades shown on the plans in the final structure.

2.0 MATERIALS

Select materials suitable for temporary works; however, select materials that also ensure the safety and quality required by the design assumptions. The Engineer has authority to reject material on the basis of its condition, inappropriate use, safety, or nonconformance with the plans. Clearly identify allowable loads or stresses for all materials or manufactured devices on the plans. Revise the plan and notify the Engineer if any change to materials or material strengths is required.

3.0 DESIGN REQUIREMENTS**A. Working Drawings**

Provide working drawings for items as specified in the contract, or as required by the Engineer, with design calculations and supporting data in sufficient detail to permit a structural and safety review of the proposed design of the temporary work.

When concrete placement is involved, include data such as the drawings of proposed sequence, rate of placement, direction of placement, and location of all construction joints. Submit the number of copies as called for by the contract.

When required, have the drawings and calculations prepared under the guidance of, and sealed by, a North Carolina Registered Professional Engineer who is knowledgeable in temporary works design.

Design falsework and formwork requiring submittals in accordance with the 1995 AASHTO *Guide Design Specifications for Bridge Temporary Works* except as noted herein.

1. Wind Loads

Table 2.2 of Article 2.2.5.1 is modified to include wind velocities up to 110 mph (177 km/hr). In addition, Table 2.2A is included to provide the maximum wind speeds by county in North Carolina.

Table 2.2 - Wind Pressure Values

Height Zone feet (m) above ground	Pressure, lb/ft ² (kPa) for Indicated Wind Velocity, mph (km/hr)				
	70 (112.7)	80 (128.7)	90 (144.8)	100 (160.9)	110 (177.0)
0 to 30 (0 to 9.1)	15 (0.72)	20 (0.96)	25 (1.20)	30 (1.44)	35 (1.68)
30 to 50 (9.1 to 15.2)	20 (0.96)	25 (1.20)	30 (1.44)	35 (1.68)	40 (1.92)
50 to 100 (15.2 to 30.5)	25 (1.20)	30 (1.44)	35 (1.68)	40 (1.92)	45 (2.15)
over 100 (30.5)	30 (1.44)	35 (1.68)	40 (1.92)	45 (2.15)	50 (2.39)

2. Time of Removal

The following requirements replace those of Article 3.4.8.2.

Do not remove forms until the concrete has attained strengths required in Article 420-16 of the Standard Specifications and these Special Provisions.

Do not remove forms until the concrete has sufficient strength to prevent damage to the surface.

Table 2.2A - Steady State Maximum Wind Speeds by Counties in North Carolina

COUNTY	25 YR (mph) (km/hr)	COUNTY	25 YR (mph) (km/hr)	COUNTY	25 YR (mph) (km/hr)
Alamance	70 (112.7)	Franklin	70 (112.7)	Pamlico	100 (160.9)
Alexander	70 (112.7)	Gaston	70 (112.7)	Pasquotank	100 (160.9)
Alleghany	70 (112.7)	Gates	90 (144.8)	Pender	100 (160.9)
Anson	70 (112.7)	Graham	80 (128.7)	Perquimans	100 (160.9)
Ashe	70 (112.7)	Granville	70 (112.7)	Person	70 (112.7)
Avery	70 (112.7)	Greene	80 (128.7)	Pitt	90 (144.8)
Beaufort	100 (160.9)	Guilford	70 (112.7)	Polk	80 (128.7)
Bertie	90 (144.8)	Halifax	80 (128.7)	Randolph	70 (112.7)
Bladen	90 (144.8)	Harnett	70 (112.7)	Richmond	70 (112.7)
Brunswick	100 (160.9)	Haywood	80 (128.7)	Robeson	80 (128.7)
Buncombe	80 (128.7)	Henderson	80 (128.7)	Rockingham	70 (112.7)
Burke	70 (112.7)	Hertford	90 (144.8)	Rowan	70 (112.7)
Cabarrus	70 (112.7)	Hoke	70 (112.7)	Rutherford	70 (112.7)
Caldwell	70 (112.7)	Hyde	110 (177.0)	Sampson	90 (144.8)
Camden	100 (160.9)	Iredell	70 (112.7)	Scotland	70 (112.7)
Carteret	110 (177.0)	Jackson	80 (128.7)	Stanley	70 (112.7)
Caswell	70 (112.7)	Johnston	80 (128.7)	Stokes	70 (112.7)
Catawba	70 (112.7)	Jones	100 (160.9)	Surry	70 (112.7)
Cherokee	80 (128.7)	Lee	70 (112.7)	Swain	80 (128.7)
Chatham	70 (112.7)	Lenoir	90 (144.8)	Transylvania	80 (128.7)
Chowan	90 (144.8)	Lincoln	70 (112.7)	Tyrell	100 (160.9)
Clay	80 (128.7)	Macon	80 (128.7)	Union	70 (112.7)
Cleveland	70 (112.7)	Madison	80 (128.7)	Vance	70 (112.7)
Columbus	90 (144.8)	Martin	90 (144.8)	Wake	70 (112.7)
Craven	100 (160.9)	McDowell	70 (112.7)	Warren	70 (112.7)
Cumberland	80 (128.7)	Mecklenburg	70 (112.7)	Washington	100 (160.9)
Currituck	100 (160.9)	Mitchell	70 (112.7)	Watauga	70 (112.7)
Dare	110 (177.0)	Montgomery	70(112.7)	Wayne	80 (128.7)
Davidson	70 (112.7)	Moore	70 (112.7)	Wilkes	70 (112.7)
Davie	70 (112.7)	Nash	80 (128.7)	Wilson	80 (128.7)
Duplin	90 (144.8)	New Hanover	100 (160.9)	Yadkin	70 (112.7)
Durham	70 (112.7)	Northampton	80 (128.7)	Yancey	70 (112.7)
Edgecombe	80 (128.7)	Onslow	100 (160.9)		
Forsyth	70 (112.7)	Orange	70 (112.7)		

Note on the working drawings any anchorages, connectors, inserts, steel sleeves or other such devices used as part of the falsework or formwork that remains in the permanent structure. If the plan notes indicate that the structure contains the necessary corrosion protection required for a Corrosive Site, epoxy coat, galvanize, metallize or otherwise protect these devices as directed by the Engineer. Any coating required by the Engineer will be considered incidental to the various pay items requiring temporary works.

B. Review and Approval

The Engineer is responsible for the review and approval of temporary works' drawings.

Submit the working drawings sufficiently in advance of proposed use to allow for their review, revision (if needed), and approval without delay to the work.

Do not start construction of any temporary work for which working drawings are required until the drawings have been approved. Such approval does not relieve the Contractor of the responsibility for the accuracy and adequacy of the working drawings.

The time period for review of the working drawings does not begin until complete drawings and design calculations, when required, are received by the Engineer.

On the drawings, show all information necessary to allow the design of any component to be checked independently as determined by the Engineer.

If requested by the Engineer, submit with the working drawings manufacturer's catalog data listing the weight of all construction equipment that will be supported on the temporary work. Show anticipated total settlements and/or deflections of falsework and forms on the working drawings. Include falsework footing settlements, joint take-up, and deflection of beams or girders. Falsework hangers that support concentrated loads and are installed at the edge of thin top flange concrete girders (such as bulb tee girders) shall be spaced so as not to exceed 75% of the manufacturer's stated safe working load. Use of dual leg hangers (such as Meadow Burke HF-42 and HF-43) are not allowed. Design the falsework and forms supporting deck slabs and overhangs on girder bridges so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

4.0 CONSTRUCTION REQUIREMENTS

All requirements of Section 420 of the Standard Specifications apply.

Construct temporary works in conformance with the approved working drawings. Ensure that the quality of materials and workmanship employed is consistent with that assumed in the design of the temporary works. Do not weld falsework members to any portion of the permanent structure unless approved. Show any welding to the permanent structure on the approved construction drawings.

Provide tell-tales attached to the forms and extending to the ground, or other means, for accurate measurement of falsework settlement. Make sure that the anticipated compressive settlement and/or deflection of falsework does not exceed 1 inch (25 mm). For cast-in-place concrete structures, make sure that the calculated deflection of falsework flexural members does not exceed 1/240 of their span regardless of whether or not the deflection is compensated by camber strips.

A. Maintenance and Inspection

Inspect and maintain the temporary work in an acceptable condition throughout the period of its use. Certify that the manufactured devices have been maintained in a condition to allow them to safely carry their rated loads. Clearly mark each piece so that its capacity can be readily determined at the job site.

Perform an in-depth inspection of an applicable portion(s) of the temporary works, in the presence of the Engineer, not more than 24 hours prior to the beginning of each concrete placement. Inspect other temporary works at least once a month to ensure that they are functioning properly. Have a North Carolina Registered Professional Engineer inspect the cofferdams, shoring, sheathing, support of excavation structures, and support systems for load tests prior to loading.

B. Foundations

Determine the safe bearing capacity of the foundation material on which the supports for temporary works rest. If required by the Engineer, conduct load tests to verify proposed bearing capacity values that are marginal or in other high-risk situations.

The use of the foundation support values shown on the contract plans of the permanent structure is permitted if the foundations are on the same level and on the same soil as those of the permanent structure.

Allow for adequate site drainage or soil protection to prevent soil saturation and washout of the soil supporting the temporary works supports.

If piles are used, the estimation of capacities and later confirmation during construction using standard procedures based on the driving characteristics of the pile is permitted. If preferred, use load tests to confirm the estimated capacities; or, if required by the Engineer conduct load tests to verify bearing capacity values that are marginal or in other high risk situations.

The Engineer reviews and approves the proposed pile and soil bearing capacities.

5.0 REMOVAL

Unless otherwise permitted, remove and keep all temporary works upon completion of the work. Do not disturb or otherwise damage the finished work.

Remove temporary works in conformance with the contract documents. Remove them in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight.

6.0 METHOD OF MEASUREMENT

Unless otherwise specified, temporary works will not be directly measured.

7.0 BASIS OF PAYMENT

Payment at the contract unit prices for the various pay items requiring temporary works will be full compensation for the above falsework and formwork.

SUBMITTAL OF WORKING DRAWINGS

(9-16-08)

1.0 GENERAL

Submit working drawings in accordance with Article 105-2 of the *Standard Specifications* and this provision. For this provision, "submittals" refers to only those listed in this provision. The list of submittals contained herein does not represent a list of required submittals for the project. Submittals are only necessary for those items as required by the contract. Make submittals that are not specifically noted in this provision directly to the Resident Engineer. Either the Structure Design Unit or the Geotechnical Engineering Unit or both units will jointly review submittals.

If a submittal contains variations from plan details or specifications or significantly affects project cost, field construction or operations, discuss the submittal with and submit all copies to the Resident Engineer. State the reason for the proposed variation in the submittal. To minimize review time, make sure all submittals are complete when initially submitted. Provide a contact name and information with each submittal. Direct any questions regarding submittal requirements to the Resident Engineer, Structure Design Unit contacts or the Geotechnical Engineering Unit contacts noted below.

In order to facilitate in-plant inspection by NCDOT and approval of working drawings, provide the name, address and telephone number of the facility where fabrication will actually be done if different than shown on the title block of the submitted working drawings. This includes, but is not limited to, precast concrete items, prestressed concrete items and fabricated steel or aluminum items.

2.0 ADDRESSES AND CONTACTS

For submittals to the Structure Design Unit, use the following addresses:

Via US mail:

Mr. G. R. Perfetti, P. E.
State Bridge Design Engineer
North Carolina Department

Via other delivery service:

Mr. G. R. Perfetti, P. E.
State Bridge Design Engineer
North Carolina Department

of Transportation
 Structure Design Unit
 1581 Mail Service Center
 Raleigh, NC 27699-1581

Attention: Mr. P. D. Lambert, P. E.

of Transportation
 Structure Design Unit
 1000 Birch Ridge Drive
 Raleigh, NC 27610

Attention: Mr. P. D. Lambert, P. E.

For submittals to the Geotechnical Engineering Unit, use the following addresses:

For projects in Divisions 1-7, use the following Eastern Regional Office address:

Via US mail:

Mr. K. J. Kim, Ph. D., P. E.
 Eastern Regional Geotechnical
 Manager
 North Carolina Department
 of Transportation
 Geotechnical Engineering Unit
 Eastern Regional Office
 1570 Mail Service Center
 Raleigh, NC 27699-1570

Via other delivery service:

Mr. K. J. Kim, Ph. D., P. E.
 Eastern Regional Geotechnical
 Manager
 North Carolina Department
 of Transportation
 Geotechnical Engineering Unit
 Eastern Regional Office
 3301 Jones Sausage Road, Suite 100
 Garner, NC 27529

For projects in Divisions 8-14, use the following Western Regional Office address:

Via US mail:

Mr. John Pilipchuk, L. G., P. E.
 Western Regional Geotechnical
 Manager
 North Carolina Department
 of Transportation
 Geotechnical Engineering Unit
 Western Regional Office
 5253 Z Max Boulevard
 Harrisburg, NC 28075

Via other delivery service:

Mr. John Pilipchuk, L. G., P. E.
 Western Region Geotechnical
 Manager
 North Carolina Department
 of Transportation
 Geotechnical Engineering Unit
 Western Regional Office
 5253 Z Max Boulevard
 Harrisburg, NC 28075

Direct any questions concerning submittal review status, review comments or drawing markups to the following contacts:

Primary Structures Contact:

Paul Lambert
 (919) 250 – 4041
 (919) 250 – 4082 facsimile
plambert@ncdot.gov

Secondary Structures Contacts:

James Gaither
 (919) 250 – 4042
 David Stark
 (919) 250 – 4044

Eastern Regional Geotechnical Contact (Divisions 1-7):

K. J. Kim
 (919) 662 – 4710
 (919) 662 – 3095 facsimile
kkim@ncdot.gov

Western Regional Geotechnical Contact (Divisions 8-14):

John Pilipchuk
 (704) 455 – 8902
 (704) 455 – 8912 facsimile
jpilipchuk@ncdot.gov

3.0 SUBMITTAL COPIES

Furnish one complete copy of each submittal, including all attachments, to the Resident Engineer. At the same time, submit the number of hard copies shown below of the same complete submittal directly to the Structure Design Unit and/or the Geotechnical Engineering Unit.

The first table below covers “Structure Submittals”. The Resident Engineer will receive review comments and drawing markups for these submittals from the Structure Design Unit. The second table in this section covers “Geotechnical Submittals”. The Resident Engineer will receive review comments and drawing markups for these submittals from the Geotechnical Engineering Unit.

Unless otherwise required, submit one set of supporting calculations to either the Structure Design Unit or the Geotechnical Engineering Unit unless both units require submittal copies in which case submit a set of supporting calculations to each unit. Provide additional copies of any submittal as directed by the Engineer.

STRUCTURE SUBMITTALS

Submittal	Copies Required by Structure Design Unit	Copies Required by Geotechnical Engineering Unit	Contract Reference Requiring Submittal¹
Arch Culvert Falsework	5	0	Plan Note, SN Sheet & “Falsework and Formwork”
Box Culvert Falsework ⁷	5	0	Plan Note, SN Sheet & “Falsework and Formwork”
Cofferdams	6	2	Article 410-4
Evazote Joint Seals ⁶	9	0	“Evazote Joint Seals”
Expansion Joint Seals	9	0	“Expansion Joint Seals”

(hold down plate type with base angle)			
Expansion Joint Seals (modular)	2, then 9	0	“Modular Expansion Joint Seals”
Expansion Joint Seals (strip seals)	9	0	“Strip Seals”
Falsework & Forms ² (substructure)	8	0	Article 420-3 & “Falsework and Formwork”
Falsework & Forms (superstructure)	8	0	Article 420-3 & “Falsework and Formwork”
Girder Erection over Railroad	5	0	Railroad Provisions
Maintenance and Protection of Traffic Beneath Proposed Structure	8	0	“Maintenance and Protection of Traffic Beneath Proposed Structure at Station ____”
Metal Bridge Railing	8	0	Plan Note
Metal Stay-in-Place Forms	8	0	Article 420-3
Metalwork for Elastomeric Bearings ^{4,5}	7	0	Article 1072-10
Miscellaneous Metalwork ^{4,5}	7	0	Article 1072-10
Optional Disc Bearings ⁴	8	0	“Optional Disc Bearings”
Overhead Signs	13	0	Article 903-3(C) & Applicable Provisions
Pile Splicers	7	2	Subarticle 450-7(C) & “Piles”
Pile Points	7	2	Subarticle 450-7(D) & “Piles”
Placement of Equipment on Structures (cranes, etc.)	7	0	Article 420-20
Pot Bearings ⁴	8	0	“Pot Bearings”
Precast Concrete Box Culverts	2, then 1 reproducible	0	“Optional Precast Reinforced Concrete Box Culvert at Station ____”
Precast Retaining Wall Panels	10	1	Article 1077-2
Prestressed Concrete Cored Slab (detensioning sequences) ³	6	0	Article 1078-11

Prestressed Concrete Deck Panels	6 and 1 reproducible	0	Article 420-3
Prestressed Concrete Girder (strand elongation and detensioning sequences)	6	0	Articles 1078-8 and 1078- 11
Removal of Existing Structure over Railroad	5	0	Railroad Provisions
Revised Bridge Deck Plans (adaptation to prestressed deck panels)	2, then 1 reproducible	0	Article 420-3
Revised Bridge Deck Plans (adaptation to modular expansion joint seals)	2, then 1 reproducible	0	“Modular Expansion Joint Seals”
Sound Barrier Wall Casting Plans	10	0	Article 1077-2 & “Sound Barrier Wall”
Sound Barrier Wall Steel Fabrication Plans ⁵	7	0	Article 1072-10 & “Sound Barrier Wall”
Structural Steel ⁴	2, then 7	0	Article 1072-10
Temporary Detour Structures	10	2	Article 400-3 & “Construction, Maintenance and Removal of Temporary Structure at Station _____”
TFE Expansion Bearings ⁴	8	0	Article 1072-10

FOOTNOTES

1. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Articles and subarticles refer to the *Standard Specifications*.
2. Submittals for these items are necessary only when required by a note on plans.
3. Submittals for these items may not be required. A list of pre-approved sequences is available from the producer or the Materials & Tests Unit.
4. The fabricator may submit these items directly to the Structure Design Unit.
5. The two sets of preliminary submittals required by Article 1072-10 of the *Standard Specifications* are not required for these items.
6. Submittals for Fabrication Drawings are not required. Submittals for Catalogue Cuts of Proposed Material are required. See Section 5.A of the referenced provision.
7. Submittals are necessary only when the top slab thickness is 18” or greater.

GEOTECHNICAL SUBMITTALS

Submittal ¹	Copies Required by Geotechnical Engineering Unit	Copies Required by Structure Design Unit	Contract Reference Requiring Submittal ²
Crosshole Sonic Logging (CSL) Reports	1	0	“Crosshole Sonic Logging”
Drilled Pier Construction Sequence Plans	1	0	“Drilled Piers”
Pile Driving Analyzer (PDA) Reports	2	0	“Pile Driving Analyzer”
Pile Driving Equipment Data ³	1	0	Article 450-5 & “Piles”
Retaining Walls	8	2	Applicable Provisions
Contractor Designed Shoring	7	2	“Temporary Shoring”, “Anchored Temporary Shoring” & “Temporary Soil Nail Walls”

FOOTNOTES

1. With the exception of “Pile Driving Equipment Data”, electronic copies of geotechnical submittals are required. See referenced provision.
2. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Articles refer to the *Standard Specifications*.
3. Download Pile Driving Equipment Data Form from following link:
<http://www.ncdot.org/doh/preconstruct/highway/geotech/formdet/>
Submit one hard copy of the completed form to the Resident Engineer. Submit a second copy of the completed form electronically, by facsimile or via US Mail or other delivery service to the Geotechnical Engineering Unit. Electronic submission is preferred. See second page of form for submittal instructions.

CRANE SAFETY**(8-15-05)**

Comply with the manufacturer specifications and limitations applicable to the operation of any and all cranes and derricks. Prime contractors, sub-contractors, and fully operated rental companies shall comply with the current Occupational Safety and Health Administration regulations (OSHA).

Submit all items listed below to the Engineer prior to beginning crane operations involving critical lifts. A critical lift is defined as any lift that exceeds 75 percent of the manufacturer's crane chart capacity for the radius at which the load will be lifted or requires the use of more than one crane. Changes in personnel or equipment must be reported to the Engineer and all applicable items listed below must be updated and submitted prior to continuing with crane operations.

CRANE SAFETY SUBMITTAL LIST

- A. **Competent Person:** Provide the name and qualifications of the "Competent Person" responsible for crane safety and lifting operations. The named competent person will have the responsibility and authority to stop any work activity due to safety concerns.
- B. **Riggers:** Provide the qualifications and experience of the persons responsible for rigging operations. Qualifications and experience should include, but not be limited to, weight calculations, center of gravity determinations, selection and inspection of sling and rigging equipment, and safe rigging practices.
- C. **Crane Inspections:** Inspection records for all cranes shall be current and readily accessible for review upon request.
- D. **Certifications:** By July 1, 2006, crane operators performing critical lifts shall be certified by NC CCO (National Commission for the Certification of Crane Operators), or satisfactorily complete the Carolinas AGC's Professional Crane Operator's Proficiency Program. Other approved nationally accredited programs will be considered upon request. All crane operators shall also have a current CDL medical card. Submit a list of anticipated critical lifts and corresponding crane operator(s). Include current certification for the type of crane operated (small hydraulic, large hydraulic, small lattice, large lattice) and medical evaluations for each operator.

GROUT FOR STRUCTURES

7-12-07

1.0 DESCRIPTION

This special provision addresses grout for use in structures, including continuous flight auger (CFA) piles, micropiles, soil nail and anchored retaining walls and backfilling crosshole sonic logging (CSL) tubes or grout pockets, shear keys, dowel holes and recesses for cored slabs and box beams. This provision does not apply to grout placed in post-tensioning ducts for bridge beams, girders, or decks. Provide grout composed of portland cement, water and at the Contractor's option, fine aggregate and/or pozzolan. If necessary, use set controlling admixtures. Proportion, mix and place grout in accordance with the plans, the applicable section of the *Standard Specifications* or special provision for the application and this provision.

2.0 MATERIALS

Refer to Division 10 of the *Standard Specifications*:

Item	Article
Portland Cement	1024-1
Water	1024-4
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Admixtures	1024-3

At the Contractor's option, use an approved packaged grout in lieu of the materials above with the exception of the water. Contact the Materials and Tests (M&T) Unit for a list of approved packaged grouts. Consult the manufacturer to determine if the packaged grout selected is suitable for the application and meets the compressive strength and shrinkage requirements.

3.0 REQUIREMENTS

Unless required elsewhere in the Contract, provide non-metallic grout with minimum compressive strengths as follows:

Property	Requirement
Compressive Strength @ 3 days	2500 psi (17.2 MPa)
Compressive Strength @ 28 days	4500 psi (31.0 MPa)

For applications other than micropiles, soil nails and ground anchors, use non-shrink grout with shrinkage of less than 0.15%.

When using approved packaged grout, a grout mix design submittal is not required. Submit grout mix designs in terms of saturated surface dry weights on M&T Form 312U in accordance with the applicable section of the *Standard Specifications* or special provision for the structure. Use an approved testing laboratory to determine the grout mix proportions. Adjust proportions to compensate for surface moisture contained in the aggregates at the time of mixing. Changes in the saturated surface dry mix proportions will not be permitted unless a revised grout mix design submittal is accepted.

For each grout mix design, provide laboratory test results for compressive strength, density, flow and if applicable, aggregate gradation and shrinkage. Submit compressive strength for at least 3 cube and 2 cylinder specimens at the age of 3, 7, 14 and 28 days for a total of at least 20 specimens tested. Perform laboratory tests in accordance with the following:

Property	Test Method
Compressive Strength	AASHTO T106 and T22
Density	AASHTO T133
Flow for Sand Cement Grout	ASTM C939 (as modified below)
Flow for Neat Cement Grout (no fine aggregate)	Marsh Funnel and Cup API RP 13B-1, Section 2.2
Aggregate Gradation for Sand Cement Grout	AASHTO T27
Shrinkage for Non-shrink Grout	ASTM C1090

When testing grout for flow in accordance with ASTM C939, modify the flow cone outlet diameter from ½ to ¾ inch (13 to 19 mm).

When grout mix designs are submitted, the Engineer will review the mix designs and notify the Contractor as to their acceptability. Do not use grout mix designs until written acceptance has been received. Acceptance of grout mix designs or use of approved packaged grouts does not relieve the Contractor of responsibility to furnish a product that meets the Contract requirements.

Upon written request from the Contractor, a grout mix design accepted and used satisfactorily on a Department project may be accepted for use on other projects.

4.0 SAMPLING AND PLACEMENT

The Engineer will determine the locations to sample grout and the number and type of samples collected for field and laboratory testing. Use API RP 13B-1 for field testing grout flow and density of neat cement grout. The compressive strength of the grout will be considered the average compressive strength test results of 3 cube or 2 cylinder specimens at 28 days.

Do not place grout if the grout temperature is less than 50°F (10°C) or more than 90°F (32°C) or if the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 40°F (4°C).

Provide grout at a rate that permits proper handling, placing and finishing in accordance with the manufacturer's recommendations unless directed otherwise by the Engineer. Use grout free of any lumps and undispersed cement. Agitate grout continuously before placement.

Control grout delivery so the interval between placing batches in the same component does not exceed 20 minutes. Place grout before the time between adding the mixing water and placing the grout exceeds that in the table below.

ELAPSED TIME FOR PLACING GROUT		
(with continuous agitation)		
Air or Grout Temperature Whichever is Higher	Maximum Elapsed Time	
	No Set Retarding Admixture Used	Set Retarding Admixture Used
90°F (32°C) or above	30 min.	1 hr. 15 min.
80°F (27°C) through 89°F (31°C)	45 min.	1 hr. 30 min.
79°F (26°C) or below	60 min.	1 hr. 45 min.

5.0 MISCELLANEOUS

Comply with Articles 1000-9 through 1000-12 of the *Standard Specifications* to the extent applicable for grout in lieu of concrete.

PRESTRESSED CONCRETE MEMBERS

(4-02-07)

The 2006 Standard Specifications shall be revised as follows:

In Section 1078-1 “General” of the Standard Specifications, add the following after the second paragraph:

(A) Producer Qualification

Producers of precast, prestressed concrete members are required to establish proof of their competency and responsibility in accordance with the Precast/Prestressed Concrete Institute’s (PCI) Plant Certification Program in order to perform work for the project. Certification of the manufacturing plant under the PCI program and submission of proof of certification to the State Materials Engineer is required prior to beginning fabrication. Maintain certification at all times while work is being performed for the Department. Submit proof of certification following each PCI audit to the State Materials Engineer for continued qualification. These same requirements apply to producers subcontracting work from the producer directly employed by the Contractor.

Employ producers PCI certified in Product Group B, Bridge Products, and in one of the appropriate categories as listed below:

- B2 Prestressed Miscellaneous Bridge Products: Includes solid piles, sheet piles and bent caps.
- B3 Prestressed Straight-Strand Bridge Members: Includes all box beams, cored slabs, straight-strand girders and bulb-tees, bridge deck panels, hollow piles, prestressed culverts and straight strand segmental components.
- B4 Prestressed Deflected-Strand Bridge Members: Includes deflected strand girders and bulb-tees, haunched girders, deflected strand segmental superstructure components and other post-tensioned elements.

Categories for other elements will be as required by the project special provision or plans.

PILE DRIVING ANALYZER

(11-17-06)

1.0 GENERAL

This special provision governs driving piles with a pile driving analyzer (PDA) in accordance with the plans and as directed by the Engineer. The PDA test method is described in ASTM D4945, "Standard Test Method for High-Strain Dynamic Testing of Piles". Install piles in accordance with Section 450 of the Standard Specifications and this provision.

Submit the proposed pile driving methods and equipment (Pile Driving Equipment Data Form) in accordance with the Submittal of Working Drawings Special Provision and the Standard Specifications. The Engineer will respond with preliminary approval or rejection of the proposed pile driving methods and equipment within 10 calendar days. Preliminary approval is required before driving piles with a PDA. Notify the Engineer of the pile driving schedule a minimum of 14 calendar days in advance.

Either a PDA Consultant or the NCDOT Geotechnical Engineering Unit, as directed by the Engineer, shall perform PDA testing and analysis. If required, retain a PDA Consultant and submit experience documentation with the proposed pile driving methods and equipment.

The Engineer will determine the number of piles and which piles to be tested with the PDA based upon the subsurface conditions and the pile installation sequence and progress.

The Engineer will complete the review of the proposed pile driving methods and equipment and provide the required driving resistance within 10 calendar days after the Engineer receives the PDA report or the Geotechnical Engineering Unit completes the PDA testing. A PDA report for PDA testing on multiple piles may be required as directed by the Engineer before the 10 day time period begins.

2.0 PREQUALIFICATION AND EXPERIENCE REQUIREMENTS

Use a PDA Consultant prequalified by the Contractual Services Unit of the Department for Pile Driving Analyzer work (work code 3060).

Submit documentation that the PDA Consultant has successfully completed at least 5 PDA testing projects within the last 3 years of a scope and complexity similar to that anticipated for this project. Documentation should include the General Contractor and Owner's name and current contact information with descriptions of each past project. Also, submit documentation of experience with PDA manufactured by Pile Dynamics, Inc and the Case Pile Wave Analysis Program (CAPWAP).

Provide a list of PDA Operators and the Project Engineer that will be assigned to this project. Submit documentation for each PDA Operator verifying employment with the PDA Consultant and a minimum of 1 year experience in collecting PDA data with past projects of scope and complexity similar to that anticipated for this project. Submit documentation for the Project Engineer verifying employment with the PDA Consultant, registration as professional engineer in North Carolina and a minimum of 5 years experience in PDA testing and analysis with past projects of scope and complexity similar to that anticipated for this project. Documentation should include resumes, references, certifications, project lists, experience descriptions and details, etc.

3.0 PREPARATION FOR PDA TESTING

Provide piles for PDA testing that are 5 ft (1.5 m) longer, or as directed by the Engineer, than the estimated pile lengths shown on the plans. Supply 110 V, 60 Hz, 30 Amp of AC electrical power to operate the PDA equipment. Direct current welders or non-constant power sources are unacceptable.

Provide a suitable shelter to protect the PDA equipment and operator from conditions of sun, water, wind and temperature. The shelter should have a minimum floor size of 6 ft x 6 ft (2 m x 2 m) and a minimum roof height of 8 ft (2.5 m). If necessary, heat or cool the shelter to maintain a temperature between 50 and 85 degrees F (10 and 30 degrees C). Place the shelter within 75 ft (23 m) of the pile such that the PDA cables reach the computer and the operator can clearly observe the pile. The Engineer may waive the shelter requirement if weather conditions allow.

Drill up to a total of 16 bolt holes in either 2 or 4 sides of the pile, as directed by the PDA Consultant or the Engineer, at an approximate distance equal to 3 times the pile diameter below the head of the pile. If the PDA Consultant or the Engineer choose to drill the bolt holes, provide the necessary equipment, tools and assistance to do so. A hammer drill is required for concrete piles and up to 2 hours may be required to drill the holes.

Lift, align and rotate the pile to be tested with the PDA as directed by the PDA Consultant or the Engineer. Place the pile in the leads and template so that the PDA instruments and their accompanying wires will not be damaged.

The PDA Consultant or the Engineer will furnish the PDA measuring instruments and materials for installing the instruments. Attach the PDA instruments as directed by the PDA Consultant or the Engineer after the pile is placed in the leads and the template.

4.0 PDA TESTING

Use only the preliminarily approved pile driving methods and equipment to drive piles with the PDA instruments attached. Drive the pile as directed by the PDA Operator or the Engineer in order to measure the wavespeed of the pile.

Drive the pile to the required bearing capacity and specified tip elevation, if applicable, as shown on the plans or as directed by the PDA Consultant or the Engineer. During pile driving, the PDA will be used to evaluate, including but not limited to, the following: hammer performance, bearing capacity, distribution of soil resistance, pile driving stresses, energy transfer, pile integrity and various soil parameters such as quake and damping.

The PDA Operator or the Engineer may require the Contractor to modify the pile installation procedure during driving as follows:

- Reduce the hammer energy
- Drive deeper or shallower because of variations in the subsurface conditions
- Readjust the transducers
- Realign the pile

The Contractor is responsible in terms of both actual expense and time delays for any damage to the PDA instruments and supporting equipment due to the Contractor's fault or negligence. Replace any damaged equipment at no additional cost to the Department.

5.0 REDRIVING PILES

When directed by the Engineer, reattach the PDA instruments and restrike or redrive the pile in accordance with Section 4.0 above and Subarticle 450-7(E) of the Standard Specifications. Obtain the required stroke and penetration (at least 6 in or 150 mm) or as directed by the PDA Operator or the Engineer. The PDA Operator or the Engineer will record dynamic measurements during restriking and redriving. The Engineer may require restriking and redriving more than once on the same pile. The Engineer will determine when PDA testing has been satisfactorily completed.

6.0 CAPWAP ANALYSIS AND PDA REPORT

The PDA Consultant shall perform analysis of the PDA raw data with the CAPWAP (version 2006 or later). At a minimum, analysis is required for a hammer blow near the end of initial drive and for each restrike and redrive. Additional CAPWAP analysis may be required as determined by the PDA Consultant or the Engineer.

Submit three hard copies and an electronic copy (pdf or jpeg format on CD or DVD) of a PDA report sealed by the Project Engineer within 7 calendar days after field testing is complete. The PDA report shall include but not be limited to the following:

A. Title Sheet

- NCDOT TIP number and WBS element number
- Project description
- County
- Bridge station number
- Pile location
- Personnel
- Report date

B. Introduction

C. Site and Subsurface Conditions (including water table elevation)

D. Pile Details

- Pile type and length
- Required bearing capacity and factor of safety
- Concrete compressive strength and/or steel pile yield strength
- Pile splice type and locations
- Pile batter
- Installation methods including use of jetting, preaugering, spudding, vibratory hammer, template, barge, etc.

E. Driving Details

- Hammer make, model and type
- Hammer and pile cushion type and thickness
- Pile helmet weight
- Hammer efficiency and operation data including fuel settings, bounce chamber pressure, blows per minute, equipment volume and pressure
- Ground or mud line elevation and template reference elevation at the time of driving
- Final pile tip elevation
- Driving resistance (ram stroke, blows per foot (0.3 meter) and set for last 10 hammer blows)
- Restrike and redrive information

F. PDA field work details

G. CAPWAP analysis results

- Table showing percent skin and tip, skin and toe damping, skin and toe quake and match quality

H. Summary/Conclusions

I. Attachments

- Boring log(s)
- Pile Driving Equipment Data Form (from Contractor)
- Field pile driving inspection data (from Engineer)
- Accelerometer and strain gauge locations
- Accelerometer and strain gauge serial numbers and calibration information
- PDA hardware model and CAPWAP software version information
- Electronic copy of all PDA raw data and executable CAPWAP input and output files (version 2006 format)

7.0 MEASUREMENT AND PAYMENT

The complete and accepted PDA testing will be paid for at the unit bid price for “PDA Testing” per each. Include in the unit bid price for “PDA Testing” all costs for providing the PDA, PDA instruments and materials for installing the instruments and recording the dynamic measurements the first time the pile is tested with the PDA. Costs for providing these items for the same pile after the pile is initially tested with the PDA will be considered incidental to the unit bid price for “Pile Redrives”. Also include in the unit bid price for “PDA Testing” all costs for performing the CAPWAP analysis on data collected during initial drive, restrikes and redrives and preparing and submitting the PDA report. No payment for “PDA Testing” will be made if the PDA report submitted is incomplete as described in Section 6.0. No payment for “PDA Testing” will be made if the Department performs PDA testing. If the Department does not perform PDA testing, the number of “PDA Testing” per pile will be equal to one.

The complete and accepted PDA assistance will be paid for at the unit bid price for “PDA Assistance” per each. Include in the unit bid price for “PDA Assistance” all costs for PDA preparation and support including all materials, labor, tools, equipment, mobilization and incidentals necessary to complete the work described in this provision excluding the costs for the PDA testing described above. Costs for PDA preparation and support for restrikes and redrives will not be paid for separately. The number of “PDA Assistance” per pile will be equal to one for each pile tested with the PDA.

The cost of the pile and the installation including driving, restriking and redriving will be paid for separately in accordance with the Standard Specifications and will not be part of these PDA pay items.

STRUCTURE DRAINAGE SYSTEM**(SPECIAL)****Materials**

Perforated pipe drains behind the abutments shall be corrugated steel pipe as detailed on the Plans. French drain material behind abutments shall be No. 467M crushed stone or gravel conforming to Table 1005-1, Aggregate Gradation.

Installation

Perforated pipe drains behind the abutments shall be laid with perforations turned down and bedded on a layer of compacted impervious clay. The perforations shall be kept open and free from the clay bedding course, asphalt coating, or other material. The French drain material shall be placed concurrently with the backfill and shall be kept separate with a thin timber slide or burlap bag. Perforated pipe behind abutments and outfall pipes shall be laid on a grade of at least one percent (1%) and shall be located as shown on the Plans.

Grades of pipe drains shall be set by the Engineer. Copies of shop drawings showing details of the drainage system shall be submitted by the Contractor to the Engineer for approval. The drainage system must be approved prior to fabrication.

Basis of Payment

Payment for the "Structure Drainage System at Sta. _____" will be made at the contract lump sum price bid, which price and payment shall be full compensation for furnishing all materials and labor to install the drainage system complete, including excavation, perforated pipe drains, French drain material, other backfill and outfall pipes.

BACKFILLING AROUND STRUCTURES**(SPECIAL)**

Backfill material behind abutments (except No. 467M crushed stone or gravel for French drains over perforated drain pipes) shall be Type A Aggregate Base Course (ABC) in accordance with the Standard Specifications. Placing and compacting shall be as provided for in Section 410-8 of the Standard Specifications.

Backfill around structures, except as specified above, shall be suitable material available from the excavations. In the event material excavated is not approved for use as backfill by the Engineer, the Contractor will be required to furnish and haul to the structure site the necessary suitable backfill material. Placing and compacting shall be as provided in Section 410-8 of the Standard Specifications.

Disposal of surplus excavated material shall be as specified in Section 410-1 of the Standard Specifications.

Payment for furnishing ABC backfill material and any suitable material to replace excavated material and for placing and compacting all backfill material shall be included in the contract unit price for other pay items.

STEEL HANDRAIL**(SPECIAL)**

The Steel Handrail shall be as shown on the Plans. The quantity of handrail to be paid for will be the actual number of linear feet of handrail measured continuously along the top bar of the rail from end to end which has been completed and accepted. Full compensation for the work shall include, but is not limited to, furnishing posts, rails, fittings and all other materials and fabricating and erecting steel handrail. The quantity of steel handrail as measured above will be paid for at the contract unit price per linear foot for "Steel Handrail."

OPTIONAL PRECAST REINFORCED CONCRETE**(2-14-04)****BOX CULVERT AT STATION 14+52.00 -MAIN-****1.0 GENERAL**

This Special Provision covers precast reinforced concrete box culverts intended for the construction of culverts and for the conveyance of storm water.

If the option is indicated on the plans, the submittal of a design for a precast reinforced box culvert in lieu of a cast-in-place culvert is permitted. Provide the size and number of barrels as indicated on the plans. Precast wing walls will not be allowed. For culverts with less than 2 feet (0.6 m) of cover, design the precast culvert sections in accordance with AASHTO M273. Detail the culvert with cast in place wings. Provide a precast box culvert that meets the requirements of Section 1077 and any other applicable parts of the Standard Specifications.

The design of the precast members is the responsibility of the Contractor and is subject to review, comments and approval. Submit two sets of detailed plans for review. Include all details in the plans, including the size and spacing of the required reinforcement necessary to build the precast box culvert. Include checked design calculations for the precast members complying with the latest AASHTO Standard Specifications and requirements detailed herein. Have a North Carolina Registered Professional Engineer check and seal the plans and design calculations. After the plans are reviewed and, if necessary, the corrections made, submit one set of reproducible tracings on 22" x 34" sheets to become the revised contract plans.

A pre-installation meeting is required prior to installation. Representatives from the Contractor, the precast box manufacturer, and the Department should attend this meeting. The precast box manufacturer representative shall be on site during installation.

2.0 PRECAST REINFORCED CONCRETE BOX SECTIONS**A. Types**

Precast reinforced concrete box sections manufactured in accordance with this Special Provision are designated by span, rise, and design earth cover.

B. Design

1. Design – The box section dimensions and reinforcement details are subject to the provisions of Section F.
2. Placement of Reinforcement – Provide a 1 inch (25 mm) concrete cover over the circumferential reinforcement subject to the provisions of Section F. Extend the inside circumferential reinforcement into the male portion of the joint and the outside circumferential reinforcement into the female portion of the joint. Detail the clear distance of the end circumferential wires so it is not less than 1/2 inch (13 mm) nor more than 2 inches (51 mm) from the ends of the box section. Assemble reinforcement per the requirements of AASHTO M259, Section 7.3. The exposure of the ends of the wires used to position the reinforcement is not a cause for rejection.
3. Laps and Spacing – Use lap splices for the circumferential reinforcement. Detail the circumferential wires so that the center to center spacing is not less than 2 inches (50 mm) nor more than 4 inches (100 mm). Do not detail the longitudinal wires with a center to center spacing of more than 8 inches (200 mm).
4. The design earth cover is reported on the plans as the elevation difference between the point of maximum fill and the top of the top slab.

C. Joints

1. Produce the precast reinforced concrete box section with male and female ends. Design and form these ends of the box section so, when the sections are laid together, they make a continuous line of box sections with a smooth interior free of appreciable irregularities in the flowline, all compatible with the permissible variations given in Section F. The internal joint formed at the male and female ends of the precast units shall be sealed with either bitumen/butyl sealant or closed-cell neoprene material. The internal joint material shall be installed in accordance with the manufacturer's recommendations. The material shall be shown on the shop drawings when they are submitted for review.
2. Seal the external joint with an outside sealer wrap that is at least 12 inches (300 mm) wide and covers the joint on both the sides and the top of the box section. Use ConWrap CS-212 from Concrete Sealants, Inc., EZ-Wrap from Press-Seal Gasket Corporation, Seal Wrap from Mar-Mac Manufacturing Co., Inc., Cadilloc External Pipe Joint from Cadilloc, or an approved equal for the outside sealer wrap. If the outside sealer wrap is not applied in a continuous strip along the entire joint, a 12 inch (300 mm) minimum lap of the outside sealer wrap is permitted. Before placing the outside sealer wrap, clean and prime the area receiving the outside sealer wrap in accordance with the sealer wrap manufacturer recommendations. The joint wrap manufacturer installation recommendations shall be included with shop drawings submitted for review. The external joint wrap shall be installed in three pieces, as indicated on Figure 1 below:

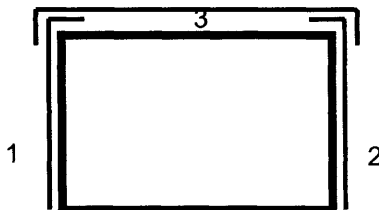


Figure 1

Cover the external joint sealer with a 3 foot (900 mm) strip of filter fabric conforming to Type 4 requirements in Section 1056 of the Standard Specifications.

Place multiple lines of a precast reinforced concrete box culvert such that the longitudinal joint between the sections has a minimum width of 3 inches (75 mm). Fill the joint between multiple lines of precast box sections with Class A concrete. Use Class A concrete that meets the requirements listed in the Standard Specifications except that Field Compressive Strength Specimens are not required.

D. Manufacture

Precast box culverts may be manufactured by either the wet cast method or dry cast method.

1. Mixture – In addition to the requirements of Section 1077 of the Standard Specifications, do not proportion the mix with less than 564 lb/yd³ (335 kg/m³) of portland cement.
2. Strength – Make sure that all concrete develops a minimum 28-day compressive strength of 5000 psi (34.5 MPa). Movement of the precast sections should be minimized during the initial curing period. Any damage caused by moving or handling during the initial curing phase will be grounds for rejection of that precast section.
3. Air Entrainment – Air entrain the concrete in accordance with Section 1077 - 5(A) of the Standard Specifications. For dry cast manufacturing, air entrainment is not required.
4. Testing – Test the concrete in accordance with the requirements of Section 1077 - 5(B).
5. Handling – Handling devices or holes are permitted in each box section for the purpose of handling and laying. Submit details of handling devices or holes for approval and do not cast any concrete until approval is granted. Remove all handling devices flush with concrete surfaces as directed. Fill holes in a neat and

workmanlike manner with an approved non-metallic non-shrink grout, concrete, or hole plug.

E. Physical Requirements

Acceptability of precast culvert sections is based on concrete cylinders made and tested in accordance with AASHTO T22 and AASHTO T23.

F. Permissible Variations

1. Flatness – All external surfaces shall be flat, true, and plumb. Irregularities, depressions, or high spots on all external surfaces shall not exceed 1/2 inch (12 mm) in 8 feet (2.5 meters).
2. Internal Dimensions – Produce sections so that the internal and haunch dimensions do not vary by more than 1/4 inch (6 mm) from the plan dimensions.
3. Adjacent Sections - Internal, external, and haunch dimensions for connecting sections shall not vary by more than 1/2 inch (12 mm).
4. Length of Tongue and Groove – The minimum length of the tongue shall be 4 inches (100 mm). The minimum length of the groove shall be 4 inches (100 mm). The dimensions of the tongue and groove shall not vary by more than 1/4 inch (6 mm) from the plan dimensions.
5. Slab and Wall Thickness – Produce sections so that the slab and wall thickness are not less than that shown on the plans by more than 5% or 3/16 inch (5 mm), whichever is greater. A thickness more than that required on the plans is not a cause for rejection.
6. Length of Opposite Surfaces – Produce sections so that variations in laying lengths of two opposite surfaces of the box section meet the requirements of AASHTO M259, Section 11.3.
7. Length of Section – Produce sections so that the underrun in length of a section is not more than 1/2 inch (13 mm) in any box section.
8. Position of Reinforcement – Produce sections so that the maximum variation in the position of the reinforcement is $\pm 3/8$ " (± 10 mm) for slab and wall thicknesses of 5 inches (125 mm) or less and $\pm 1/2$ " (± 13 mm) for slab and wall thicknesses greater than 5 inches (125 mm). Produce sections so that the concrete cover is never less than 5/8 inch (16 mm) as measured to the internal surface or the external surface. The preceding minimum cover limitations do not apply at the mating surfaces of the joint.
9. Area of Reinforcement – Use the design steel shown on the plans for the steel reinforcement. Steel areas greater than those required are not cause for rejection.

The permissible variation in diameter of any wire in finished fabric is prescribed for the wire before fabrication by either AASHTO M32 or M225.

G. Marking

1. Each section shall be match-marked in order of intended installation as indicated on the approved shop drawings. Ensure that pieces fit together neatly and in a workmanlike manner. In order to ensure a good, neat field fit, assemble adjacent sections at the producer's facility and match-mark the pieces. This will require that a minimum of three adjacent sections of the culvert be fitted at the production yard at a time and then match-marked. Once three sections have been match-marked, the first section may be removed for shipment and a fourth section set for marking. Continue in a progressive manner until all sections have been properly match-marked.
2. Clearly mark each section of the box culvert in accordance with AASHTO M259, Section 15.

H. Construction

1. Foundation – Foundation for precast box culvert shall meet the requirements of Section 414 of the Standard Specifications. In addition, Type VI foundation material shall be encapsulated in filter fabric conforming to Type 4 requirements in Section 1056 of the Standard Specifications. The filter fabric shall be placed perpendicular to the culvert barrel. Provide sufficient overhang beyond the excavation to allow a minimum lap of 3 feet (900 mm) when the foundation material is placed and fabric wrapped on top. Perpendicular sections of fabric shall be continuous. A minimum lap of 2 feet (600 mm) shall be provided between sections of fabric.
2. Installation – Sections shall be placed at the beginning of the outlet end of the culvert with the groove end being laid upgrade. Tongue sections shall be laid into the groove sections. Positive means shall be provided to pull each section firmly into the previously placed section so that the joints are tightly homed. Use a "come-along", box pullers or other approved methods to create a positive means of joining box sections. Construction equipment shall not have direct contact with the box section. The load of the box shall be suspended by lifting device during joining procedure.
3. Backfill – Complete backfill in accordance with Section 414 of the Standard Specifications.

3.0 BASIS OF PAYMENT

Any additional cost of redesigning will be paid for by the Contractor if Precast Reinforced Concrete Culvert is used in lieu of the cast-in-place culvert shown on the plans. Except for Foundation Conditioning Material and Culvert Excavation, payment for the Precast Box

Culvert will be a lump sum amount equal to the payment that would be allowed for construction of a Cast-in-Place Box Culvert. Plan quantities and unit bid prices will be used to compute the lump sum amount. Such price and payment will be full compensation for all work covered by this Special Provision, the plans and applicable parts of the Standard Specifications and will include, but not be limited to, furnishing all labor, materials (including all filter fabric), equipment and other incidentals necessary to complete this work. Such price and payment will also be full compensation for concrete, reinforcing steel, labor, equipment and all other related materials necessary for the completion of the barrel section, and the construction of the headwalls, leveling pad, end curtain walls, wings and wing footings.

HP 14x73 STEEL PILES

(SPECIAL)

Description

HP 14x73 Steel Piles shall be in accordance with the plans, this special provision and Section 450 of the standard specifications.

Measurement and Payment

HP 14x73 Steel Piles will be measured and paid as the actual number of linear feet of piles incorporated into the completed and accepted structure. This quantity is measured as the length of pile before driving minus any pile cut-offs. No payment will be made for pile cut-offs or cutting off piles. However, once the required bearing and penetration has been achieved, the Contractor may drive the remaining portion of a pile to grade in lieu of cutting off the pile provided the remaining portion does not exceed 5 feet and the pile can be driven without damaging the pile or reaching the maximum blow count or practical refusal. When this occurs, the additional length of pile driven will be measured as described above.

Payment will be made under:

Pay Item	Pay Unit
HP 14x73 Steel Piles	Linear Foot

16" O.D. GALVANIZED STEEL PIPE PILES

(SPECIAL)

Description

16" O.D. Galvanized Steel Pipe Piles shall be in accordance with the plans, this special provision and Section 450 of the standard specifications.

Measurement and Payment

16" O.D. Galvanized Steel Pipe Piles will be measured and paid as the actual number of linear feet of piles incorporated into the completed and accepted structure. This quantity is measured as the length of pile before driving minus any pile cut-offs. No payment will be

made for pile cut-offs or cutting off piles. However, once the required bearing and penetration has been achieved, the Contractor may drive the remaining portion of a pile to grade in lieu of cutting off the pile provided the remaining portion does not exceed 5 feet and the pile can be driven without damaging the pile or reaching the maximum blow count or practical refusal. When this occurs, the additional length of pile driven will be measured as described above.

Payment will be made under:

Pay Item	Pay Unit
16" O.D. Galvanized Steel Pipe Piles	Linear Foot

CONCRETE BALLAST CURB **(SPECIAL)**

Description

Concrete Ballast Curb shall be in accordance with the plans, this special provision and Section 460 of the standard specifications.

Measurement and Payment

Concrete Ballast Curb will be measured and paid for as the number of linear feet of Concrete Ballast Curb provided on the plans.

Payment will be made under:

Pay Item	Pay Unit
Concrete Ballast Curb	Linear Foot

4'-0" x 4'-6" PRESTRESSED CONCRETE BOX GIRDER **(SPECIAL)**

Description

4'-0" x 4'-6" Prestressed Concrete Box Girder shall be in accordance with the plans, this special provision and Section 430 of the standard specifications.

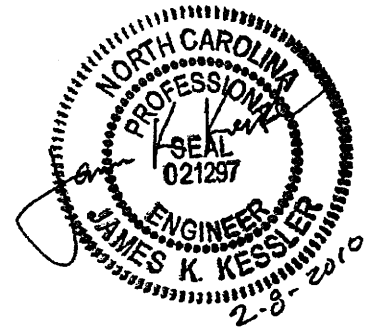
Measurement and Payment

4'-0" x 4'-6" Prestressed Concrete Box Girder will be measured and paid for as the number of linear feet of Prestressed Concrete Box Girders estimated on the plans as being necessary to complete the project.

Payment will be made under:

Pay Item	Pay Unit
4'-0" x 4'-6" Prestressed Concrete Box Girder	Linear Foot

PROJECT SPECIAL PROVISIONS (PSP)
RAILROAD REQUIREMENTS



SAFETY REQUIREMENTS:

This work is to be conducted partially on or in close proximity to operating railroad tracks. The Contractor shall comply with the following Special Provisions when working on North Carolina Railroad Company (NCRR) Property.

The Contractor shall ensure that his entire work force, including employees, agents and subcontractors, comply fully with all applicable FRA RAILROAD WORKPLACE SAFETY Rules, 49 C.F.R. PART 214.

Particular attention is directed to the requirements for fall protection, protective footwear, protective head gear (hard hats) and eye and face protection equipment (safety goggles or safety eyeglasses).

Particular attention is also directed to the requirements of the NORFOLK SOUTHERN ROADWAY WORKER PROTECTION PROGRAM (hereinafter referred to as "Program"), as required by FRA RAILROAD WORKPLACE SAFETY Rules, 49 C.F.R. PART 214. (A copy of the Program Manual, along referenced Operations Division Bulletins, will be provided to the Contractor when the Contract is awarded). The Contractor must, at all times, maintain, at the job site, a copy of the Program Manual, along with referenced Operations Division Bulletins.

It will be the responsibility of the Contractor to ensure that all of his employees, agents and subcontractors have been properly trained in all applicable provisions of the Program. Particular attention must be paid to the provisions regarding the Roadway Worker In Charge (R.W.I.C.), and following instructions of the R.W.I.C. Each Worker must know, at all times, who is the designated R.W.I.C.

Norfolk Southern Railway (NSR) does NOT provide Program training for Contractor employees, agents and subcontractors. As detailed above, this is the sole responsibility of the Contractor. As information, The American Railway Engineering and Maintenance of Way Association (AREMA) has, from time to time, provided Railway Worker Protection Training Seminars for Contractors. For information regarding training through AREMA, you may contact Ms. Kathy Hemming at (301)459-3200, Extension 703. In addition, some private training organizations also provide this training.

The Contractor must, at all times, maintain documentation that all employees, agents and subcontractors have been properly trained in the Program, and fully understand their responsibility regarding their safety, and the safety of their co-workers. The documentation must be available, at all times, for inspection by the Company, or FRA Inspector.

SECURITY REQUIREMENTS

All employees of the Contractor who are working on NCRR property must have received security training and must wear an E-RailSafe ID badge while on NCRR property. The Contractor can obtain E-RailSafe ID badges for its employees by going to the web page www.e-railsafe.com.

INTERFERENCE WITH RAILROAD TRAFFIC

General traffic patterns, including anticipated daily work windows, will be discussed at the pre-bid site meeting. The Contractor is expected to ask sufficient questions to gain an understanding of rail operations prior to planning and submitting a bid for the work.

The Contractor shall conduct his operations so as to minimize interference with rail traffic. The Contractor shall not proceed with any portion of the work on NCRR property until he has obtained specific authority and directions from the proper representative of the Company and has the approval of the Engineer. If the Contractor fails to comply with the above and performs his work in a manner that causes unreasonable delays to the train operations of Norfolk Southern Corporation (NSR), he shall be liable for any additional operating costs incurred by NSR for such delays and shall reimburse the NSR upon receipt of bills thereafter.

Whenever work is liable to affect the operations or safety of trains, the method of doing such work shall be first submitted to NSR for approval, but such approval shall not relieve the Contractor from liability. Any work to be performed by the Contractor which requires flagging or inspection services shall be deferred by the Contractor until the flagging or inspection services are provided by NSR.

Whenever work with the NCRR right-of-way is of such a nature that impediment to NSR operations is unavoidable, the Contractor shall schedule and conduct his operations so that such impediment is reduced to the absolute minimum.

Should conditions arising from, or in connection with the work, require that immediate and unusual provisions be made to protect operations and property of NSR and NCRR, the Contractor shall make such provisions. If in the judgment of NSR or NCRR such provisions are insufficient, either may require or provide such provisions as deemed necessary. In any event, such unusual provisions shall be at the Contractor's expense and without cost to NCDOT, NSR or NCRR.

No claim by the Contractor against NCDOT or NSR will be allowed for hindrance or delay caused by Railway traffic; any work done by NSR or other delay incident to or necessary for safe maintenance of railway traffic or for any delays due to compliance with these special provisions. Any cost incurred by the NSR for repairing damaged roads, tracks or other facilities resulting from the operations of the Contractor shall be paid by the Contractor to the NSR.

The Contractor shall assume all responsibility for any and all damages to his work, men, and equipment caused by the operations of NSR and the Company.

The authorized representative of Norfolk Southern shall have final authority in all matters affecting the safe maintenance of railroad traffic of NSR including the adequacy of the foundations and structures supporting the railroad tracks.

NOTICE OF STARTING WORK

The Contractor shall not commence any work on the NCRR right-of-way until the following conditions are met:

1. Written notice has been provided to Norfolk Southern at least ten days in advance of the start date of proposed construction on NCRR right-of-way. Notice shall be provided to:

Office of Chief Engineer
Bridges and Structures
Norfolk Southern Corporation
1200 Peachtree Street NE
Internal box #142
Atlanta, GA 30309

2. Written approval has been obtained from NS of the Contractor's Railroad Protective Liability Insurance as required herein. It should be noted that NSR does not accept notation of Railroad Protective insurance on a certificate of liability insurance form or binders as NSR must have the full original countersigned policy. Further, please note that mere receipt of the policy is not the only issue

but the policy must also be reviewed by NSR for compliance. It typically takes a minimum of 30 to 45 days for NSR to review the insurance policy.

3. Obtained railroad flagging services as required herein.
4. Obtained written authorization from NSR for the Contractor to begin work on the NCRR right-of-way. Such authorization shall also include and outline of specific conditions with which the Contractor must comply.
5. A schedule for work on the NCRR right-of-way has been furnished to NSR.

Norfolk Southern's written authorization to proceed with work on the NCRR right-of-way shall include the names, addresses, and telephone numbers of the NSR representatives who are to be notified as hereinafter required. Where more than one representative is designated, the area of responsibility of each representative shall be as specified.

OBSTRUCTING TRACKS

The track must remain in service for regular rail traffic at all times except as described herein and major track outages as outlined herein.

The Contractor will not be permitted to transport material or equipment across or between the North Carolina Railroad tracks except when authorized by NSR.

When the Contractor desires to occupy any space above the top of rail within the horizontal distance of ten (10) feet either side of the centerline of track measured at right angles to the track centerline, it will be necessary that he obtain permission from the Track Supervisor, or his representative, at least twenty four (24) hours in advance of such occupancy. If, in the judgment of the NS, flagmen are required, they will be furnished at the Contractor's expense.

The Contractor shall require his employees, agents, or sub-contractors to comply with any and all instructions or warnings of the NS flagman as to clearance for the passage of trains.

All scaffolding and/or any other projections used the Contractor's operations shall at all times be maintained at a clearance from the NCR track(s) as approved by the Company.

The Contractor shall indemnify and save harmless the Company from and against any and all liability for personal injury (including death) and/or property damage to whomsoever or whatsoever occurring arising directly or indirectly from the Contractor's failure to comply with the aforesaid notice requirement.

Before undertaking any work within the NCRR right-of-way or before placing any obstruction over any track, the Contractor shall:

1. Notify the NSR representative at least 72 hours in advance of the work.
2. Receive assurance from the NSR representative that arrangements have been made for flagging service as may be necessary.
3. Receive permission from the NSR representative to proceed with the work.
4. Ascertain that NCDOT has received copies of the Contractor's notice to NSR and NSR's response thereto.

CONSTRUCTION PROCEDURES

Construction work and operations by the Contractor on NCRR right-of-way shall be:

1. Subject to inspection and approval of NSR.
2. In accordance with NSR's written outline of specific conditions.
3. In accordance with NSR's general rules, regulations and requirements including those related to safety, fall protection and personal protective equipment.

The subgrade of an operated track shall be maintained with edge of berm at least 10' 0" from centerline of track and not more than 24 inches below top of rail. Contractor shall not be required to make existing section meet this specification if substandard, in which case existing section will be maintained. Additionally, NSR may require installation of orange construction safety fencing for protection of work area.

STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall not be stored where they will interfere with NSR operations, nor on the right of way of NCRR, without having first obtained permission from NSR. Such permission will be with the understanding that NSR will not be liable for damage to such material and equipment from any cause, and that NSR may move, or require the Contractor to move, at the Contractor's expense, such material and equipment.

All grading or construction machinery that is left parked near the track unattended by a watchman shall be effectively immobilized so that it cannot be moved by unauthorized persons. The Contractor shall protect, defend, indemnify and save NSR and any associated, controlled or affiliated corporation, harmless from and against all losses, costs, expenses, claim or liability for loss or damage to property or the loss of life or personal injury, arising out of or incident to the Contractor's failure to immobilize grading or construction machinery.

CLEANUP

Upon completion of the work, the Contractor shall remove from within the limits of the NCRR right-of-way all machinery, equipment, surplus materials, falsework, rubbish or temporary buildings of the Contractor, and leave said right-of-way in a neat condition satisfactory to the Chief Engineer of NSR or his authorized representative.

DAMAGES

The Contractor shall assume all liability for any and all damages to his work, employees, servants, equipment and materials caused by railroad traffic.

Any cost incurred by NSR for repairing damages to its property or to property of its tenants, caused by or resulting from the operations of the Contractor, shall be paid directly to NSR by the Contractor.

FLAGGING

Flagging services will not be provided until the contractor's insurance has been reviewed and approved by NSR.

It shall be the responsibility of the Contractor to submit specific requests to NSR's contact to arrange for any flagging that may be required for the Construction Project. The NSR contact to arrange flagging is Gregg Cody, Division Engineer, Greenville, SC (telephone 864-255-4245).

Any work on NCCR right of way or property or any work that could affect NSR/NCCR facilities or property may require flagging. NSR shall have the sole authority to determine the extent of flagging needed during any activity on the Construction Project. In general, the requirements of such services will be whenever the Contactor's personnel or equipment are, or are likely to be, working on the NCCR right-of-way, or across, over, adjacent to, or under a track, or when such work has disturbed or is likely to disturb a railroad structure or the railroad roadbed or surface and alignment of any track to such extent that the movement of trains must be controlled by flagging.

If the Contractor works within distances that violate instructions given by NSR's authorized representative, a flagman or flagmen may be required full time until all work on the NCCR right-of-way has been completed.

NSR will furnish flagging personnel at the expense of the Contractor and will endeavor to do so within ten (10) working days notice. No delay to the Contractor will be claimed against the NSR or NCDOT if qualified flagging personnel are not available within this period.

Contractor's personnel shall be required to obey the instructions of NSR flagging personnel and shall not perform any activity requiring flagging unless NSR flagging personnel are present.

Scheduling and Notification

The Contractor's work requiring railroad flagging should be scheduled to limit the presence of a flagman at the site to a maximum of 50 hours per week. The Contractor shall receive NSR approval of work schedules requiring a flagman's presence in excess of 40 hours per week.

No later than the time that approval is initially requested to begin work on NCCR right-of-way, the Contractor shall furnish to NSR and NCDOT a schedule for all work required to complete the portion of the project within the NCCR right-of-way and arrange for a job site meeting between NSR, NCDOT and the Contractor. Flagmen may not be provided until the job site meeting has been conducted and the Contractor's work scheduled.

The Contractor will be required to give NSR at least 10 working days of advance written notice of intent to begin work within the NCCR right-of-way in accordance with this special provision. Once begun, if any of the Contractor's activities requiring flagging services are temporarily suspended, the contractor shall be required to give NSR's Division Engineer or his authorized representative at least three (3) days' notice before any proposed date to resume such work. If flagging is required, no work shall be undertaken until the flagman is present at the site. No delay to the Construction Project will be claimed against NSR or NCDOT if qualified flagging personnel are no longer available within the three (3) day period.

It may take up to thirty (30) days to obtain flagging initially from NSR. When flagging begins, the flagman is usually assigned by NSR to work at the project site on a continual basis until no longer needed and cannot be called for on a spot basis. If flagging becomes unnecessary and is suspended, it may take up to 30 days to again obtain for NSR. Due to NSR labor agreements, it is necessary to give 5 working days notice before flagging services may be discontinued and responsibility for payment stopped.

If, after the flagman is assigned to the project site, an emergency arises that requires the flagman's presence elsewhere, the Contractor shall delay work on the NCCR right-of-way until such time as the flagman is again available. Any additional costs resulting from such delay shall be borne by the Contractor and not by NCDOT or NSR.

No delay will be charged to NSR or NCDOT in the event that flagging services are unavailable when requested by the Contractor, nor will delay be charged to NSR or NCDOT when flagging personnel are pulled from Construction Project activity for any reason deemed necessary by NSR.

Measurement and Payment

The need for flagging will be determined by NSR. For estimating purposes, thirty (30) Man Days will be used.

The estimated cost of flagging is current rate per day based upon a 10 hour work day. This cost includes the base pay for the flagman, overhead, and includes a per diem charge to travel expenses, meals and lodging. The charge to the Contractor by NSR shall be the actual cost based upon this rate o pay for NSR's employees who are available for flagging service at the time the service is required.

Work by a flagman in excess of 8 hours per day or 40 hours per week, but not more than 12 hours a day will result in overtime pay a 1 ½ times the appropriate rate. Work by a flagman in excess of 12 hours per day will result in overtime of 2 times the appropriate rate. If work is to be performed on a holiday, the flagging rate is 2 ½ times the appropriate rate.

NSR work involved in preparing and handling bills will also be charged to the Contractor.

Flagging costs are subject to change.

Railroad flagman will be measured and paid for at the contract price per man day. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing labor and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (MD)	Man Day
Railroad Flagging	

TRACK OUTAGES

Track Windows. The Contractor is expected to carry out the work with the minimum possible disruption of rail traffic. It may be necessary for Contractor to adjust his working hours or work week to best fit track availability. Rail traffic patterns are subject to change, therefore details regarding train movements and anticipated track windows will be provided at the pre-bid meeting to insure up to date information.

Extended Track Outages (4 hours or longer). The tie-in segments of the work may require longer track outages than can be provided on a routine, daily basis. The number and duration of these major outages will be determined by the construction methods selected by the Contractor.

HAUL ACROSS RAILROAD

The Contractor will be required to make all necessary arrangements with NSR regarding means of transporting materials across the railroad. The Contractor will be required to bear all costs incidental to such crossings whether services are performed by his own forces or by NSR personnel.

No crossing may be established for use of the Contractor for transporting materials or equipment across the tracks of the railroad unless specific authority for its installation, maintenance, necessary watching and flagging thereof and removal, until a temporary crossing agreement has been executed between the Contractor and NSR. The approval process for an agreement normally takes 90 days.

TRAINMANS WALKWAYS

Along the outer side of each exterior track of multiple operated track, and on each side of single operated track, an unobstructed continuous space for trainman's use in walking along trains, extending to a line not less than 10 feet from centerline of track shall be maintained. Any temporary impediments to walkways and track drainage encroachment or obstructions allowed during work hours while NSR's protective service is provided shall be removed before the close of each work day. If there is an excavation near the

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walkway, a handrail with 10' 0" minimum clearance from centerline of the track shall be placed and must conform to AREMA and /or FRA standards.

GUIDELINES FOR PERSONNEL ON RAILROAD RIGHT-OF-WAY

All persons shall wear hard hats. Appropriate eye and hearing protection must be used. Working in shorts is prohibited. Shirts must cover shoulders, back and abdomen. Working in tennis or jogging shoes, sandals, boots with high heels, cowboy or other slip-on type boots is prohibited. Hard sole, lace up footwear, zippered boots or boots cinched up with straps which fit snugly about the ankle are adequate. Wearing of safety boots is strongly recommended. In the vicinity of at-grade crossing, it is strongly recommended that reflective vests be worn.

No one is allowed within 25' of the centerline of track without specific authorization from the flagman.

All persons working near track while train is passing are to lookout for dragging bands, chains and protruding or shifted cargo.

No one is allowed to cross tracks without specific authorization from the flagman.

All welders and cutting torches working within 25' of track must stop when train is passing.

No steel tape or chain will be allowed to cross or touch rails without permission.

GUIDELINES FOR EQUIPMENT ON RAILROAD RIGHT-OF-WAY

No crane or boom equipment will be allowed to set up to work or park within boom distance plus 15' of centerline of track without specific permission from NSR official and flagman.

No crane or boom equipment will be allowed to foul track or lift a load over the track without flag protection and track time.

All employees will stay with their machines when crane or boom equipment is pointed toward track.

All cranes and boom equipment under load will stop work while train is passing (including pile driving).

Swinging loads must be secured to prevent movement while train is passing.

No loads will be suspended above a moving train.

No equipment will be allowed within 25' of centerline of track without specific authorization of the flagman.

Trucks, tractors or any equipment will not touch ballast line without specific permission from NSR official of flagman.

No equipment or load movement within 25' or above a standing train or railroad equipment without specific permission of the flagman.

All operating equipment within 25' of track must halt operations when an train is passing. All other operating equipment may be halted by the flagman if the flagman views the operation to be dangerous to the passing train.

All equipment, loads and cables are prohibited from touching rails.

While clearing and grubbing, no vegetation will be removed from railroad embankment with heavy equipment without specific permission from NSR and flagman.

No equipment or materials will be parked on stored on NSRR right-of-way unless specific authorization is granted from NSR.

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All unattended equipment that is left parked on NCCR right-of-way shall be effectively immobilized so that it cannot be moved by unauthorized person.

All cranes and boom equipment will be turned away from track after each work day or whenever unattended by and operator.

PROTECTION OF RAILWAY INTEREST

INSURANCE: **State Project: U-2928B** **County: Lenoir**

A. In addition to any other forms of insurance or bonds required under the terms of the contract and specifications, the Prime Contractor will be required to provide coverage conforming to the requirements of the Federal-Aid Policy Guide outlined under 23 CFR 646A for all work to be performed on Railroad right(s) of way by carrying insurance of the following kinds and amounts:

1. **CONTRACTOR'S COMMERCIAL GENERAL LIABILITY INSURANCE:**

The Contractor shall furnish an original and one copy of the certificate of insurance and one certified copy of the policy to the Department as evidence that, with respect to the operations he performs on railroad right of way, he carries regular Commercial General Liability Insurance having a combined single limit of not less than \$2,000,000 per occurrence for all loss, damage, cost and expense, including attorneys' fees, arising out of bodily injury liability and property damage liability during the policy period. Said policy shall include explosion, collapse, and underground hazard (XCU) coverage, shall be endorsed to name Railroad specified in item A.2.c. below as an additional insured, and shall include a severability of interests provision.

2. **RAILROAD PROTECTIVE LIABILITY INSURANCE:**

The Contractor shall furnish to the Department an original and one duplicate of the Railroad Protective Liability Insurance having a combined single limit of not less than \$2,000,000 each occurrence and \$6,000,000 in the aggregate applying separately to each annual period. If the project involves track over which passenger trains operate, the insurance limits required are not less than a combined single limit of \$5,000,000 each occurrence and \$10,000,000 in the aggregate applying separately to each annual period. Said policy shall provide coverage for all loss, damage or expense arising from bodily injury and property damage liability, and physical damage to property attributed to acts or omissions at the job site.

The standards for the Railroad Protective Liability Insurance are as follows:

- a. The insurer must be rated A- or better by A.M. Best Company, Inc.
- b. The policy must be written using one of the following combinations of Insurance Services Office ("ISO") Railroad Protective Liability Insurance Form Numbers:
 - (1) CG 00 35 01 96 and CG 28 31 10 93; or
 - (2) CG 00 35 07 98 and CG 28 31 07 98; or
 - (3) CG 00 35 10 01; or
 - (4) CG 00 35 12 04.

c. The named insured shall read:

Norfolk Southern Railway Company
 Three Commercial Place
 Norfolk, Virginia 23510-2191
 Attn: Director Risk Management

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- d. The description of operations must appear on the Declarations, must match the project description in this agreement, and must include the appropriate Department project and contract identification numbers.

The Description and Designation shall read: All Construction within the Railroad's right of way located along the Global Transpark Lead Track in Kinston, North Carolina (Lenoir County).

- e. The job location must appear on the Declarations and must include the city, state, and appropriate highway name/number.
- f. The name and address of the prime contractor must appear on the Declarations.
- g. The name and address of the Department must be identified on the Declarations as the "Involved Governmental Authority or Other Contracting Party."
- h. Other endorsements/forms that will be accepted are:
 - (1) Broad Form Nuclear Exclusion – Form IL 00 21
 - (2) 30-day Advance Notice of Non-renewal or cancellation
 - (3) 60- day written notice be given the Department prior to cancellation or change
 - (4) Quick Reference or Index Form CL/IL 240
- i. Endorsements/forms that are NOT acceptable are:
 - (1) Any Pollution Exclusion Endorsement except CG 28 31
 - (2) Any Punitive or Exemplary Damages Exclusion
 - (3) Known injury or Damage Exclusion form CG 00 59
 - (4) Any Common Policy Conditions form
 - (5) Any other endorsement/form not specifically authorized in item no. 2.h above.

B. If any part of the work is sublet, similar insurance, and evidence thereof as specified in A.1 above, shall be provided by or on behalf of the subcontractor to cover its operations on Railroad's right of way. As an alternative, the Prime Contractor may provide insurance for the subcontractor by means of separate and individual policies.

C. Prior to entry on Railroad right-of-way, the original and one duplicate copy of the Railroad Protective Liability Insurance Policy shall be submitted by the Prime Contractor to the Department at the address below for its review and transmittal to the Railroad. In addition, certificates of insurance evidencing the Prime Contractor's Commercial General Liability Insurance shall be issued to the Railroad and the Department at the addresses below, and one certified copy of the Prime Contractor's policy is to be forwarded to the Department for its review and transmittal to the Railroad. All policies and certificates of insurance shall state that the insurance coverage will not be suspended, voided, canceled, or reduced in coverage or limits without (30) days advance written notice to Railroad and the Department. No work will be permitted by Railroad on its right-of-way until it has reviewed and approved the evidence of insurance required herein.

DEPARTMENT:

Department of Transportation
 Rail Division
 C/O Mr. David Hinnant, State Railroad Agent
 1556 Mail Service Center
 Raleigh, NC 27699-1556

RAILROAD:

Director, Risk Management
 Norfolk Southern Railway Company
 Three Commercial Place
 Norfolk, Virginia 23510-2191

- D. The insurance required herein shall not limit the obligations of Department or its Contractors under the terms of this agreement.
- E. All insurance herein before specified shall be carried until the final inspection and acceptance of the project, or that portion of the project within railroad right of way, by the Department or, in the case of subcontractors, until the Contractor furnishes a letter to the Engineer stating that the subcontractor has completed his subcontracted work within railroad right of way to the satisfaction of the Contractor and that the Contractor will accomplish any additional work necessary on railroad right of way with his own forces. It is understood that the amounts specified are minimum amounts and that the Contractor may carry insurance in larger amounts if he so desires. As to "aggregate limits", if the insurer establishes loss reserves equal to or in excess of the aggregate limit specified in any of the required insurance policies, Contractor shall immediately notify the Department of Transportation and shall cease all operations until the aggregate limit is reinstated. If the insurer establishes loss reserves equal to or in excess of one/half of the aggregate limit, Contractor shall arrange to restore the aggregate limit to at least the minimum amount stated in these requirements. Any insurance policies and certificates taken out and furnished due to these requirements shall be approved by the Department and the Railroad Company as to form and amount prior to beginning work on railroad right of way.

FAILURE TO COMPLY:

- A. In the event the Contractor violates or fails to comply with any of the requirements of these Special Provisions:
 - (1) The Railroad Engineer may require that the Contractor vacate Railroad property.
 - (2) The Engineer may withhold all monies due the Contractor on monthly statements.

Any such orders shall remain in effect until the Contractor has remedied the situation to the satisfaction of the Railroad Engineer and the Engineer.

PAYMENT FOR COST OF COMPLIANCE:

- A. No separate payment will be made for any extra cost incurred on account of compliance with these special provisions. All such cost shall be included in prices bid for other items of the work as specified in the payment items.

RAILROAD SITE DATA:

The following information is provided as a convenience to the Contractor. This information is subject to change and the Contractor should contact the Railroad to verify the accuracy. Since this information is shown as a convenience to the Contractor but is subject to change, the Contractor shall have no claims whatsoever against either the Railroad or the Department of Transportation for any delays or additional costs incurred based on changes in this information.

Number of tracks	-	1	
Number of trains per day	-	4	
Maximum speed of trains	-	40	

NORFOLK SOUTHERN CONSTRUCTION

A portion of the work on the NCRS corridor will be performed by NSR as indicated below. This work is subject to the terms of a construction agreement between North Carolina Department of Transportation, Norfolk Southern Railway Company and North Carolina Railroad Company. The Contractor shall be responsible for coordinating his work with NSR. The ability of NSR to complete the work indicated below and make a track connection between the NSR Main Track and the NCGTP Connecting Track

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available to the contractor for delivery of materials and on-track equipment is dependent upon the completion of grading, earthwork and other work items by the Contractor in a timely manner. NSR will have the turnouts installed and the track constructed to the derail on the west leg of the wye two months after the Contractor has completed his work and NSR has accepted the roadbed for track construction. NSR will have the turnouts installed, the track constructed to the derail on the east leg of the wye and revision of warning devices at Hillcrest Road completed six months after the Contractor has completed his work and NSR has accepted the roadbed for track construction. The Contractor shall complete the roadbed within the NCCR right of way and make it available to NSR for the construction of their portion of the trackwork as described in this agreement no later than March 1, 2011.

NORFOLK SOUTHERN TRACK CONSTRUCTION

Norfolk Southern Railway (NSR) will perform certain items of track construction as shown on the Contract Plans. NSR will perform the following:

- Furnish and install the No. 10 turnout at the connection of the West Wye track to the NCCR Main Track (West Wye PS Station 9+93.77 = NCCR Main Track PS Station 1000+00.00).
- Furnish and install the No. 10 turnout at the connection of the East Wye track to the NCCR Main Track (East Wye PS Station 7+57.11 = NCCR Main Track PS Station 1017+95.87).
- Remove existing main track as required for the installation of the No. 10 turnouts.
- Surface and line NCCR Main Track.
- Furnish and install spot ties in NCCR Main Track.
- Construct West Wye Track from the No. 10 turnout on NCCR Main Track to the double switch point derail (West Wye Station 11+05 ± to 11+77 ±). NS will furnish and install **stone ballast**, running rail, wood ties, and other track material. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, sedimentation erosion control, preparing subgrade and furnishing and installing sub-ballast.
- Furnish and install the double switch point derail at West Wye PS Station 12+16.69. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, sedimentation erosion control, preparing subgrade and furnishing and installing sub-ballast.
- Construct East Wye Track from the No. 10 turnout on NCCR Main Track to the double switch point derail (East Wye Station 8+69 ± to 10+96 ±). NS will furnish and install stone ballast, running rail, wood ties, and other track material. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, sedimentation erosion control, preparing subgrade and furnishing and installing sub-ballast.
- Furnish and install the double switch point derail at East Wye PS Station 11+36.38. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, sedimentation erosion control, preparing subgrade and furnishing and installing sub-ballast.
- Furnish and install the rubber rail seal grade crossing at Hill crest Road for the East Wye Track. NS will be responsible only for the track and rubber rail seal. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, sedimentation erosion control, preparing subgrade, furnishing and installing sub-ballast and all roadway work.

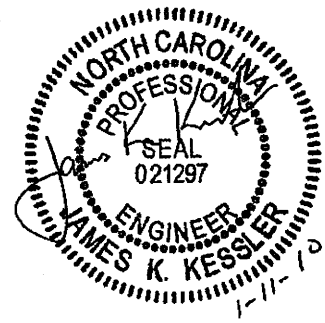
NORFOLK SOUTHERN SIGNAL CONSTRUCTION

Norfolk Southern Railway (NSR) will perform certain items of signal construction as shown on the Contract Plans. NSR will perform the following:

- Furnish and install the grade crossing warning devices at the Hillcrest Road at-grade crossing. Contractor will be responsible for all other work at this location including, but not limited to, clearing and grubbing, grading and earthwork, and sedimentation erosion control.

PROJECT SPECIAL PROVISIONS (PSP)
RAILROAD CONSTRUCTION

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STONE BALLAST

PART 1 - GENERAL

DESCRIPTION - The Work specified in this section consists furnishing all labor, materials and equipment necessary and incidental to providing and placing track ballast material.

1.1 SUBMITTALS - Submit the following information:

- A. Compliance: Supplier's certification that the materials delivered to the site are in compliance with the specifications.
- B. Samples: Submit, as requested by the Engineer, samples of not less than 150 pounds taken for every 2000 tons from each source of ballast.
- C. Testing and inspection shall conform to the AREMA Manual for Railway Engineering.
- D. The name and location of all ballast sources must be submitted to the Engineer for approval prior to delivery of stone ballast material.

1.2 QUALITY ASSURANCE

- A. Comply with latest edition and addenda of the following provisions, codes, specifications, standards, and recommended practices, except as otherwise indicated:
 - 1. AASHTO American Association of State Highway and Transportation Officials
 - 2. AREMA American Railway Engineering and Maintenance of Way Association, Manual for Railway Engineering
 - 3. ASTM American Society for Testing and Materials
- B. During ballast production, the supplier shall test the material being furnished. One test shall be performed for each 1000 tons, or fraction thereof, delivered to the project site. Tests shall be performed to certify compliance with the ballast specifications in Section 2.1 below.
- C. If, during ballast installation, the source of ballast material changes, the supplier shall perform tests of the new production site in accordance with these Specifications. Ballast shall have the same or higher classification, quality and grading as the former ballast supplied. New ballast shall be approved prior to commencement of delivery.
- D. During the progress of track construction, the Engineer may have samples of ballast obtained from in-place locations, as designated by the Engineer, and tested to ensure compliance with these Specifications.
- E. If ballast in-place does not conform the requirements of these Specifications, the Engineer will notify the Contractor to stop further loading of ballast until the fault has been corrected and to remove the defective ballast from the site and replace it with approved ballast at no additional cost to the NCDOT.
- F. When ballast does not come clean with preliminary washing, wash ballast at the quarry or the crusher plant.
- G. Material not meeting these specifications will not be accepted for placement in project track construction.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Handle prepared ballast in such a manner that it is kept clean and free from segregation. Deliver ballast which is clean and free from rubbish or any substance which might foul the ballast. Manage blending, stockpiling and other production and handling operations to minimize segregation of finished product. Minimize breakage and excessive fall of ballast during stockpiling operations. Limit the movement of wheeled or tracked machines over stockpiled materials. Unless ballast is stored on a concrete pad, do not use ballast from the bottom 12 inches of the stockpile.

PART 2 - PRODUCTS

2.1 MATERIAL AND GRADING REQUIREMENTS

- A. Ballast shall be crushed stone Granite with angular fragments resulting from crushing by mechanical means quarried from undisturbed, consolidated deposits. Crushed gravel, carbonite and slag are not acceptable.
- B. Ballast gradation shall conform to the limits shown on Table 1-2-2, Recommended Ballast Gradations, of AREMA Manual for Railway Engineering, Chapter 1, Part 2. Main track ballast shall conform to the gradation requirements for size no. 4A. Ballast placed on the GTP siding track and tracks A and B at Spirit shall be size no. 5.
- C. Property requirements shall be in conformance with the values for Granite as shown on Table 1-2-1, Recommended Limiting Values of Testing for Ballast Material, of AREMA Manual for Railway Engineering, Chapter 1, Part 2.
- D. Chemical analyses shall be in accordance with the recommendations of Article 2.4.2, Chemical Analyses of AREMA Chapter 1, Part 2.
- E. Methods of sampling and properties testing shall be as recommended under Article 2.4.1 of AREMA Chapter 1, Part 2, except as otherwise specified herein.
- F. Provide ballast with resistance to degradation and a percentage of wear not greater than 27.5 percent, as determined by the Los Angeles Abrasion Test, ASTM C-535 (1000 revolutions, Grading 3). Minimum allowable Durability index is 50, as measured by ASTM D-3744 Procedure A – Coarse Aggregate.
- G. When tested in sodium sulfate in accordance with ASTM C88, the maximum allowable weighted average loss is 10 percent after five (5) cycles.
- H. Test magnesium carbonate content in accordance with ASTM C25. No carbonates are allowed.
- I. Determine weight per cubic yard in accordance with the requirements of ASTM C29.
- J. Particles of ballast shall be broken by the crusher and have at least two (2) broken surfaces.
- K. Boulders which pass through a 5 inch circular opening before crushing shall be rejected.

2.2 SOURCE QUALITY CONTROL

- A. The quality of material from each source of ballast shall be determined prior to delivery. The material shall be tested for gradation and other required tests as specified in Article 2.1 herein.
- B. Once a source of material has been accepted, representative samples of ballast of not less than 150 pounds shall be taken for every 2000 tons from each source of ballast and tested for gradation and other required tests as specified Article 2.8.1.b of AREMA Chapter 1, Part 2. Each shipment of ballast to the site shall be accompanied

by a certification as specified.

- C. Certified results of the tests required to demonstrate conformance with this Specification shall be provided prior to any material being used for the work.
- D. The ballast delivered to the site shall be from the same source from which samples were tested and found to conform to the Specification and shall be of the same type and quality of that which was tested. If a different source of ballast is utilized, the requirements of paragraphs A. and B. of this Article will again apply.
- E. At the quarry, the Contractor will load ballast from all four sides of the stockpile.

2.3 CRUSHED WALKWAY STONE

- A. Walkway stone shall be of the same quality material specified for stone ballast in Article 2.1 herein. Gradation requirements shall conform to those shown on Table 1-2-2, Recommended Ballast Gradations, of AREMA Manual for Railway Engineering, Section 2.4 for ballast size number 5.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place ballast in accordance with Section 02729, Ballasted Track Construction. Ballast cross sections shall be as indicated on the Contract Drawings.
- B. Crushed Walkway Rock shall be placed 4 inches in depth where required.

PART 4 - MEASUREMENT AND PAYMENT

4.1 STONE BALLAST

- A. Stone ballast will not be separately measured nor paid. Stone ballast will be incidental to the items of work into which it is incorporated.

4.2 CRUSHED WALKWAY STONE

- A. Crushed walkway stone will be measured and paid for at the contract unit price per ton. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Payment will be made under:

Pay Item	Pay Unit
Furnish & Install Walkway Stone	Ton

SUB-BALLAST

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies furnishing, placing, and compacting sub-ballast on the track sub-grade in areas of new track construction. Finished sub-ballast shall conform to the depth, width and slope as indicated on the plans.

1.2 SUBMITTALS - Submit the following information:

- A. Certificate of Compliance: Submit supplier's certification that material delivered to the site is in compliance with this Specification.
- B. Samples: Submit as required by the Engineer samples of not less than 150 pounds. Samples may be obtained independently by the Engineer's representative for testing to ensure that the material delivered to the site is in compliance with the Specifications.
- C. Name and location of proposed supplier for approval.

- D. Gradation reports of representative samples of the material furnished together with certification that the material meets the requirements of these specifications.

1.3 QUALITY ASSURANCE

- A. Comply with latest edition and addenda of the following provisions, codes, specifications, standards, and recommended practices, except as otherwise indicated:
 1. AASHTO American Association of State Highway and Transportation Officials
 2. AREMA American Railway Engineering and Maintenance of Way Association, Manual for Railway Engineering
 3. ASTM American Society for Testing and Material
 4. NCDOT North Carolina Department of Transportation

PART 2 - PRODUCTS

2.1 MATERIALS AND GRADING REQUIREMENTS

- A. Sub-ballast Material
 1. Subballast shall be crushed stone (dense graded aggregate) and shall meet the requirements of AREMA Manual for Railway Engineering, Part 2. Sub-ballast shall be composed of clean, hard uncoated particles free from lumps of clay, shale and other objectionable materials.
 2. Gradation. Gradation shall be as follows:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2 inch	100
1 inch	90-100
3/8 inch	50 to 84
No. 10	26 to 50
No. 40	12 to 30
No. 200	5 to 12

The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

3. Sub-ballast material shall be produced from sound rock or naturally occurring deposits and shall be free from organics and deleterious material as defined by AASHTO T 112.
 4. Other required characteristics
 - a) Liquid Limit in not exceeding 25 as defined by AASHTO T 89.
 - b) Plasticity Index not exceeding 6 as defined by AASHTO T 90.
 - c) Wear shall not exceed 50 percent in accordance with the LA Abrasion test.
 - d) Soft Particles: ASTM C235. Not to exceed 5 percent of sample weight
 - e) Clay lumps and friable particles: ASTM C142. Not to exceed 0.5 percent of sample weight.
 - f) DELETED
 - g) Absorption: ASTM C127. 0.5 percent maximum.
 5. Crushing of sub-ballast shall not be required except the supplier may, at their option, elect to crush any oversize particles present in the deposit as an alternative to screening.
- B. Calcium chloride conforming to requirements of ASTM D98 may be used as an additive for dust control.

- C. Use only one approved material to complete order. Do not change source of material or supplier until required documentation as noted under 1.2 above is submitted and is approved in writing by the Designer.
- D. To satisfy the requirements of this Specification, sub-ballast may be screened, crushed, washed or otherwise processed to produce a uniform, acceptable product.
- E. Blending of different materials from different sources to improve the quality will not be permitted.

PART 3 - EXECUTION

3.1 PROCESSING, HANDLING, AND STORAGE:

- A. Sub-ballast shall be handled during all stages of production and supply in a manner that will provide a uniform product and will avoid contamination and segregation.
- B. Uniformity of sub-ballast will be a measure of the adequacy of processing, handling, and storage methods.
- C. When necessary, to satisfy requirements of type of materials specified, sub-ballast shall be screened, crushed, washed, and otherwise processed with approved equipment that is of adequate capacity and capable of consistently yielding a uniform and acceptable product.
- D. Sub-ballast shall be washed only in properly designed and constructed washing plants. Truck or mixer washing of aggregates and washing methods of like intent will not be permitted.
- E. Sub-ballast that has been washed shall be stored for a sufficient time to allow all free water to drain there from and for materials to attain a uniform water content. Washed materials shall be stored for at least 24 hours after washing or for such periods as determined by the Engineer.
- F. Blending of qualitatively acceptable sub-ballast may be permitted to satisfy grading requirements specified, provided that blending is performed in a satisfactory manner and with equipment approved by the Engineer, so as to consistently produce a uniformly well graded and acceptable product. Blending to improve quality will not be permitted.
- G. Sub-ballast shall be handled and transported at all times in a manner and with equipment that will avoid undue segregation and contamination by mud or any other deleterious material.
- H. Sub-ballast shall not be allowed to fall from a height in a manner that larger particles are thrown beyond smaller particles or that sizes will be separated by wind. Sub-ballast being placed in a bin shall be dropped vertically over center of bin.

3.2 STOCKPILING:

- A. Stockpiling sites shall be level, well drained, free of all foreign materials, and of adequate bearing capacity to support weight of materials to be placed thereon.
- B. Except where stockpiled on concrete foundations or on otherwise acceptably stabilized area, a compacted sand stockpile base not less than 1-foot deep shall be provided to prevent contamination of piled material.
- C. Stockpiles shall be built in layers not to exceed 3 feet in depth and each layer shall be completed over entire area of stockpile before beginning the next layer. Sub-ballast delivered to the stockpile in trucks shall be uniformly spot-dumped and stockpile built as specified. Coning of piles or spilling of material over edges of pile will not be permitted.

D. Prevent material from freezing if installed during cold weather.

3.3 DEFECTIVE MATERIALS:

A. Unless otherwise permitted by the Engineer, rejected materials shall be removed from site of the work within 48 hours of each rejection.

3.4 PLACEMENT, FINE GRADING, AND COMPACTING:

A. Material shall not be placed on sub-grade that is muddy, rutted, snow covered, or frozen.

B. Designer's inspection and acceptance of sub-grade is required prior to placement of sub-ballast on sub-grade.

C. Before placement of sub-ballast, sub-grade shall be proof-rolled using heavily loaded pneumatic-tired equipment or, by vibratory roller on granular sub-grades. Where soft places are located they shall be undercut to a suitable depth, no less than 6 inches, and backfilled with granular aggregate.

D. Sub-ballast shall be compacted and bladed sufficiently to produce a uniform sub-grade support to a surface tolerance of plus or minus 0.1 foot of designated top of sub-ballast.

E. Sub-ballast shall be hauled and placed by trucks or earthmoving equipment in such a way that rutting or disturbing of completed sub-grade is avoided. Disturbed or rutted sub-grade shall be removed from the fill, disposed of and replaced, at the instruction of and to the satisfaction of the Designer, at no additional cost to the Owner.

E. Sub-ballast shall be placed to a compacted depth 8 inches and applied in layers that when compacted shall not exceed 4 inches. Water may be uniformly added to facilitate compaction. Compaction shall be by pneumatic-tired equipment heavily loaded or, by vibratory roller or other equipment approved by the Designer. Small vibrators or pneumatic tampers may be used at places of work where heavy compactors cannot work. All compaction effort shall be uniformly distributed so that all layers are evenly compacted to a density not less than 100 percent of the with ASTM D1556, ASTM D2167, or ASTM D2922.

F. Under no circumstances shall frozen material be installed.

3.5 ADMIXTURE:

A. Calcium chloride may be used for control of moisture.

PART 4 - MEASUREMENT AND PAYMENT

4.1 SUB-BALLAST

A. Sub-ballast will be measured and paid for at the contract unit price per ton. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
ABC (Sub-ballast)	Ton

CONTINUOUSLY WELDED RAIL

PART 1 - GENERAL

1.1 DESCRIPTION - The Work specified in this section consists of furnishing rails; fabricating rails into continuous welded rail (CWR) strings using the electric flash butt welding method; and inspecting, testing, shipping and delivering the CWR strings to the project work site. The Work includes the following:

- A. Manufacturing of rails in standard rail lengths, including inspection and testing.
- B. Fabricating rails into continuously welded strings. The contractor may either deliver welded rail strings to the site or fabricate rails into strings at the site.
- C. Shipping and delivery of CWR to the job site.
- D. All track included in the project (East Wye Track, West Wye Track, Main Track, Siding Track, Track A and Track B) shall be constructed with continuously welded rail (CWR).

1.2 SUBMITTALS - Submit the following information:

- A. Material test results and submittals as stipulated in the AREMA Manual and herein.
- B. Continuously welded rail weld test results.
- C. Submit a schedule of lengths of CWR strings and the location of each string in the finished track. Include schedule of CWR lengths and CWR string designation system.
- D. Drawings and specifications of the proposed equipment, materials, methods and procedures to be used for the electric flash butt welding process for joining of rail. Include layouts of the welding line showing locations of welding components.
- E. Procedure for transportation of CWR to work site, proposed off-load locations and timing, stockpiling and handling procedures.
- F. Qualifications of welding supervisor demonstrating flash butt welding experience of no less than 3 years.
- G. If the Contractor elects to fabricate welded rail strings on-site using a portable welding facility the following shall be submitted prior to fabrication in addition to the other submittals required by this specification:
 - 1. Location(s) of proposed facility.
 - 2. Proposed hours of operation.
 - 3. Description of equipment used and details of set-up configuration.
 - 4. Other detailed information as may be required by the engineer that fully describes the process.

Location of proposed on-site welding facility and the hours of operation are subject to review and approval of the engineer.

1.3 QUALITY ASSURANCE

- A. Comply with the latest edition and addenda of the following provisions, codes, specifications, standards, and recommended practices, except as otherwise indicated:
 - 1. AREMA American Railway Engineering and Maintenance of Way Association, Manual for Railway Engineering
 - 2. AWS American Welding Society
 - 3. ASTM American Society for Testing and Materials
- B. Load, transport, unload, store, and handle CWR in a manner which will prevent damage to the CWR. Submit procedures, and equipment for loading, unloading, handling and storing rail.
- C. Assign responsibility to the welding supervisor for ensuring that welding equipment is in proper operating condition, during the entire period in which rail welding is taking place.
- D. Test all electric flash butt production welds on the welding line. Remove defective electric welds and reweld the rails at the flash butt welding plant location. Do not leave defective welds for later field welding.
- E. Take special care to prevent damage to all surrounding facilities when moving CWR strings. Do not damage other completed or partially completed facilities and

structures including but not limited to pavements, pavement bases, geotextiles, drainage structures, light poles, fire hydrants, utilities, traffic signals, traffic devices, and buildings.

- F. Do not place or store CWR on the completed railroad sub-grade until it has been approved by the Engineer.

1.4 PERSONNEL QUALIFICATIONS

- A. Employ a welding supervisor with a minimum of three years experience in flash butt welding.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rail shall be new 136RE section, meeting requirements of AREMA Manual, Chapter 4, Part 2, Manufacture of Rail, Specifications Section 2.1, "Specifications for Steel Rails", and Part 4, Maintenance of Rail. Only one rail section shall be supplied for the project. Multiple rail sections are not permitted.
- B. The standard length of rail to be welded into strings shall be 80 feet in accordance with AREMA Manual, Chapter 4, Part 2, Section 2.1.1 - Length.
- C. Rail for tangent track and for curves less than seven (7) degrees shall be new 136RE section standard strength, with minimum Brinell Hardness Number of 300.
- D. Rail for curves greater than or equal to seven (7) degrees shall be new 136RE high strength rail, with minimum Brinell Hardness Number of 352.
- E. All rail within the limits of special trackwork construction shall be new 136RE high strength rail, with minimum Brinell Hardness Number of 352.

PART 3 - EXECUTION

3.1 GENERAL

- A. Rails shall be fabricated into strings using the flash butt welding method. The Contractor may either deliver welded rail strings to the site or fabricate rails into strings at the site.
- B. Flash butt welding and testing of rail to the current AREMA Manual, Chapter 4, Part 3, Section 3.12, Specifications for Fabrication of Continuous Welded Rail, unless otherwise specified herein.
- C. Weld CWR strings to minimum delivered lengths at work site of 1200 feet unless otherwise approved by the Engineer.
- D. Cut out and reweld rejected welds with a minimum of 19 feet - 6 inches plugs, at no additional cost.
- E. Bolt holes are not permitted except for insulated joints.

3.2 WELDING EQUIPMENT

- A. Use welding machine which is capable of automatically recording pertinent data including pre-heating impulses, flashing time, upset current, time and platen travel during flashing, and capable of testing the welds during production using the ultrasonic testing method or the dry powder method of magnetic particle inspection.
- B. Maintain welding equipment in good working order at all times.

3.3 RAIL BENDING AND STRAIGHTENING

- A. Alignment tolerances for straightened rails shall be as specified in AREMA Manual, Chapter 4.
- B. Cut back any rail sections that cannot be straightened a sufficient distance to achieve the specified tolerances.
- C. If straightened rail does not meet specification tolerance in two passes through the straightener, cut the rail out of the string.

3.4 RAIL CUTTING AND PREPARATION OF ENDS

- A. Saw cut or abrasive disc-cut rail ends square and clean by means of accepted equipment.
- B. Torch cutting of rail is prohibited.
- C. Prepare the head and base of rails prior to welding by removing mill scale down to bright metal for a length of approximately six inches from the welding end.
- D. Remove all burrs from the rail end area where the welding current carrying electrodes contact the head and base of the rail.
- E. Holes are not permitted in the rail, except as approved by the Engineer.

3.5 ELECTRIC FLASH BUTT WELDING

- A. Fabricate CWR strings so that the branding of all individual rail section appears on the field side of installed track.
- B. Align rails in the welding machine on the head of the rail. Align rails vertically at the head so as to provide for a flat running surface, with any difference in the height of the rails only occurring in the base. Align rails for horizontal alignment so that any difference in the widths of heads of rails is divided equally on both sides of the rail.
- C. Forge all electric flash butt welds to point of refusal to further plastic deformation and to have a minimum upset of 0.5 inches, with 0.625 inches as standard.
- D. Ensure that the upset cylinder does not bottom-out during the upset portion of the weld cycle.
- E. Post weld straightening may be permitted if performed before the surface temperature of the weld falls below 500 degrees Fahrenheit.
- F. Quenching the weld metal is not permitted.

3.6 FINISHING

- A. Pre-flash jagged, notched or badly mismatched end faces to an even or mated condition before setting up rails for preheating and final flashing, to assure that the entire surfaces of the rail ends are uniformly flashing immediately preceding upsetting.
- B. Perform all heavy grinding used during the finishing process on the hot metal immediately following welding, to prevent metallurgical damage.
- C. Finish rails to eliminate cracks visible to the unaided eye.
- D. Eliminate notches created by offset conditions or twisted rails by grinding to blend variations.
- E. Remove all fins on the weld due to grinding drag prior to final inspection.

3.7 TOLERANCES IN ELECTRIC FLASH BUTT WELDS

- A. Tolerances shall be as set forth in the AREMA Manual, Chapter 4, Part 3, Section 3.12, Specifications for Fabrication of Continuous Welded Rail.

3.8 RECORDS FOR ELECTRIC FLASH BUTT WELDING

- A. Submit the following records to the Engineer documenting the production of each CWR string:
 1. CWR string designation number and station location in the field.
 2. Heat numbers of the first and last pieces of rail in the string.
 3. Heat numbers on each side of any weld which has been cut out and rewelded.
 4. A small sketch or graph indicating the current flow during the production of each weld.
 5. Test reports of the production welds.

3.9 CWR STRING MARKINGS

- A. Mark each completed string with the appropriate CWR string designation indicated in the schedule of CWR strings.

- B. Rails shall be identified with branding and stamping in accordance with AREMA Chapter 4, Section 2.16.
- C. The length of each rail shall be painted on the head of the rail at one end.
- D. The following colors must be painted on the top of the head of rail at least 3 feet from the end:

<u>Rail</u>	<u>Paint Color</u>
High Strength	Orange
Shorts	Green
Trackwork	White

3.10 CWR STRING HANDLING

- A. Handle CWR in accordance with submitted and approved procedures for transport and handling.
- B. After welding is completed on CWR strings, transport the strings from the welding line to the track location or a suitable stockpile location.
- C. Submit stockpile location to the Engineer for approval if it lies within the right-of-way.

3.11 VISUAL INSPECTION

- A. Visually inspect all production welds for surface cracks. Welds with surface cracks visible to the eye will not be accepted.

3.12 TESTING OF PRODUCTION WELDS

- A. Test flash butt production welds during the fabrication process by an inspection agency approved by the Engineer, using the dry powder method of magnetic particle inspection or ultrasonic method, in accordance with ASTM E709 and the AREMA Manual of Railway Engineering, Chapter 4.

3.13 REPLACEMENT OF DEFECTIVE WELDS

- A. Cut-out, reweld and retest any flash butt production welds giving fault indication in magnetic particle or ultrasonic inspection during production. Do not leave these for field welding.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CONTINUOUSLY WELDED RAIL

- A. Continuously welded rail will not be separately measured nor paid. Continuously welded rail will be incidental to the items of work into which it is incorporated. See BALLASTED TRACK CONSTRUCTION and SPECIAL TRACKWORK CONSTRUCTION for applicable payment items.

WOOD CROSS TIES AND WOOD SWITCH TIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes specifications for the manufacture, treatment, inspection and shipment of new timber cross ties and switch ties.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
- B. American Wood Preserver's Association (AWPA)

1.3 QUALITY ASSURANCE

- A. During all phases of the process of manufacturing cross ties and switch ties for this

Contract, an Independent Certified Inspector shall perform tests and inspections specified in Chapter 30 of the AREMA Manual for Railway Engineering and these specifications. The Independent Certified Inspector shall have at least 5 years experience inspecting and certifying the manufacture and preservative treatment process of wood ties as specified in the MRE and the Standards of the AWP.

- B. Tie inspection and testing shall be completed and certified by the Independent Certified Inspector prior to shipment.
- C. To be accepted ties shall meet the requirements of the AREMA and these Specifications.
- D. Materials that do not meet these Specifications shall be removed and replaced with acceptable ties at no additional cost to the Owner.

1.4 SUBMITTALS - Submit the following information:

- A. Compliance: Manufacturer's or Supplier's certification that the materials delivered to the site are in compliance with the Specifications.
- B. Submit the name and qualifications of the Independent Certified Inspector.
- C. Tests: Certified test results, as specified in AREMA, as required to demonstrate compliance of materials specified herein shall be received by the Engineer before any wood ties are used in the work.

PART 2 - PRODUCTS

2.1 WOOD SPECIES

- A. Cross ties shall be new, creosote treated mixed oak and mixed hardwoods. Crossties furnished shall be a minimum of 50% oak and the balance shall be hardwoods of the following species:

Ashes	Hickories
Beech	Locusts
Birches	Hard Maples
Cherries	Mulberries
Elms	Sassafras
Gums	Walnuts
Hackberries	

- B. Switch Ties shall be mixed oak and mixed hardwood with the following exceptions: poplar, cottonwood, willow, basswood and sycamore. Mixed oak, not counting hickory, shall make up a minimum of 50% of the switch ties furnished.

2.2 ANTI-SPLITTING END PLATES

- A. Anti-Splitting End Plates shall be manufactured from a minimum of 18 gage galvanized steel plate, hot dipped. End plate shall have nail teeth not less than 3/8 inch in length and of sufficient sharpness to fully penetrate oak ties. Plate shall be fabricated so that teeth twist vertically to provide better grip in tie. Plates shall be 6 inches by 7 inches and shall be machine applied so that nail teeth side of plate is flush with end surface of tie. Plates shall be centered on the ends of the tie.
- B. Anti-Splitting End Plates shall be applied to both ends of the ties prior to seasoning.
- C. End plates shall be applied by mechanical device capable of squeezing the splits together, bringing the tie back to its original dimensions prior to application.

2.3 GENERAL QUALITY

- A. Ties shall be manufactured from sound, live timber and must be free from any defects as further described in this section. The felled timber must be delivered to the mill,

milled and brought to the treatment facility for seasoning as quickly as possible, to avoid wood fiber infection.

- B. All ties shall be straight, well sawn on four sides, cut square at the ends, have top and bottom parallel and have bark completely removed. Ties shall be within the dimensional tolerances specified in AREMA. Ties shall be free from the following defects:
1. Decay - Ties that show decay of any nature and ties that show strain from being left in the log too long will be rejected. "Blue stain" is not decay and is permissible in any wood.
 2. Holes - Ties will be rejected if a large hole, or numerous holes with the net effect of a large hole, is present. A large hole is one exceeding 1/2 inch in diameter and 3 inches deep within the RBA*, or more than one-fourth the width of the surface on which it appears and 3 inches deep outside the RBA.
 3. Knots - Ties with a large knot, or numerous knots with the net effect of a large knot within the RBA will be rejected. A large knot is one whose average diameter is greater than one-fourth the width of the surface on which it appears.
 4. Shake - Shake greater than one-third the width of the tie will be cause for rejection of the tie.
 5. Split - A tie will be rejected if a split exceeds 5 inches long or 1/2 inch wide.
 6. Slanting Grain - A tie will be rejected if a slant in grain in excess of 1:15 is present, except in the case of woods with interlocking grain.
 7. Wane - Excessive wane (more than 1" and as further specified in AREMA) will be cause for rejection of the tie.

* RBA - Rail Bearing Area – the area of the tie between 20 inches and 40 inches from its middle.

2.4 DIMENSIONS

- A. Crossties shall be 8'-6" long 7" grade crossties in accordance with the requirements of AREMA Manual for Railway Engineering Part3, Section 3.1.1.3.1 Dimensions. Ties shall be 7 inches by 9 inches in cross section with a maximum of 1" wane in the top rail bearing area. A maximum of 20% of the ties may be square sawn 7 inches by 8 inches with no wane in the rail bearing areas.
- B. Switch ties shall be 7 inches by 9 inches with no wane allowed and shall be in lengths and quantities as shown on AREA Plan No. 912-02 – BILLS OF SWITCH TIES FOR TURNOUTS AND CROSSOVERS, (Table A) for a number 10 turnout with straight switches.
- C. The lengths and thicknesses specified are minimum dimensions. Ties over one inch wider or thicker or over three inches longer, at any point, than the specified dimensions will be rejected.

2.5 INSPECTION AND TREATMENT

- A. General
 1. All cross ties and switch ties must have certification from an Independent Certified Inspector that each piece furnished was inspected as and when indicated below. Such certification is a condition of but will not constitute final acceptance of the material. Final acceptance will occur after inspection by the Designer at the point of delivery.
- B. Inspection Prior to Seasoning
 1. Green ties must have been inspected at the time of delivery to seasoning area.

Dry ties will be subject to inspection after seasoning and before treatment.

2. Prior to treatment, the Independent Certified Inspector will examine the top, bottom, sides and ends of each tie. Each tie will be graded independently without regard for the grading of the others in the same lot. Ties covered with ice, or too muddied for ready examination, will be rejected.

C. Seasoning

1. Ties shall be air seasoned prior to treatment. Ties shall be stacked for seasoning in accordance with AREMA, Chapter 30. Ties shall be seasoned for at least 12 months and no more than 18 months.
2. In the absence of air seasoned ties, the Boulton drying process may be used. If the Boulton process is used, conditioning should continue until moisture removal rate indicates a percent moisture retained equal to a 12 month air dried tie, but a minimum of 45 percent by weight.
3. A minimum of 20 borer cores per treatment charge shall be taken of seasoned ties to determined that adequate drying has taken place.
4. The borer cores shall be taken mid-way between the ends and mid-way between the top and bottom faces of the tie. Three 3-inch borer cores shall be taken to determined moisture content.

D. Treatment

1. Prior to treatment, anti-splitting plates must be checked by the treating facility to ensure that plates are firmly imbedded in the tie. If plates are found to be loose or not flush against the end of the tie, plate shall be firmly pressed against the tie before treatment begins.
2. Tie treatment shall be to retention of seven pounds or to refusal of 60/40 creosote coal tar solution per cubic foot of timber in accordance with the MRE, Chapter 30.
3. A minimum of 20 borings shall be taken per charge after treatment to determined proper penetration.

E. Final Inspection/Acceptance

1. Ties will be inspected at the project site by the Engineer. Anti-splitting plates that are found to be loose or not firmly against the end of the tie will be rejected.
2. Ties not accepted will be replaced by the Supplier with material meeting these specifications within two weeks of initial delivery at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 SHIPPING AND HANDLING

- A. The Contractor shall arrange transportation of the material to the project site and coordinate delivery times with the Construction Manager. The Contractor shall unload the material at the location on the project site designated by the Construction Manager.
- B. Arrange delivery schedule with the Construction Manager not less than one week in advance to allow inspection by the Engineer.
- C. Handle ties during all phases of processing and loading so as not to cause damage to the material.

PART 4 - MEASUREMENT AND PAYMENT

4.1 WOOD CROSS TIES AND WOOD SWITCH TIES

- A. Wood cross ties and wood switch ties will not be separately measured nor paid. Wood cross ties and wood switch ties will be incidental to the items of work into which they are incorporated. See BALLASTED TRACK CONSTRUCTION and SPECIAL TRACKWORK CONSTRUCTION for applicable payment items.

OTHER TRACK MATERIALS (OTM)

PART 1 – GENERAL

- 1.1 DESCRIPTION - This section specifies the material requirements for other track materials (OTM) including tie plates, cut spikes, joint bars, insulated joints, bolts, rail anchors, rail flangeway lubricators and bumping posts to be furnished and installed in accordance with the Contract Drawings.
- 1.2 SUBMITTALS - Submit the following information:
 - A. Supplier's certification that the material delivered to the site is in compliance with the Specifications.
 - B. All test results and submittals stipulated in the AREMA Manual for Railway Engineering and Portfolio of Trackwork Plans.
 - C. Samples of materials specified under this section as requested by the Engineer.
 - D. Submit shop drawings and product data for track work items not specifically defined by the Contract Drawings.
- 1.3 APPLICABLE STANDARDS
 - A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
- 1.4 QUALITY ASSURANCE
 - A. All OTM shall be standardized throughout the project. Mixing and matching of different materials from different suppliers will not be permitted.
 - B. Testing and inspection shall conform to AREMA Manual.
 - C. Material not meeting the Specifications shall not be used in the work.

PART 2 – PRODUCTS

- 2.1 GENERAL
 - A. All material provided by the Contractor shall be new as specified.
- 2.2 TIE PLATES
 - A. New tie plates shall be manufactured to the requirements of the AREMA Manual for Railway Engineering, Chapter 5, Part 1, Section 1.1, Tie Plates - Specifications for Steel Tie Plates.
 - B. Tie plates to be used with cut spike fasteners shall be 14 inch size AREMA Figure 5-1-8, Plan No. 12, Punching A. Tie plates shall be double shoulder, canted with cant of 1:40.
- 2.3 CUT SPIKES
 - A. New track cut spikes shall be new 5/8 inch, 6" under head, with reinforced throat in accordance with AREMA Manual Volume 1, Chapter 5, Part 2, Track Spikes.
- 2.4 RAIL ANCHORS
 - A. Rail anchors shall be manufactured to the requirements of AREMA Manual for Railway Engineering, Chapter 5, Part 7 Rail Anchors. Rail anchors shall be new one piece drive on anchors designed to be applied either manually or with standard anchor machines.

- B. All rail anchors supplied for this contract shall be of the same type and form one manufacturer.

2.5 JOINT BARS, BOLTS AND NUTS

- A. Joint bars, bolts and nuts shall be used for the temporary joining of CWR rail sections only. All permanent joints shall be welded. Joint bars shall be new or good relay and conform to material specifications of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 - Joining of Rail, Section 3.4 - Specifications for Quenched Carbon-Steel Joint Bars, Microalloyed Joint Bars and Forged Compromise Joint Bars.
- B. All joint bars shall be 6 hole, 36 inches in length.
- C. All track bolts and nuts shall be new and conform to the material specifications of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 - Joining of Rail, Section 3.5, Specifications for Heat-Treated Carbon Steel Track Bolts, and Carbon-Steel Nuts.
- D. All spring washers shall be new and conform to the material specifications of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 - Joining of Rail, Section 3.6, Specifications for Spring Washers.

2.6 COMPROMISE JOINTS

- A. Compromise joints shall be welded in accordance with the requirements of THERMITE FIELD RAIL WELDING of these Special Provisions.

2.7 BONDED INSULATED JOINT PLUG RAILS

- A. Contractor shall furnish all bonded insulated joint plug rails which shall be prefabricated, adhesive bonded type. Prefabricated bonded insulated joint plug rails shall be new and conform to the requirements of AREMA Manual for Railway Engineering, Chapter 4, Part 3 - Joining of Rail, Section 3.8 - Specifications for Bonded Insulation Rail Joints.
- B. Joint bars shall be six hole, 36 inch.
- C. Fastenings shall be 1 inch diameter A-490 bolts. Rails shall be drilled to accommodate bolts and insulated sleeves. High pressure end posts shall be 1/4 inch thickness.
- D. Rail for bonded insulated joints shall be new 136RE high strength rail with minimum Brinell Hardness Number of 352.
- D. Insulated joint plug rails shall be a minimum of 19 feet long.
- E. Insulated joints shall be suspended between two adjacent ties. Tie plates must not be located within four inches of the rail gap of an insulated joint. Insure that the rails are electrically isolated from one side of the joint to the other after assembly and installation of insulated joint.

2.8 BUMPING POSTS

- A. Bumping posts shall be a WD type compatible with general freight rail operations at the ends of long industrial tracks.
- B. The bumping post shall be designed for use with the rail section where it is to be installed.
- B. Bumping posts shall be furnished with middle rails.
- C. Bumping post shall be furnished with a shock free head.

- A. The flangeway lubricator shall be a mechanical wayside lubricator, including a ramp assembly, wiping bar, all fittings and fastenings, and a grease tank. The lubricator shall be similar to Portec Model MC-3, or equal as approved by the Engineer.
- B. The flangeway lubricator shall be installed at the locations indicated on the Contract Drawings. Install and adjust the lubricator in accordance with the Manufacturer's recommendations.
- C. The flangeway lubricator shall be designed and installed to lubricate both rails in both directions of travel.

2.10 SLIDING BLOCK DERAIL

- A. Sliding block derails shall be designed to operate on and off the rail in a sliding motion. Derails shall be single handed type and must be sized to fit the rail section.
- B. Derails shall be thrown with an operating stand. The operating stand shall be furnished with a target.
- C. Derails shall be furnished complete including derail, operating rods, operating stands, targets and long timbers.
- D. Sliding block derails shall be installed in accordance with the manufacturer's instructions and requirements.

PART 3 – EXECUTION

3.1 GENERAL

- A. Other track materials shall be installed in accordance with the reference specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.1 OTHER TRACK MATERIAL

- A. Tie plates; cut spikes; rail anchors; joint bars, bolts and nuts; and compromise joints will not be separately measured nor paid. These materials will be incidental to the items of work into which they are incorporated. See BALLASTED TRACK CONSTRUCTION and SPECIAL TRACKWORK CONSTRUCTION for applicable payment items.

4.2 BONDED INSULATED JOINT PLUG RAILS

- A. Bonded insulated joint plug rails will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Thermite welds are not included in the payment item for Bonded Insulated Joint Plug Rails. Thermite welds are measured and paid under the Bid Item for General Trackwork Item (EA), Furnish & Install Field Welds.
- C. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install Ins. Joint Plug Rails	

4.3 BUMPING POST

- A. Bumping post will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install Bumping Post	

4.4 FLANGEWAY LUBRICATOR

A. Flangeway lubricator will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install Rail Lubricators	

4.5 SLIDING BLOCK DERAIL

A. Sliding block derail will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install Sliding Block Derail	

NO. 10 TURNOUTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing and shipment of a new 136RE No. 10 right hand turnout, including switches and frogs as required in accordance with the requirements of this specification.
- C. Turnouts shall be of welded construction, cut spike fastened.
- D. Unit shall include a complete, specified switch operating mechanism furnished with an ergonomic operating handle.
- E. Units furnished shall include additional rail and OTM as required to install a complete turnout from end to end of long timbers.
- F. No. 10 turnouts to be installed on the North Carolina Railroad main track only will be furnished and installed by Norfolk Southern.
- F. The installation of No. 10 turnouts is specified in SPECIAL TRACKWORK CONSTRUCTION.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1.3 SUBMITTALS

- A. Submit the following to the Engineer for approval.
 - 1. Shop drawing plans for No. 10 turnouts indicating the switch tie layout and the lengths of all switch ties. See 2.02 C below for particular requirements for tie layout.

2. Shop drawing plans for turnout frog indicating the joints before the toe of frog to the joints after the heel of frog, the frog angles, heel and toe lengths, heel and toe spreads, frog angles and critical dimensions.
3. Shop drawing plans for switch including stock and switch rails, all special plates, switch rods, including all details and critical dimensions.
4. Shop drawing indicating a rail/joint layout that is compatible with the tie schedule indicated on AREMA Plan No. 912 – 02 – BILLS OF SWITCH TIES FOR TURNOUTS AND CROSSOVERS.
5. Catalog cuts and details of switch stand, operating rod, switch stand target and ergonomic operating handle.

1.4 INSPECTION / ACCEPTANCE

- A. Material will not be accepted until unloaded and inspected at the Project Site. The Engineer will make a close examination of all materials after being unloaded at the Project Site. Any turnout item that is not in strict compliance with these specifications will be rejected. Contractor shall remove and replace the rejected material at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Turnout material shall be 136RE new rail. Turnouts shall include all components for an operable turnout. Turnout metals shall be complete, including double reinforced switch points with stops and heel blocks, switch throwing mechanisms, stock rails, straight closure rails, curved closure rails, connecting rails, frogs, frog guard rails, and all other metals necessary for a complete installation including tie plates and spikes. The turnout components shall conform in basic design to the following AREMA Manual of Railway Engineering plans and specifications referenced herein, as applicable.

2.2 TURNOUT LAYOUT

- A. Basic turnout dimensions and geometry shall be per AREMA Plan No. 910-02 - Turnout And Crossover Data For Straight Split Switches
- B. The location of joints shall generally conform to AREMA Plan No. 921-02 - Location of Joints for Turnouts with Curved Split Switches (Type "S"). No rails shall be less than 16 feet long. Rail layout shall provide suspended joints with the proposed tie layout. No supported rail joints will be allowed.
- C. The timber schedule shall be as indicated on AREMA Plan No. 912 – 02 – Bills of Switch Ties for Turnouts and Crossovers.

2.3 SWITCH

- A. Switch components shall generally conform to AREMA Plan No. 111-08 – 16' 6" Straight Split Switch with Uniform Risers. Hand Throw Insulated Switch with Adjustable Rail Braces.
- B. Supplier shall fit all switch points to stock rails, install heel blocks and bolts and band together with two steel straps and ship components combined and assembled. Switch points shall mate properly to stock rails. Switch points provided shall conform in basic design to AREMA Plan 221-00 Detail 5100. Heel Joint Assemblies and Stops shall conform in basic design as shown on Plan 221-00. Stock rails shall be 39 feet long. The turnout side stock rail shall be bent in accordance with AREMA requirements to match the type of switch point provided. Stock rails for Sampson points (AREMA detail 5100) shall be under-cut and ground to assure fit of switch points.

2.4 FROGS

- A. Frogs shall be rail bound manganese steel frogs with guard rails.
- B. Frogs, hook twin plates, and frog guard rails furnished shall consist of the following components and conform in basic design to the following AREMA plans and specifications:
 1. AREMA Plan No. 600B-03 – Point and Flangeway Dimensions for Manganese Frogs and Crossings
 1. AREMA Plan No. 621-03 – Data and Sections for Rail Bound Manganese Steel Frogs for Rails 112 LB. and Heavier Heavy Wall.
 2. AREMA Plan no. 623-03 – No. 9, No. 10 and No. 11 Rail Bound. Manganese Steel Frogs for Rails 112 Lb. and Heavier Heavy Wall.
 3. AREMA PLAN 241-03 - Details and Typical Applications of Hook Twin Tie Plates.
 4. AREMA Plan No. 502-03 - Setting for Guard Rails Tee Rail Design. Guard rails shall be 13' 0" long.
 5. Guard Rails for Rail Bound Manganese Steel Frog may be either hook flange type or one piece design per AREMA Plan No. 510-01 Manganese Steel One Piece Guard Rail.

2.5 ADDITIONAL RAIL AND OTM

A. Rail

1. All rails supplied shall be new 136RE high strength rail, with minimum Brinell Hardness Number of 352. Rail layout shall be as indicated on AREMA Plan No. 921-02 - Location of Joints for Turnouts with Curved Split Switches (Type "S") and to fit the tie schedule indicated in 2.2 C above.
2. Rails and metals supplied, shall complete the turnouts, and shall extend to or beyond the limits of the tie layouts as shown in tables on AREMA Plan No. 912-02 – Bills of Switch Ties for Turnouts and Crossovers.

B. OTM

1. All joints, bolts/nuts and washers, canted double shouldered tie plates, and hook twin tie plates, shall be supplied for the installation of rails, switch points, and frogs over the timber layout as shown in AREMA PLAN 912-02 - Bills of Switch Ties for Turnouts and Crossovers.
2. Rail Joints
 - a. Joint bars shall be new and conform to material specifications of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 - Joining of Rail, Section 3.4 - Specifications for Quenched Carbon-Steel Joint Bars, Microalloyed Joint Bars and Forged Compromise Joint Bars.
 - b. All joint bars shall be 6 hole, 36 inches in length.

C. TIE PLATES

1. New tie plates shall be manufactured to the requirements of the AREMA Manual for Railway Engineering, Chapter 5, Part 1, Section 1.1, Tie Plates - Specifications for Steel Tie Plates.
2. Tie plates to be used with cut spike fasteners shall be 14 inch size AREMA Figure 5-1-8, Plan No. 12, Punching A. Tie plates shall be double shoulder, canted with cant of 1:40.

D. FASTENERS

1. All track bolts and nuts shall be new and conform to the material specifications

of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 – Joining of Rail, Section 3.5, Specifications for Heat-Treated Carbon Steel Track Bolts, and Carbon-Steel Nuts.

2. All spring washers shall be new and conform to the material specifications of the AREMA Manual for Railway Engineering, Chapter 4, Part 3 – Joining of Rail, Section 3.6, Specifications for Spring Washers.
3. New track cut spikes shall be new 5/8 inch, 6” under head, with reinforced throat in accordance with AREMA Manual Volume 1, Chapter 5, Part 2, Track Spikes.

E. RAIL ANCHORS

1. Rail anchors shall be manufactured to the requirements of AREMA Manual for Railway Engineering, Chapter 5, Part 7 Rail Anchors. Rail anchors shall be new one piece drive on anchors designed to be applied either manually or with standard anchor machines.

2.6 SWITCH OPERATING MECHANISM

- A. Switch operating mechanisms shall be a New Century Low Model 51-A, Pettibone No. 4 Hub, Racor Tri Glide Series 36 E, National Trackwork Low Model 1003ARS, or approved equal and be complete with operating rod, switch direction targets, and all necessary hardware to connect to switch furnished. Operating rod shall allow placement of switch stand not less than 6 feet – 6 inches from centerline of track. Stands must be provided with provision for placement of switch locks.
- B. Switch stand operating handle shall be of an ergonomic type designed to minimize bending by operating personnel. Coordinate handle furnished that is physically compatible with specified stand.

PART 3 - EXECUTION

3.1 SHIPPING AND HANDLING

- A. The Contractor shall arrange transportation of the material to the Project Site and coordinate delivery times with the Engineer.
- B. Arrange delivery schedule with the Engineer not less than one week in advance to allow inspection by the Engineer.
- C. Material shall be packaged and handled as follows:
 1. Band switch rails together with stock rails for each turnout unit. Identify stock rails so as to indicate the turnout number and whether right-hand or left-hand. Identify the center of balance point of combined units, by painting its location on the top.
 2. Package frogs as a single unit per turnout.
 3. Identify each rail center of balance point, of all rails being supplied by painting its location on the top of each rail. Also identify the turnout unit of each rail by painting the turnout unit identification on the top of each rail being supplied.
 4. Package turnout metals as separate turnout components. Do not mix components of turnouts but keep them separate and clearly mark and ship all components required to comprise a complete turnout.
 5. Handle special trackwork materials in a manner that will prevent damage during loading, transporting, and unloading.

3.2 INSTALATION

- A. The installation of No. 10 turnouts is specified under SPECIAL TRACKWORK CONSTRUCTION.

PART 4 - MEASUREMENT AND PAYMENT

4.1 NO. 10 TURNOUTS

- A. No. 10 turnouts will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Thermite welds are not included in the payment item for No. 10 Turnouts. Thermite welds are measured and paid under the Bid Item for General Trackwork Item (EA), Furnish & Install Field Welds.
- C. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install No. 10 Turnout	

DOUBLE SWITCH POINT DERAILS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing and shipment of two (2) double switch point derails.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1.3 SUBMITTALS

- A. Submit the following to the Engineer for approval.
 1. Shop drawing plans for 16' - 6" Double Switch Point Derail indicating the switch tie layout and the lengths of all switch ties.
 2. Catalog cuts and details of switch stand, operating rod, switch stand target and ergonomic operating handle.

1.4 INSPECTION / ACCEPTANCE

- A. Material will not be accepted until unloaded and inspected at the Project Site. The Engineer will make a close examination of all materials after being unloaded at the Project Site. Any turnout item that is not in strict compliance with these specifications will be rejected. Contractor shall remove and replace the rejected material at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Double split switch point derail material shall be 136RE new rail. Derails shall include all components for an operable derail. The derail components shall conform in basic design to the following AREMA Manual of Railway Engineering plans and specifications referenced herein, as applicable.

2.2 SWITCH

- A. Switch components shall generally conform to AREMA Plan No. 111-08 - 16'-6" Straight Split Switch with Uniform Risers. Hand Throw Insulated Switch with Adjustable Rail Braces.
- B. Supplier shall fit all switch points to stock rails, install heel blocks and bolts and band together with two steel straps and ship components combined and assembled. Switch points shall mate properly to stock rails. Switch points provided shall conform in basic design to AREMA Plan 221-00 Detail 5100. Heel Joint Assemblies and Stops shall conform in basic design as shown on Plan 221-00. Stock rails shall be 39 feet long.

The turnout side stock rail shall be bent in accordance with AREMA requirements to match the type of switch point provided. Stock rails for Sampson points (AREMA detail 5100) shall be under-cut and ground to assure fit of switch points.

PART 3 – EXECUTION

- A. The installation of double switch point derails is specified under SPECIAL TRACKWORK CONSTRUCTION.

PART 4 - MEASUREMENT AND PAYMENT

4.1 DOUBLE SWITCH POINT DERAILS

- A. Double switch point derails will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (EA)	Each
Furnish and Install Dbl. Switch Pt. Derail	

GRADE CROSSINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies furnishing and installing precast modular grade crossing surfaces and rubber rail seal and asphalt grade crossing surfaces. Grade crossing surfaces shall be installed in accordance with the contact plans and the manufacturer’s recommendations.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
- B. AASHTO Policy on Geometric Design of Highways and Streets
- C. USDOT / FHA Railroad Highway Grade Crossing Handbook

1.3 SUBMITTALS

- A. Submit the following to the Engineer for approval.
 1. Detailed description of construction procedures for the specific type of grade crossing to be installed.
 2. Manufacturer’s brochures and other detailed descriptions of crossing materials to be furnished.
 3. Detailed shop drawings and a detailed description of the installation procedure.
 4. Detailed information of changes to the typical ballasted track construction details and/or construction methods to accommodate the crossing surfaces. Modifications may include, but are not limited to, tie spacing, tie size and length, and ballast section.

1.4 INSPECTION / ACCEPTANCE

- A. Material will not be accepted until unloaded and inspected at the Project Site. The Engineer will make a close examination of all materials after being unloaded at the Project Site. Any material that is not in strict compliance with these specifications

will be rejected. Contractor shall remove and replace the rejected material at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 FULL DEPTH CONCRETE PRE-CAST CROSSING PANELS

- A. Furnish crossing surfaces of a modular full depth concrete panel design. Concrete shall conform to ASTM C150, Type III, with a minimum 28 day compressive strength of 6000 psi. Reinforcing steel shall conform to ASTM C615, Grade 60. Crossings shall be as manufactured by Omni Products, Inc., Century Group, Inc. or equal approved by the Engineer.
- B. Type, design and style of crossing shall be as approved by the Engineer.
- C. Furnish new, prefabricated modular panels without modifications to the manufacturer's standard design except as approved by the Engineer. Crossing panels shall be one piece design which fit without field modifications.
- D. The running surface of each panel shall be at the top of rail to 1/8 inch below the top of running rail when installed.
- E. Provide field side panels having a continuous side surface from the top of the panel to top of the ties to interface and retain highway paving materials.
- F. Furnish crossings with removable panels which allow uncomplicated removal and reinstallation without causing damage to the crossing system. Furnish crossing which, after removal and when being reinstalled, does not require new material.
- G. Furnish crossing system with a proven skid resistant surface which is highly resistant to chemicals and organic solvents.
- H. Crossing panels shall be one piece modular section without shims to support the panels. Design crossing panels to seat the entire tie surface providing full bearing support except in the fastening area.
- I. Design crossing panels with a tongue and groove interlocking system to provide a continuous surface or a secured hold down at every tie positioned to control the intersecting corner areas.
- J. Design crossing panels to fit securely under the rail head on both the gauge side and field side of the rail.
- K. Crossing panels shall be furnished with all associated hardware necessary for a complete installation.

2.2 RUBBER RAIL SEAL CROSSING MATERIALS

- A. At-grade modular virgin rubber rail seal system consisting of four rubber rail seals (one seal on both gage and field side of both rails), including all adhesives, any required fasteners, and all other material necessary to completely install the quantity of rail seals. Rubber rail seals shall be elastomeric type crossing material in gauge and field sections, designed and manufactured of 100% virgin rubber and have the ability to interface with a bituminous surface. All rubber materials shall meet ASTM Specification D-2000, M4A712, B35, C32, EA14, G21, and Z1 thru Z6. Elastomeric type rubber, both field and gauge sections, must be capable of being installed and secured using standard cut spike track construction on timber ties using 136#RE rail section. Rubber rail seals must be furnished in one-piece sections not less than 12 feet long. Any system using rail seals less than 12 feet long will not be accepted.

2.3 GEOTEXTILE FABRIC

- A. Geotextile fabric shall be in accordance with the requirement of AREMA Manual for Railway Engineering, Chapter 1, Part 10. The physical properties of geotextile fabric shall meet the requirements for Extra heavy Weight fabric as shown in Table 1-10-2.

PART 3- EXECUTION

3.1 GRADE CROSSING INSTALLATION

- A. Construct road crossings to the alignment and limits shown on the Contract Drawings.
- B. Install the proprietary type road crossing in accordance with the manufacturer's recommendations.
- C. Prior to installing the crossing surface, the track shall be brought to a true grade and shall be shaped and compacted.
- D. Geotextile fabric shall be placed as indicated on the Contract Drawings. Geotextile shall be placed between the subgrade and sub-ballast through the grade crossing area. The geotextile fabric shall be placed 100 feet from the centerline of roadway on both sides except for Harvey parkway where the distance shall be 150 feet.
- E. All tie plates within the limits of grade crossing construction shall have a minimum of 4 spikes.

PART 4 - MEASUREMENT AND PAYMENT

4.1 FULL DEPTH CONCRETE PRE-CAST GRADE CROSSINGS

- A. Full depth concrete grade crossings will be measured and paid for at the contract unit price per lineal foot of track. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Track within the limits of the crossing shall not be included in the pay item for Furnish and Install Concrete Grade Crossing but shall be measured and paid as specified in BALLASTED TRACK CONSTRUCTION.
- C. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (LF)	Lineal Foot
Furnish and Install Concrete Grade Crossing	

4.2 RUBBER RAIL SEAL GRADE CROSSINGS

- A. Rubber rail seal grade crossings will be measured and paid for at the contract unit price per lineal foot of track. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Track within the limits of the crossing shall not be included in the pay item for Rubber/Asphalt Grade Crossing but shall be measured and paid as specified in BALLASTED TRACK CONSTRUCTION.
- C. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (LF)	Lineal Foot
Furnish and Install	
Rubber/Asphalt Grade Crossing	

BALLASTED TRACK CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies new ballasted track construction using new materials.
- B. This section also specifies work on existing tracks to permit the installation of new No. 10 turnouts. This work includes spot tie replacement and surfacing and lining of existing track.
- C. The Contractor shall furnish all materials for the construction of ballasted track.

- D. New ballasted track construction includes:
 1. Placing and compacting ballast.
 2. Placing and aligning wood ties.
 3. Distributing and installing rails.
 4. Stress relieving and destressing running rails.
 5. Aligning and anchoring rail.
 6. Tamping, lining and surfacing track and turnouts.
 7. Other operations as specified.
- E. Modifications to existing ballasted track include the following:
 1. Re-aligning and surfacing existing track to new horizontal and vertical alignment.
 2. Removing existing track to permit installation of new No. 10 turnouts.
 3. Spot tie replacement.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1.3 TRACK CONSTRUCTION TOLERANCES

- A. The track and turnout construction tolerances shall be as specified in Table 1 below.

TABLE 1
TRACK CONSTRUCTION TOLERANCES

GAUGE		CROSS LEVEL	
DEVIATION	DIFFERENCE IN 62' TRACK	DEVIATION (1)	DIFFERENCE IN 62' TRACK
±1/4"	3/8"	±1/4"	1/4"
VERTICAL ALIGNMENT		HORIZONTAL ALIGNMENT	
TOTAL DEVIATION (2)	MID-ORDINATE DEVIATION IN 62' CHORD (3)	TOTAL DEVIATION(4)	MID-ORDINATE DEVIATION IN 62' CHORD (5)
±1/2"	±1/2"	±1/2"	±3/8"
RAIL END MISMATCH - TREAD		RAIL END MISMATCH - GAUGE	
3/16"		3/16"	

NOTES:

- (1) Measured between the actual and the designed track cross level.
- (2) Measured between the actual and the designed top of either rail on tangent track and between the actual and the designed top of inside rail on curved track.
- (3) Measured on the inside rail of curved track and either rail on tangent track. On vertical curves, mid ordinates are in addition to mid ordinates produced by design.
- (4) Measured between the actual and the designed track centerline.

- (5) Measured on the line rail. Use either rail as the line rail on tangent track, except that the same rail shall be used for the full length of the tangent. Use the outer rail as the line rail on curved track.

PART 2 - PRODUCTS

2.1 MATERIALS FURNISHED BY CONTRACTOR

- A. The contractor shall furnish all materials for the work specified herein.

PART 3 - EXECUTION.

3.1 PLACEMENT OF FILL MATERIAL

- A. Fill material for railroad track construction shall be placed in accordance with NCDOT Standard Specifications and the following requirements.
- B. All earth fills shall be made in uniform layers of not more than 6 inches thick after compaction. Rock may be placed in compacted layers of not more than 24 inches thick. Each fully compacted layer shall extend the full width of the cross section.
- C. Each layer shall be free from mud, snow, ice or excessive standing water when a subsequent layer is placed.
- D. Sandy or rocky material shall be spread in full width layers to form drainage planes from the center through the edge of the embankment. Pockets of open graded materials surrounded by more impervious material shall be avoided.
- E. Organic material such as brush, stumps, roots and trees or other perishable items shall not be placed in embankments.
- F. If rock is used as embankment material, voids shall be filled with a fine material. Rocks larger than 4 inches in any dimension shall not be placed within 12 inches of finished sub-grade elevation.
- G. In construction embankments over or against culverts or other structures only the best available materials shall be used. No rock over 4 inches in diameter shall be placed within 12 inches of any structure. Embankment to be placed on both sides of a culvert or other structure shall be brought up equally on both sides.
- J. The height and width of fills shall be increased as deemed necessary to provide for shrinkage and erosion. Slopes shall be maintained to the proper height, dimension and shape. Any erosion or gulying of slopes shall be promptly restored and repaired. Any drainage conditions that are causing slope erosion shall be corrected and controlled.
- K. The contractor may be restricted from using partial or completed roadbed as construction haul roads. Any embankment or roadbed that is damaged by hauling activities shall be repaired by the contractor at no additional cost to the NCDOT.

3.2 COMPACTION OF SUBGRADES AND FILLS

- A. In a fill section, after stripping topsoil and organic material, the entire area upon which the embankment is to be placed shall be plowed and scarified for a minimum depth of 6 inches. The surface and all future fill layers shall be compacted to 95 percent of maximum density per Standard Proctor in accordance with AASHTO T 99 or 90 percent of maximum density per Standard Proctor in accordance with AASHTO T 180, except that a minimum of the top 2 feet of fill shall be compacted to 100 percent Standard Proctor. The top 12 inches of the sub-grade in cuts shall be plowed, scarified and compacted to 100 percent Standard Proctor. The Engineer shall determine the AASHTO test method to be used.
- B. The contractor shall notify the Engineer of when fill layers are ready for compaction testing. Successive layers shall not be placed prior to compaction testing.

- C. Field testing for density control of fill and sub-grade materials shall be made in accordance with the requirements of AASHTO T 191 and T 205 or by use of a portable nuclear density testing device with field test locations selected by the Engineer. Testing shall not relieve the contractor of the responsibility for ensuring that the work is done in accordance with these Specifications.
- D. Contractor may increase the depths of successive fill layers beyond the depths specified in Section 3.2 if tests, performed at his expense, determine that the specified densities can be obtained for the increased layer's depths.
- E. Moisture content of the soil shall be controlled as necessary to obtain the specified densities based upon the optimum moisture content of each material. Water shall be added to the soil, when, in the opinion of the Engineer, additional moisture may be necessary to obtain the specified density. Soil that is too wet shall be allowed to dry or be worked by plowing, disking, harrowing or other means to dry the material to a workable moisture content.
- F. In the event that a specified density is not obtained, the Engineer may order additional rolling, watering or drying of the soil as necessary to obtain the specified density. Fill layers not meeting a specified density after additional working shall be removed and new material shall be placed and compacted to the specified density at no additional cost to NCDOT.

3.3 PLACEMENT OF INITIAL BALLAST

- A. Ballast shall not be distributed until the sub-grade has been completed and accepted by the Engineer and the sub-ballast has been placed, compacted and accepted by the Engineer.
- B. Distribute and compact no more than four inch layers of ballast at a time, uniformly over the finished sub-grade prior to tie distribution.
- C. Deliver ballast at a rate no faster than can be incorporated into the Work, maintaining a proper interval of operations, and at such times as to permit inspection by the Engineer.
- D. Unload ballast in position for use with a minimum of redistribution and dressing.
- E. Shape stone ballast to a true section conforming to the ballast section shown on Contract Drawings.
- F. Thoroughly compact ballast until stones are firmly interlocked and surface is true and unyielding. Compact each lift with not less than four passes of a roller or a vibratory compactor subject to the following requirements:
 1. Compact by rolling using either a self-propelled, three-wheel, two axle roller of such weight that will provide compression under the rear wheels of not less than 350 pounds per linear inch of tread; or using a two or three-wheel tandem roller having a weight per inch of drive roll of not less than 350 pounds, and every part of the surface receiving compression from the drive wheels.
 2. Compact by vibration using vibration compactors of either the roller or pad type. Dynamic force for either type shall not be less than 20,000 pounds and the frequency range shall be 1100 to 1500 vpm. Use machines equipped with a governor that can be set and locked to control rate of impulse.
- G. Top surface of initial layers of ballast shall be smooth, flat and uniformly compacted prior to distributing ties.
- H. The initial layer of ballast shall be a minimum of 4 inches thick and shall extend a distance of a minimum of one foot beyond the end of ties.

3.4 DISTRIBUTING AND SPACING WOOD CROSS TIES

- A. Distribute and space ties on initial layer of ballast. Space ties at design spacing of 19½" inches on center.
- B. Place timber ties so that heartwood is down. Do not adze ties.
- C. Handle treated ties in a manner to avoid breaking and bruising. Do not throw ties from cars or trucks onto rails or rocks.
- D. Place ties normal to centerline of track unless shown otherwise on Contract Drawings.
- E. Space and align ties prior to rail installation.
- F. In placing or spacing treated ties, handle only with tongs or lining bars. Do not use chisels, forks, mauls, picks, punches, shovels, or sledges for moving ties or placing them in position beneath rails.
- G. Distribute ties in proper position for use without further handling.
- H. Remove ties damaged as result of improper handling by the Contractor and rejected by the Designer and replace with undamaged ties at no additional cost to the Owner.

3.5 TIE PLATES

- A. Timber cross ties shall have tie plates installed under each rail.
- B. Prior to installation of tie plates, clean contact surfaces to allow flat bearing of the tie plate on the tie and canted bearing of the rail on the tie plate.
- C. Locate centerline of tie plates on 8 feet 6 inch ties so that the line side of the tie is 18 1/2 inches from outer edge of base of rail. Tie plate shall be centered on the cross tie under rail.
- D. Locate tie plates on longitudinal centerline of each tie and place square to centerline of rail so that outside shoulder of plate bears fully against rail base. Place plate with the downward cant toward center of track.
- E. Secure rail in proper relation to tie end before securing opposite rail.
- F. Use line rail as reference in securing opposite rail to proper gauge.

3.6 CUT SPIKES

- A. Start and drive spikes vertically and square with rail. Drive spikes straight.
- B. Spikes shall be set and driven with long side of head toward rail.
- C. Spiking pattern for shall be as shown on the Contract Drawings.
- D. Gauge of track shall be within tolerances specified in Article 1.3 herein.
- E. Straightening spikes will not be permitted. Spikes bent during driving shall be withdrawn and replacement spikes driven at no additional cost to the Owner.
- F. Under no circumstances shall gauge be adjusted by striking rail, lags, spikes, or plate edge after it is fixed to tie.
- G. Seat rail properly between tie plate shoulders, with outside base of rail tight against outside plate shoulder.

3.7 INSTALLATION OF RAIL

- A. Install and joint rail with end gap adjustment per AREMA Chapter 5, Part 5.1.4. Table 5-5-2.
- B. Install rail in such a manner that damage to ties or OTM is avoided, and ties are not dislodged from their proper position.
- C. Rail joints in track shall have a minimum stagger of 12 feet.
- D. Running rail for all tracks shall be continuously welded rail. Rail shall be welded as specified herein in accordance with the requirement for CONTINUOUSLY WELDED RAIL and THERMITE FIELD RAIL WELDING. Holes may be drilled

in the ends of CWR strings for the temporary connection of rail strings during construction. Rail drilling shall be in accordance with the requirements of AREMA Chapter 4. End holes shall not be drilled. No holes shall be burned under any circumstances.

3.8 INSTALLATION OF RAIL JOINTS

Standard rail joints and compromise joints shall be welded in accordance with the requirements of THERMITE FIELD RAIL WELDING of these Special Provisions.

3.9 TIE PLUGS

- A. Install treated tie plugs in holes where spikes have been pulled from ties.
- B. Drive plugs into tie to refusal and cut plug flush with top of tie, using an adze, before installing tie plates.

3.10 RAIL ALIGNMENT

- A. Construct track conforming to alignment and profile data shown on Contract Drawings.
- B. Alignment is based on centerline of track equidistant between gauge sides of running rails.
- C. For tangent track, profile refers to top of rail in final position. For curved track, profile refers to top of inner (low) rail in final position.

3.11 REALIGN EXISTING TRACK

- A. Existing track shall be aligned to permit the installation of new No. 10 turnouts.
- B. Cross ties that fall out of track during realigning operations shall be replaced with new cross ties as specified herein.

3.12 SURFACING AND ALIGNING

- A. Ballasting
 - 1. Following assembly of track, unload ballast in tie cribs and shoulders of track structure.
 - 2. Unload ballast in quantities that will fill tie cribs and provide ballast for the initial track raise with surplus to continue to hold track after initial raise.
 - 3. Prior to dumping ballast in track, ties shall be spaced as specified and shall be square with rails.
 - 4. Contractor shall re-space and straighten ties to meet specifications herein before stone is distributed.
 - 5. The Contractor shall distribute the stone ballast for tamping the track and for restoring the ballast section.
 - 6. The Contractor shall avoid pulling sod, vegetation, and other foreign material onto the track structure or shoulders for purpose of tamping or dressing the ballast section. Any sod, vegetation or foreign matter inadvertently pulled in shall be removed by the Contractor prior to tamping at no additional cost to the Authority.
 - 7. Clean the trackway area of all debris and standing water prior to placing of ballast. Do not place ballast on frozen subgrade or subbase.
 - 8. Deliver ballast at a rate no faster than can be incorporated into the Work.
 - 9. To the extent practicable, unload ballast in position for use with a minimum of redistribution and dressing.
- B. Tamping
 - 1. Tamp ballast with 16 tool, squeeze-vibratory type, power tamping equipment capable of tamping track and turnouts. Control of power tamper shall ensure maximum compaction of ballast uniformly along track. The Authority's Consultant will determine tamping variables, including rate of advance, number of passes, number of insertions per tie (if more than two are required), length and

number of blades, and frequency of vibration. Tamping tools shall be replaced when the working surface is worn more than 30 percent of its original surface area.

2. Tamp ballast thoroughly under both sides of tie from a point 15 inches inside rails to ends of tie.
3. For each tie, tamp simultaneously inside and outside both running rails on both sides of tie. Minimum tamping insertions will be two.
4. Tamping on snow covered or frozen ballast will not be permitted.

C. Initial Surfacing and Aligning of New Track

1. Surface and align track and turnouts to achieve horizontal and vertical alignment as specified on Contract Drawings.
2. Initial surfacing and aligning shall be performed to bring track geometry to within one inch of final profile and to within one inch of final alignment.
3. Surface and align track by methods that will prevent undue bending of rail, straining of joints, or damaging of rail fastening assemblies.
4. Surface and align track only after cribs are filled with ballast.
5. The amount of any track lift shall neither exceed three inches nor endanger horizontal and vertical stability of tracks.
6. Perform as many raising and surfacing passes of three inches or less as needed to bring track surface to within one inch of final design elevation as shown on Contract Drawings.
7. Initially line track to within one inch of final alignment.
8. Restore ties pulled loose during surfacing to full bearing against rail and properly secure them.
9. Remove and replace with new ties and fasteners any ties or fasteners damaged during surfacing operations at no additional cost to the Authority.

3.13 RAIL ANCHORING / STRESS RELIEVE AND DESTRESS RAIL

- A. Immediately following final surfacing and aligning, the Contractor shall anchor and adjust the welded rail at a rail temperature of 85° to 100°F, ideally 95°F.
- B. Install rail anchors on all tracks. Box anchor every other tie.
- C. All curves of five (5) degrees or greater shall have every tie box anchored throughout the curve and 100 feet on adjacent tangents beyond the curve limits.
- D. Anchors must be applied so as to have full bearing against the tie or tie plate.
- E. Contractor shall maintain a record the degree of rail temperature when anchored along with the date and time of anchoring. Rail temperature records shall be recorded a minimum of three times daily (morning, noon and afternoon). Heat records shall be furnished to NCDOT.
- F. The Contractor shall submit the procedure for stress relieving and destressing rail to the Engineer for review and approval.

3.14 FINAL SURFACING AND ALIGNING

- A. Final surface and alignment of track and turnouts shall be within the tolerances specified in Article 1.3 herein and as shown on the Contract Drawings.
- B. Final surfacing and aligning of track and turnouts shall be completed after track has been initially surfaced and aligned, anchored and jointed and after completion of installation of new turnouts.
- C. Final surfacing and aligning shall be performed on all new track and turnouts. In

addition, existing track shall be final surfaced and aligned wherever it was modified and to blend into new track construction.

- D. Final surfacing and aligning shall bring the track and turnouts to final grade and alignment and shall comply with surface and super-elevation tolerances specified herein and shall consist of a lift of one inch maximum.
- E. During final track raise, line track to final alignment. Track lining will not disturb final track surface and track surfacing will not disturb final alignment.

3.15 BALLAST DRESSING

- A. Concurrent with both initial and final surfacing and aligning of all tracks and turnouts, dress ballast to conform to ballast section shown on Contract Drawings.
- B. After final surfacing and alignment of track is completed, dress ballast to conform to ballast section shown on Contract Drawings. Top of ballast shall be level with top of tie.
- C. Subbase outside toe of slope of ballast that has been fouled or disturbed by Contractor's operations shall be properly treated and sloped as shown on Contract Drawings at no additional cost to the Owner.

3.16 CONSTRUCTION WITHIN EXISTING TRACK STRUCTURE

- A. Other elements of work within existing track include:
 - 1. Installing compromise joint bars, track bolts, nuts and washers to join existing rail to new rail.

3.17 SPOT TIE INSTALLATION

- A. Remove and replace with new ties and fasteners any ties or fasteners damaged during surfacing operations or that unable to be fully tamped.
- B. Ties and fasteners on the newly constructed track shall be removed and replaced by the Contractor at no additional cost to NCDOT.

3.19 FINAL TRACK INSPECTIONS

- A. Final horizontal and vertical alignment, gauge, rail end mismatches, super-elevation and cross level shall be within the tolerances specified herein throughout the project limits. To determine the acceptability of finished track, the Contractor and Engineer shall conduct a walking inspection and measurements to establish that track construction is within tolerances specified herein and free of defects.
- B. Track deviations and defects disclosed by inspection which in the opinion of the Engineer exceed tolerances specified herein, shall be corrected by the Contractor at no additional cost to NCDOT. Re-inspections shall be made by the Contractor and the Engineer to ensure that corrections have been made.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CONSTRUCT WOOD TIE TRACK WITH 136 RE CONTROL COOLED RAIL

- A. The construction of wood tie track with 136 lb. control cooled rail will be measured and paid for at the contract unit price per track foot. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

- B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (TF)	Track Foot
Construct Track, Wood Ties, 136RE, CC	

4.2 CONSTRUCT WOOD TIE TRACK WITH 136 RE PREMIUM RAIL

A. The construction of wood tie track with 136 lb. premium rail will be measured and paid for at the contract unit price per track foot. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (TF)	Track Foot
Construct Track, Wood Ties, 136RE, Premium	

4.3 FINAL SURFACING AND ALIGNING

A. Final surfacing and aligning of track will be measured and paid for at the contract unit price per track foot. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (TF)	Track Foot
Final Surface & Align Track	

4.4 SPOT TIES

A. Spot ties installed in newly constructed track will not be separately measured nor paid but will be incidental to the items of work into which they are incorporated.

4.5 STRESS RELIEVE / DESTRESS RAIL

A. Stress relieving and distressing rail will be measured and paid for at the contract unit price per track foot. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (TF)	Track Foot
Stress relieve / Destress Rail	

SPECIAL TRACKWORK CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the following:
1. Installing complete, fully operational ballasted No. 10 turnouts.
 2. Installing double switch point details.

1.2 APPLICABLE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
- B. Shop drawing plans and catalogue cuts.

1.3 TRACK CONSTRUCTION TOLERANCES

- A. Construction tolerances are as specified in Ballasted Track Construction.

PART 2 - PRODUCTS

2.1 MATERIALS FURNISHED BY CONTRACTOR

- A. Complete No. 10 New 136 RE Turnout Package including Switch Operating Mechanism, Rails, and Other Track Materials (OTM) as specified.
- B. Timber Cross Ties.
- C. Track Ballast.
- D. Dry switch plate lubricant as specified in the AREMA Manual for Railway Engineering.
- E. All other incidental materials required for the installation of Special Trackwork.
- F. Geotextile fabric shall be in accordance with the requirement of AREMA Manual for Railway Engineering, Chapter 1, Part 10. The physical properties of geotextile fabric shall meet the requirements for Extra Heavy Weight fabric as shown in Table 1-10-2.

PART 3 - EXECUTION

3.1 TURNOUT INSTALLATION

- A. Install turnouts, as shown on Contract Drawings and in accordance with the requirements for Ballasted Railroad Track Construction.
- B. Dismantle and remove existing track to install turnouts as indicated on Contract Drawings. Removed track material will remain the property of the North Carolina Department of Transportation or their designee and shall be stockpiled at the project location as designated by the Engineer.
- C. Space and align all designated switch ties within the limits of turnouts. Install ties with heartwood face down. Do not adze ties.
- D. Field bore screw spike holes to a diameter and depth below the top of the tie to suit the type of rail fastener screw spikes used on the special trackwork. Immediately treat the boring with creosote. Do not allow bored holes to penetrate the bottom surface of the tie. Determine the location and number of spike holes by actual placement of each plate upon the tie as indicated. Do not bore holes in any tie in excess of the number of screw spikes to be used.
- E. Clean switch ties and plates prior to installing to ensure full bearing of the plates on the ties. Install plates, special plates and gauge plates as indicated within the limits of turnout.
- F. Fully spike the turnout plates at the plate holding locations indicated on supplier provided Shop Drawings. Start the spikes vertical and drive them square and straight. Do not straighten started spikes. Withdraw bent spikes and drive new spikes. Do not overdrive the spikes or strike the rail, plate or other items.
- G. Install geotextile fabric between the subgrade and sub-ballast layers beneath the turnout. The geotextile fabric shall extend the length of track encompassing the long timbers.

3.2 SWITCH OPERATING MECHANISM

- A. Install switch operating mechanism with operating rod and switch position indicator. After installation, lubricate and adjust to provide proper switch throw with point tight against the stock rails in both normal and reverse directions.
- B. Coordinate installation requirements with switch stand manufacturer.
- C. Place switch stand on side of turnout indicated on Contract Drawings.

3.3 SURFACING AND ALIGNING

- A. Surface, tamp, anchor and align special trackwork as specified herein and Ballasted Railroad Track Construction.
- B. Tamp ballast under both sides of each tie directly under each running rail for a distance of 18 inches on both sides of the rail.
- C. Bring the top of the ballast section to within 1 inch below the base of the rail throughout the special trackwork.
- D. Conform the width and slope of the ballast shoulders to the sections indicated.
- E. In areas of special trackwork where standard rail mounted power tamping equipment cannot be used, use hand held power tamping equipment.

3.4 FINAL ALIGNMENT

- A. The final surface and alignment of the special trackwork shall be within the tolerances specified in Ballasted Railroad Track Construction.
- B. After final surfacing and aligning, dress the ballast to conform to the ballast sections indicated in the Contract Drawings.
- C. In the event that sub-grade outside the toe of the slope is fouled or disturbed as a result of the Contractor's operations, re-slope those portions of the sub-grade at no additional cost to NCDOT.

3.5 JOINTS

- A. All rail joints in special trackwork shall have all holes bolted.

3.6 LUBRICATION

- A. Switch plates shall be given a film of dry graphite switch plate lubricant on all sliding contact surfaces in accordance with the AREMA Specifications for Special Trackwork.

PART 4 - MEASUREMENT AND PAYMENT

4.1 NO. 10 TURNOUTS

- A. No. 10 turnouts will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Thermite welds are not included in the payment item for No. 10 Turnouts. Thermite welds are measured and paid under the Bid Item for General Trackwork Item (EA), Furnish & Install Field Welds.
- C. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install No. 10 Turnout	

4.2 DOUBLE SWITCH POINT DERAILS

- A. Double switch point derails will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by

this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Trackwork Item (EA)	Each
Furnish and Install Dbl. Switch Pt. Derail	

THERMITE FIELD RAIL WELDING

PART 1 – GENERAL

1.1 DESCRIPTION – This section specifies procedures, performance criteria and tolerances for Field Welding continuous welded rail (CWR) strings and connection of rail to insulated joint plugs and special trackwork using the flash butt welding process or approved thermite welding method.

1.2 SUBMITTALS - Submit the following information:

- A. Proposed materials, methods and procedures to be used for flash butt field welding of CWR. If Contractor elects to perform field welding of CWR using the thermite welding process, submit proposed method subject to the Engineer’s approval. For either method, include procedure, materials and methods and include the following items:
 - 1. Manufacturer's trade name for the welding process.
 - 2. Method used for cutting and cleaning of the rail ends.
 - 3. Minimum and maximum spacing between rail ends.
 - 4. Method used for maintaining the rails in alignment during welding.
 - 5. Method used for preheating including time and temperature.
 - 6. Tapping procedure including the minimum time required to cool the weld under the mold insulation.
 - 7. Method used, including a description of special tools and equipment for removing the gates and risers and finishing the weld to the final contour.
 - 8. Details for compromise welds for different rail sections to be joined.
- B. Prior to the initiation of thermite welding, submit detailed specifications showing the proposed quick preheat, self tapping thermite weld kit, and method and procedure for thermite welding. The specifications shall comply with these specifications and that of the weld kit manufacturer.
- C. Submit qualification certifications for each supervisor and field welder who will perform work on this Contract. Weld supervisors and welders shall be required to submit their qualification certificate throughout the duration of the project when requested by the Authority’s Consultant.
- D. Submit name of independent testing contractor and certification that testing laboratory and persons who shall perform ultrasonic testing of field welds have previously tested a minimum of 250 welds.

1.3 QUALIFICATION

- A. Welding shall be performed under the direct supervision of an experienced welding foreman or supervisor with a minimum of three years experience in field flash butt or thermite welding.
- B. Each welder must have a certificate for the type of welding that he is to perform.

C. Thermite Field Weld Qualification

1. Prior to field welding, the Contractor shall employ a supervisor for each welding crew, who is trained and certified for the performance of thermite field welding by the manufacturer supplying the weld kits. Should any supervisor of the welding crew be replaced during the Work the welding crew shall qualify again under the new supervisor.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Thermite Weld Kits shall contain a mixture of aluminum and iron oxide, which when ignited, produces a filler metal to fuse the rail ends together, by heat produced by the thermite reaction. Each weld kit shall contain all molds, luting material and thimble required to complete one weld.
- B. Thermite weld kits shall be self-tapping crucible type requiring minimum pre-heat as manufactured by Calorite, U. S. Thermit, Inc. (Thermit), or Du-Wel Steel Products Company (Boutet), or approved equal.
- C. Packaging shall be waterproof to resist damage to molds and thermite charge.
- D. All other incidental materials required for the execution of Rail Welding.

PART 3 - EXECUTION

3.1 GENERAL

- A. For thermite welding, methods and procedures shall comply with the AREA Manual, Chapter 4, Part 4, Section 3.14 -Specification for the Quality Assurance of Thermite Welding of Rail and with the welding kit manufacturer's recommendations and as specified herein.
- B. Rail ends for thermite welding shall be prepared in accordance with the recommendations of the welding kit manufacturer.
- C. For thermite welding, the rail ends shall be preheated prior to welding to a sufficient temperature and for sufficient time to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.
- D. The completed weld shall be finished by mechanically controlled grinding to conform to the same requirements as specified in AREMA Chapter 4, Section 3.12 Specification for Fabrication of Continuous Welded Rail.
- E. Flash butt welds shall not be made within six inches of bolt holes or within 3 feet of a plant weld.
- F. Do not locate thermite field welds within the following locations in standard track work:
 1. Within 8 feet of the center of any bolted, bonded, or insulated joint.
 2. Within 2 feet of a thermite weld in the opposite rail, or 13 feet in the same rail.
 3. Within 4 inches of any hole drilled in rail.
 4. Within 9 inches of a weld which has been cut out.
 5. Within 1 inch of a tie plate.
 6. Within 4 feet of a shop weld in the same rail.
- G. Compromise welds shall be in accordance with the manufacturer's recommendations.
- H. Welding heat treated or high strength rails shall be in accordance with the rail manufacturer's recommendations.

- I. Welding of heat treated or high strength rails to standard rails shall be in accordance with the manufacturer's recommendations.
- J. Welds must be located in tie cribs and located no closer than four inches to the nearest tie.
- K. Torch cut rails at the ends of CWR strings must be saw cut a minimum of six inches from the torch cut end.
- L. If plug rails are required to meet requirements shown above, or to replace a defective weld, minimum length of plug rail is 18 feet.

3.2 FIELD WELDING RECORD

- A. Field welding record shall be continuously maintained and furnished weekly to the Engineer. Record shall include the following details:
 - 1. Date and time of weld(s)
 - 2. Location by station, stating track and rail
 - 3. Contractor's foreman
 - 4. Kit manufacturer and identity of each mold and portion (themite welds)
 - 5. Weather, air and rail temperature
 - 6. Track condition, anchorage and rail stress
- B. Rail shall be painted in legible characters at least 1-1/2 inches high at each field weld with the following information:
 - 1. Date of Weld (MO/DAY/YR)
 - 2. Initials of welder performing weld
 - 3. Air temperature at time of weld (AT XXX)
 - 4. Rail temperature at time of weld (RT XXX)
 - 5. Example: 6/5/10 ABC AT90 RT120

3.3 TOLERANCES OF FIELD WELDS

- A. A straight edge 36 inches in length, applied to finished welded joint area may show the following maximum variations of the railhead:

1. Vertical Offset	0.060 inches maximum
2. Horizontal Offset	0.060 inches maximum
3. Vertical Crown	+0.060 inches maximum, - 0.000 inches minimum
4. Horizontal Kink	0.025 inches maximum
5. Combined Horizontal Offset and Kink	0.060 inches maximum
6. Combined Vertical Offset and Crown	0.090 inches maximum

3.4 FINISHING OF FIELD WELDS

- A. Sharp edges and burrs are to be removed, including chimneys from welds. All welds shall be ground smooth.
- B. Weld joints shall be smooth on top and sides and straight in line. No over grinding is permitted.
- C. Weld joints shall be smooth on sides and bottom. Offset blending permitted at rate of 0.010 per inch.
- D. Weld joints shall be smooth on both sides to within approximately 1/8 inch of original contour. Width of remaining upset will be between 1/2 inch and 5/8 inch.

3.5 FIELD WELD TESTING

- A. Rail welds shall be tested by the contractor through the use of a testing agency using the Ultrasonic testing method in accordance with ASTM E 164.
- B. Each completed weld shall have full penetration and complete fusion and be entirely free of cracks. Total area of internal defects such as porosity and slag inclusions shall not exceed 0.060 square inch and the largest single porosity or slag defect permitted shall not exceed 1/8" in diameter.
- C. Other causes for rejection of welds shall be:
 - 1. Cracks that show in the finished weld are cause to reject weld.
 - 2. Pit holes that show in web and base of weld after finish grinding are cause to reject weld. Pit holes in head not exceeding 1/4 inch in depth may if approved by the Engineer, be repaired by gas welding.
 - 3. Welded joints not meeting these Technical Provisions and tolerances will be replaced at no additional cost. The defective weld shall be cut out an a new section of rail no less than 13 feet long shall be inserted, welded and tested at no additional cost.

3.6 CUTTING IN SHORT SECTION RAIL AND THERMITE WELDING THE ENDS

- A. A short section of rail shall be cut in the CWR, when directed by the Engineer, for the following reasons:
 - 1. To repair defective rail
 - 2. To repair defective welds
 - 3. To de-stress rail
 - 4. To make a connection between rail strings or adjust rail to meet a specific point (i.e. to connect CWR to stock rail or frog).
 - 5. The short section of rail to be cut in shall be at least 13 feet long and shall be of the same weight, size, section, and class of rail being replaced or joined.
- B. Before cutting out rail in CWR, prevent remaining CWR from further movement by applying anchors. After cutting CWR, rail expander/puller or other means shall be used to prevent rail movement.
- C. The ends of the short rail section and the CWR shall be sawed or abrasive cut.
- D. Follow procedures specified for completing field welding by thermite process.
- E. Repair of rail due to damage by Contractor shall be at Contractor's expense.
- F. When repairing defective rail or weld, new rail shall be the same length as rail being replaced, or as required to achieve thermal adjustment.

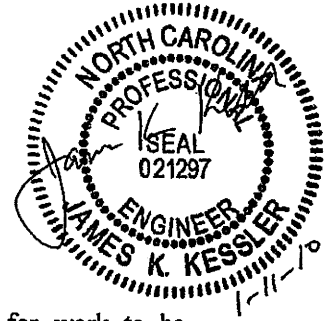
PART 4 - MEASUREMENT AND PAYMENT

4.1 THERMITE FIELD WELDS

- A. Thermite field welds will be measured and paid for at the contract unit price each. Such prices and payment will be full compensation for all work covered by this provision including but not limited to furnishing, installing and all incidentals necessary to complete the work.
- B. Payment will be made under:

Pay Item	Pay Unit
General Trackwork Item (EA)	Each
Furnish & Install Field Welds	

**PROJECT SPECIAL PROVISIONS (PSP)
RAILROAD SIGNALS AND COMMUNICATIONS**



BASIC TECHNICAL SIGNAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the basic requirements and design criteria for work to be performed by the Contractor to design, furnish, and install the equipment, material, hardware, and all necessary appurtenances specified, or required, to provide complete, safe, and operating Automatic Highway Crossing Warning Systems (AHCW), as described within these Specifications and as shown on the Contract Drawings.
- B. The design and workmanship of the apparatus shall comply in every respect with the Rules "Grade Crossing Signal System Safety" and the, Standards and Instructions for the Installation, Inspection, Maintenance and Repair of Automatic Block and Interlocking Systems", as set forth by the Office of Railroad Safety of the Federal Railroad Administration, effective February 27, 1984, and any supplements thereto which shall become effective before this Contract is awarded.
- C. Typical circuits and layout plans have been designed for the AHCW System and Power Supply Systems. These circuits and plans are intended to illustrate the design criteria necessary to implement the basic requirements of the Contract. It shall be the Contractor's responsibility to finalize the system design for his proposed equipment and furnish all labor and material to provide a workable system.
- D. The AHCW system shall be of the most modern type, including the latest improved designs which shall provide the highest degree of safety and reliability for passenger and freight train service. The AHCW control system shall be so designed as to meet all the applicable Signal Manual Parts of the Communications and Signal Section, American Railway Engineering and Maintenance Association, except that where the word "may" appears in the Manual, as part of a directive, the word "Shall" shall be substituted.
- E. Unless otherwise specified herein, all items furnished and/or installed shall be in accordance with applicable AREMA, AREA, IEEE, NEMA, and Authority standards, practices, and recommendations. In case of conflict the priority shall be:
 1. Federal, State, and local laws and regulations.
 2. Contract Specifications and Contract Drawings.
 3. Authority standards.
 4. AREMA Standards, practices, and recommendations.
 5. AREA standards.
- F. Full circuit design is being provided for the AHCW Systems. These circuits and plans illustrate the design criteria necessary to implement the basic requirements of the Contract. It shall be the Contractor's responsibility to provide detail design and finalize the system design for his proposed equipment and furnish all labor and material to provide a workable system.
- G. The AHCW Systems shall be designed to meet applicable requirements of the latest revision of the Manual of Uniform Traffic Control Devices (MUTCD) Part VIII, where the requirements of the MUTCD do not conflict with these Specifications.
- H. All apparatus, including the signal instrument housings (cabinet), signal junction boxes, gates, flashers, and cantilevers shall be furnished completely factory wired and

tested. The Contractor shall furnish all plans required to install the systems.

- I. The new AHCW system shall be as described herein and as shown on the Contract Drawings. The Contract Drawings show the general arrangement of the AHCW apparatus to be furnished and installed under this Contract. It shall be the responsibility of the Contractor to furnish and install all necessary material and appurtenances to provide a fully safe and consistently reliable AHCW system.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The material and apparatus required for the work to be performed is specified within the respective Sections of these Specifications.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Work shown on the Contract Drawings and defined in these Specifications shall be performed by the Contractor and shall include all work complete including design, procurement, installation and testing of all AHCW, communication and power equipment.

3.2 SYSTEM CIRCUIT DESIGN REQUIREMENTS

- A. The Contract Documents provide vital AHCW system design. The Contractor shall detail design, furnish and install all final circuits and wiring plans. In the event the Contractor's proposed equipment does not fit the vital design provided, it shall be the Contractor's responsibility to modify the design and submit his alternate design for approval.

3.3 DESIGN CRITERIA

- A. Fail Safe Design Criteria
 - 1. Vital circuits shall be designed on fail-safe design principles; i.e., broken wires, damaged or dirty contacts, a relay failing to respond when energized, or a loss of power supply energy shall not result in unsafe conditions.
 - 2. Component or system failures which are not self-detecting shall not cause unsafe conditions, even if added to other failures. Any number of simultaneous component or system failures attributable to the same cause or related causes shall not cause unsafe conditions. Any component or wire becoming grounded or any combination of such grounds shall not cause unsafe conditions.
 - 3. All vital circuits shall be double-break, except within a signal instrument house or wayside case, after the entering or leaving circuits are double-broke.
 - 4. All vital repeater relay circuits shall be designed on the cascade principal; the paralleling of vital repeater relays will not be permitted.
 - 5. Repeater relay contacts shall be assigned so that safety will not be compromised by the failure of any repeater relay to energize.
- B. Signal equipment proposed for this Contract must be proven by a minimum in-service operation of two years.

3.5 AUTOMATIC HIGHWAY GRADE CROSSING WARNING (AHCW) CRITERIA

- A. In the design of the AHCW systems start circuits, a minimum of 30 seconds shall be required prior to the arrival of trains at crossings. Additional start time shall be provided for multiple track crossings with wide travel surfaces. The crossing times for wide crossings are shown on the Contract Drawings. Other pertinent criteria shall be as shown

on the Contract Drawings. The Contractor shall verify that the AHCW systems start circuits shown on the Contract Drawings are correct for the reaction time of the type of equipment he proposes to install. Any relocation of the start circuits due to the reaction time of proposed/approved equipment shall be at no additional cost to the Authority.

B. Control Circuits

1. Control circuits shall be in accordance with AREMA requisites where they do not conflict with the typical circuits shown on the Contract Drawings and these Specifications.
2. Where means are provided for cutting out the warning devices during intervals when trains make regular operating stops or perform switching operations on approach circuits, the following features shall be provided:
 - a. Controls shall be designed to provide that warning devices are again operating before the train enters the crossing.
 - b. Automatic control of the warning devices actuated by approaching trains other than the train that has stopped or is performing switch operations shall take precedence over any cutout features.
3. Warning devices shall operate until the rear of the train clears the crossing for trains operating in either direction.

C. Constant warning time systems shall be provided for train detection for Automatic Highway Crossing warning system locations shown on the Contract Drawings.

3.6 EQUIPMENT REQUIREMENTS

A. Environment

1. Physical - Signal Equipment Shelters and Wayside Cases

All equipment housed in Signal Equipment housings or wayside cases shall function in accordance with the specifications and within a temperature range of -22 degrees F. to +158 degrees F. at relative humidity's of 0 percent to 100 percent.

2. Physical - Wayside

Signal equipment installed outside of the signal equipment housings shall be designed to operate satisfactorily in all weather conditions such as rain, snow, dirt, temperature variations and humidity variations. This shall be determined by the climatic conditions from data published by the United States Government, National Oceanic and Atmospheric Administration for Raleigh and surrounding areas. In addition, the recommendations of the AREMA Signal Manual, Part 2.4.25, shall be followed to minimize condensation and frost buildup.

3. Electrical

The electrical environment to which the Signal equipment will be exposed shall be determined by the Contractor. Design, construction and field application of the signal system shall prevent interference by the site environment from affecting the signal system operation. Some of the possible sources of interference are: ac 60 hertz, rotating machinery, lightning discharges, and communication systems.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

FOUNDATIONS AND PADS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work to be done under this Section consists of furnishing and installing precast concrete foundations, galvanized steel foundations, cast-in-place foundations and cast-in-place concrete pads. Foundations to be furnished and installed shall be complete with galvanized anchor bolts, washers, nuts and associated hardware and installed at locations shown on the Contract Drawings. Where cast-in-place concrete foundations are required, as indicated on the Contract Drawings, or as specified herein, such foundations shall be installed per manufacturer's recommendations
- B. Precast concrete or galvanized steel (square type) foundations shall be furnished and installed for signal housings, junction boxes, and other associated equipment as specified herein and as shown on the Contract Drawings.
- C. Precast concrete foundations shall be furnished and installed for bracket mast signals, cantilevers, and ground mount signals, as specified herein and as shown on the Contract Drawings. At the discretion of the Engineer, approved cast-in-place foundations may be used for cantilevers.
- D. All foundations shall include all fastening hardware and associated material.
- E. Crib walls for foundations which require close wall cribbing (support walls) shall be furnished and installed as specified herein.

1.2 QUALITY ASSURANCE

- A. Concrete for precast foundations shall be in accordance with specifications of the American Railway Engineering Association entitled "Specifications for Concrete Structures, Chapter 8".
- B. A permanent record shall be kept by the precast fabricator of the date and conditions of casting of each unit.
- C. Test Specimens
 - 1. Representative test specimens of the concrete poured during the fabrication of the precast units shall be tested to determine the compressive strength of the concrete by an "Accredited Authoritative Structural Testing Laboratory" at no additional cost to the Contract.
 - 2. Cement aggregates, mixing water and reinforcement used for precast units shall conform to the requirements of NCDOT Standard Specifications.
- D. Proper control of water-cement ratio, vibration frequency, protection and curing processes shall be monitored to provide the minimum strength of concrete as specified herein.
- E. Proprietary wall or close wall timber cribbing shall be in accordance with AREMA Chapter 8, Section 6.3.

1.3 SUBMITTALS

- A. The Contractor shall submit the following to the Engineer for approval:
 - 1. Catalog cuts and descriptive literature for all material as specified herein and as shown on the Contract Drawings.
 - 2. Drawings of the cast-in-place foundations proposed to be furnished and installed. These drawings shall include the following:
 - a. Physical Dimensions

- b. Type of Formwork
 - c. Reinforcing
 - d. Bolt spacing, size and detail of galvanized bolts, nuts and washers
 - e. Depth of foundation from top of finished grade
3. Drawings of proposed timber, concrete or steel cribs, where cribbing is required, as indicated on the Contract Drawings.
- B. Upon the Engineer's request, the Contractor shall submit the following for approval:
- 1. Drawings of the precast foundations proposed to be furnished and installed. These drawings shall include the following:
 - a. Physical Dimensions
 - b. Reinforcing
 - c. Bolt spacing, size and detail of galvanized bolts, nuts and washers
 - d. Depth of foundation from top of finished grade
 - 2. Two copies of the fabricator's records showing the date and conditions relating to the manufacture of each precast unit, which shall include type of fabricator's building or enclosure, form material used, curing procedures, (steam or water), temperature ranges, air entrainment content, water-cement ratio, method of finishing the units, and all other pertinent information.
 - 3. Four certified copies of the tests conducted by the "Accredited Authoritative Testing Laboratory" for approval and acceptance of the precast units.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be protected from damage throughout delivery, storage and handling.
- B. Damage to precast concrete foundations, resulting from improper handling by the shipper or the Contractor, shall require that all damaged materials be replaced with new materials at no additional cost to the Contract.

PART 2 - PRODUCTS

2.1 PRECAST MATERIALS

- A. Precast concrete foundations shall be made of concrete with a compressive strength of not less than 5000 p.s.i. and be in accordance with the applicable drawing section of Part 14.4 of the AREMA Signal Manual for the type of precast foundation required.
- B. Precast concrete foundations shall be steel reinforced. Reinforcing steel shall be placed not less than one inch from any outside surface.
- C. Finish and Curing of Precast Foundations. Proper control of the water-cement ratio, high frequency vibration and controlled curing shall be used. An air entraining agent shall be used to increase the resistance to weathering. All outside surfaces shall present a smooth and finished appearance.

2.2 BOLTS, NUTS AND HARDWARE

- A. Bolts, nuts and washers shall be galvanized. Nuts and threads shall be in accordance with AREMA Specifications for Bolts, Nuts and Threads, Signal Manual, Part 14.6.20.
- B. Plain washers shall be in accordance with AREMA Specifications for Plain and Spring Lock Washers, Signal Manual, Part 14.6.21. Steel shall be in accordance with AREMA Specifications for Various Types of Steel, Signal Manual, Part 15.1.4, Section 1.

2.3 GALVANIZED STEEL FOUNDATIONS

- A. Steel foundations shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4 inch steel angle and 1/4 inch steel plate.
- B. Bolt spacing shall be the manufacturer's standard(s) for equipment to be supported by the foundation.
- C. Steel foundations shall be galvanized in accordance with the requirements of specification section SIGNAL MISCELLANEOUS PRODUCTS.

2.4 CRIBBING

- A. The Contractor shall furnish proprietary walls, treated timbers, concrete, or steel and fastenings for cribbing, as hereinafter specified.
- B. Crushed stone, gravel or other suitable coarse granular material, in accordance with SIGNAL EARTHWORK of these Specifications, shall be used as backfill for cribbing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to placing foundations, the excavations and installations of crushed stone base shall be placed and compacted as specified in SIGNAL EARTHWORK.
- B. When placing foundations, the Contractor shall exercise care to ensure that anchor bolts are not bent or threads damaged. All anchor bolt threads, washers and nuts shall be protected by applying friction tape, or other approved method satisfactory to the Engineer, until such time as the unit to be supported is installed. Anchor bolts requiring leveling nuts shall be of sufficient length.
- C. Foundations and pads shall be installed level and plumb.
- D. If the surfaces of all foundations exposed to view do not present a uniformly clean surface of even texture and appearance, the surface shall be treated and rubbed to obtain a satisfactory finish, subject to approval by the Engineer.
- E. After back filling foundations, the Contractor shall ensure that the foundation is plumb and level. Top of final grade shall be no less than eight inches below top of foundation. If a crib support wall is required the top of final grade in relation to the top of foundation shall be approved by the Engineer.
- F. Each tier of timber cribbing shall be drift bolted to the one upon which it rests with three-quarter inch galvanized drift bolts in sufficient length to extend through two tiers and not less than four inches into the third tier. Concrete or steel cribbing shall be installed in accordance with the manufacturer's instructions.
- G. The filling of the interior of the crib shall follow closely the erection of the successive tiers and at no time shall the cribbing be laid up higher than three feet above the backfilled portion.
- H. The cribbing shall be installed so as to have a minimum perimeter walkway around the case, or signal, of six feet.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

AUTOMATIC HIGHWAY CROSSING WARNING SYSTEM LAYOUTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work to be done in this Section consists of furnishing and installing automatic highway crossing warning system layouts as specified herein and shown on the Contract Drawings

1.2 QUALITY ASSURANCE

- A. Automatic highway crossing warning system layouts shall meet the requirements of the applicable sections of the AREMA Signal Manual and be in compliance with the latest Part 234 of CFR 49 (FRA) where the requirements do not conflict with these Specifications.
- B. The Contractor shall test and inspect the equipment prior to shipment in accordance with the approved Factory Test and Inspection Procedure.
- C. The Contractor shall perform operational testing of the equipment in accordance with the requirements specified in SIGNAL TESTING.

1.3 SUBMITTALS

The Contractor shall submit the following to the Engineer for approval:

- A. Shop drawings for the assembly of automatic highway crossing warning layouts, including detailed bills of material.
- B. Detailed installation drawings for each layout.
- C. Final circuits and detail wiring plans showing the control of the specified equipment for each newly-circuited location.
- D. Factory test and inspection procedures.
- E. Certified factory test reports of the completed factory tests.
- F. Installation test procedures for testing of the final installed system(s).
- G. Ten manuals describing the installation, maintenance, and operation of the automatic highway crossing warning layouts furnished under this Contract.

1.4 PRODUCT DELIVERY

- A. Prior to shipment, all parts of the automatic gate crossing mechanism that are not painted or made of non-corroding material shall be coated with an approved grease to prevent corrosion. All unused threaded outlets shall be plugged or capped.
- B. LED's shall be packaged separately from flashing light units in which they are to be used.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All equipment specified herein shall be manufactured by one manufacturer, Harmon Industries, Western Cullen Hayes, General Railway Signal Co. (now Alstom), Union Switch and Signal Co., or approved equal in entirety where practicable, so as to ensure proper integration of components into a complete highway crossing signal layout. All equipment specified for AHCW layouts shall be made of aluminum insofar as practicable.
- B. Highway crossing warning equipment shall meet the requirements established by AREMA Signal Manual, Automatic Highway Crossing Warning Systems, part 3.3.1, and AREMA Signal Requisites, Control of Automatic Highway Crossing Signals and

Devices, Part 3.1.15, except where such instructions and requisites conflict with this Specification.

- C. Railroad Crossing signs, as hereinafter described shall be furnished and installed at all public highway crossings indicated on the Contract Drawings.
 - 1. Signs shall be standard circular RXR signs, in accordance with the Manual of Uniform Traffic Control Devices (MUTCD).

2.2 FLASHING LIGHT SIGNAL EQUIPMENT

- A. The Contractor shall furnish mast mounted flashing light signals as shown on the Contract Drawings. The flashing light signal layout shall be equipped with a standard Railroad Crossing sign, and where required, bells, and multiple track signs, as specified herein.
- B. The flashing light signal shall be 12 inch Light Emitting Diode (LED) assemblies in accordance with these specifications and also conform to AREMA Signal Manual, Part 3.2.35 and 3.2.5.
- C. Flashing light assemblies shall consist of various configurations of back-to-back and single-direction flashing light signals as indicated on the Contract Drawings. 30-inch spacing is required per MUTCD and AREMA regulations. Additional mounting hardware may be required in some instances.
- D. Each lamp housing shall be constructed of cast aluminum. The housing shall be equipped with a door with front access, hinged at one side with a weatherproof seal. A ventilation opening shall be provided at the bottom of the housing and covered with brass, or copper, wire screen. A sidelight shall be provided on both sides of the lamp housing complete with gasket, lens, and retainer.
- E. The lamp receptacle or terminations shall be provided for LED maintenance and replacement.
- F. Color of LED shall have a "Y" chromaticity coordinate value not to exceed 330.
- G. Traffic Signal Interconnection. Interconnection of traffic signals at an adjacent highway intersection with protective devices at a crossing normally shall provide for a preemption phase for the traffic signals on the approach of a train to the crossing. The preemption phase shall operate in a manner which will expedite vehicle movement off the track area and will prevent additional vehicles from entering the track area at the crossing. This is normally accomplished by providing a clear-out phase for vehicles waiting on the track and, in some cases, a special "STOP HERE ON RED" signal to keep additional vehicles from entering the track area. In addition, part-time turn restriction signals shall be installed as ordered to prevent vehicles from turning right or left from the highway intersection into the track area. (See Rule 860-42-136).
- H. Each light unit shall be equipped with 20-inch backgrounds with visors.
- I. Bells, when required, shall be provided with 12-inch diameter by 2-inch deep gong with a steel faced clapper in a weatherproof housing. The housing shall be constructed of cast aluminum with a steel gong. The bell shall be provided with a clapper having a steel face on the striking end. The door shall be designed with suitable hinges and a gasket. The bell shall conform to AREMA Signal Manual, Part 3.2.60. Normal operating voltage shall be 10 volts dc.
- J. Crossarms for flashing light units shall be constructed of cast aluminum in accordance with AREMA Drawing, Part 3.2.50 as approved by the Authority's Consultant.

- K. Railroad Crossing Signs shall be white reflex-reflective sheeting on sheet aluminum with the words 'RAILROAD CROSSING' in black letters, in accordance with MUTCD, Article 8 B-2.
- L. Number-of-Tracks signs, where required for multiple track crossings, shall be constructed of aluminum alloy and be corrosion resistant. Black letters on a white background shall be of reflex-reflective sheeting or sheet aluminum.
- M. Flashing light signal assemblies shall be similar to Safetran Model FLX-2000 LED, Western Cullen Hayes (WHC) Model 985-811, Harmon Industries 51791-0X or approved equal.

2.3 CANTILEVER FLASHING LIGHT SIGNALS

- A. Cantilever flashing light layouts shall be equipped with an aluminum cantilever structure, standard Railroad Crossing sign, flashing light signal units, crossarms, visors, backgrounds and, where required, bell(s), and multiple track signs, all as specified herein and shown on the Contract Drawings.
- B. The cantilever structure shall be an aluminum non-rotatable walkout type. The structure assembly shall be as manufactured by Harmon Industries, Model 54004-01, Progress Rail Service, Lincoln Industries Div., Model 59091026, Modern Industries, Model 54004-XX, Safetran Model 071270-XX or approved equal.
- C. The cantilever shall be designed to withstand a wind velocity of 100 mph, gusts of 130 mph, with a maximum horizontal deflection of 3 degrees-15 minutes, and be capable of supporting a 500-pound load at the end of the arm.
- D. The structure shall be equipped with a ladder, ladder guard, and walkway. The walkway shall be equipped with handrails on both sides and shall be a minimum of 20 inches wide, constructed of expanded metal to provide good footing and prevent ice or snow build up. The hand rails shall consist of a top hand rail 30 inches above the walkway and an intermediate hand rail 18 inches above the walkway.
- E. The mast shall be constructed of 12-inch aluminum pipe with a solid base. The structure shall be a single mast structure for arm lengths up to 26 feet and double mast for arms over 26 feet. A pole mounted junction box shall be furnished with provisions for terminating the signal cable on AREMA (AAR) terminals. The junction box shall be equipped with a gasket and front door provided with a means for padlocking.

2.4 AUTOMATIC HIGHWAY CROSSING WARNING GATES

- A. The Contractor shall furnish automatic highway crossing warning gates complete with gate mechanism, gate arm, counterweights, gate arm lights, mast mounted flashing light units, Railroad Crossing signs, extension brackets for signs, and, where required, bell(s) and Number-of-Tracks signs, together with all necessary hardware as specified herein, in accordance with AREMA Signal Manual, Part 3.2.15, and as shown on the Contract Drawings.
- B. The ground-mounted mast for supporting a gate mechanism shall be constructed of five-inch aluminum pipe, 15 feet long complete with pinnacle cap and cast aluminum split base junction box. Junction boxes shall be provided with AREMA terminals, gaskets, and provisions for padlocking. Cantilever mounted gate mechanisms shall include all the appurtenances as the ground mounted mast gate. All special gate hardware for cantilever supported gates shall be ordered with the cantilever assembly as manufactured by the cantilever supplier.

- C. The gate mechanism shall be housed in one enclosure and include a 12 volt dc motor, 15 watt internal heater, gear train, control elements, wire terminals and suitable counterweights.
- D. The general design, painting and striping of the gate arm shall conform to AREMA Signal Manual, Part 3.2.25 or 3.2.26. The striping shall consist of 16-inch alternate reflectorized red and white stripe on both sides of the arm. The arm shall be constructed of fiberglass and be designed to ensure reasonable durability and rigidity to prevent undue sway or whipping. The clearance between the gate arm and any fixed portion of the assembly shall be a minimum of two inches.
- E. The highway crossing gate arms shall be of sufficient length to extend to within one foot of the centerline of the roadway and provide a minimum clearance of two feet from overhead wire and cable.
- F. All roadway gates shall be equipped with wind support devices. The wind support devices shall be as specified in AREMA Signal Manual, Part 3.2.22.
- G. All roadway gates except those mounted on cantilevers shall be equipped with self-restoring gate arm devices. The self-restoring gate arm devices shall be as specified in AREMA Signal Manual, Part 3.2.23 except they shall operate with a gate 32 feet or less in length. The gate arm devices shall be manufactured by Western Cullen Hayes "Gate Gard", National Electric Gate Co. "Gate Saver", General Signal Industries "Gate Keeper" or approved equal.
- H. The gate mechanism housing shall be weatherproof and of ample size to house the equipment properly without crowding. The housing shall be equipped with a door for convenient and ready access and be designed with at least two hooded ventilation openings with brass or copper wire screens. The case housing shall be constructed of cast aluminum.
- I. The circuit controller shall be equipped with copper or brass contacts with sufficient mechanical strength, current carrying capacity, and self cleaning design. The contacts shall also be accessible and adjustable. The circuit controller shall be equipped with sufficient contacts to accommodate the control and indication circuits as shown on the Contract Drawings.
- J. The gate mechanisms shall be supplied with an internal wiring diagram protected by a plastic laminate and shall be fastened to the inside of mechanism cover.
- K. The mechanism shall be equipped with a hold clear device to hold the mechanism in the clear position with 450 foot-pounds applied to the shaft.
- L. Binding posts, nuts, washer and insulators shall conform to AREMA Signal Manual, Part 14.1.11.
- M. Ten volt weatherproof, bi-directional gate arm lights shall be provided in accordance with AREMA Signal Manual, Part 3.2.40 with highway crossing red lenses. Gate arm lights shall be adjustable to permit focusing of lights at gates installations parallel to the tracks but not perpendicular to the roadway.
- N. The highway crossing gate mechanism shall be Western-Cullen-Hayes, Type 3593, Alstom Type D, Safetran Type S-40 or approved equal.
- O. A mechanism support shall be furnished with each gate mechanism. The mechanism support shall provide a base upon which the gate mechanism rests and shall support the weight of the mechanism when it is necessary to swing the mechanism and gate for repairs.
- P. Relays in the gate operating unit shall be of the vital type.

- Q. Crossarms for flashing light units shall be in accordance with AREMA Signal Drawing, Part 3.2.51, as approved by the Engineer.

PART 3 - EXECUTION

3.1 FLASHING LIGHT SIGNAL UNITS INSTALLATION

- A. A hole shall be factory drilled in the mast for the bottom crossarm. The center line of the hole shall be located so that, when the crossarm with light units is attached thereto, the center of the lens of the light unit shall be seven feet, ten inches above the top of the foundation. Holes for additional crossarms, when required, shall be located in the field after the bottom crossarm has been secured to the mast. The location and drilling of the hole shall result in the centerline of the additional light units to be 23 inches above the centerline of the lower light unit.
- B. Bell(s) shall be installed on the top of the mast of the flashing light unit as shown on the Contract Drawings. The face of the bell gong shall be parallel with the highway.
- C. Underground cables shall be installed within the mast and terminate in the crossarm junction box in a manner as specified in SIGNAL WIRE AND CABLE.
 - 1. Wiring for the flashing light units and the bell shall be 37 strand, No. 10 AWG in accordance with the requirements of AREMA Signal Manual, Part 10.3.1.
 - 2. Where additional light units are used, wiring for these units shall multiple off the wiring in the next lowest crossarm junction box.
 - 3. Wiring for bells shall go directly from the bottom junction box to the bell.
 - 4. Terminations for flasher unit and bell wiring shall be solderless compression type terminals as specified in SIGNAL MISCELLANEOUS PRODUCTS.
- D. With ac power off and standby battery in a fully charged condition, the lamp voltage shall be adjusted to nine and one-half volts (measured at the lamp) by varying the resistor for the flasher unit; then, with ac power on the lamp voltage (measured at the lamp) shall be adjusted to the same voltage.
- E. The front lights of the flashing light unit shall be focused to provide maximum visibility for oncoming highway traffic. The back lights of the flashing light unit shall be focused to provide close up visibility for oncoming highway traffic from the opposite direction.

3.2 CANTILEVER LAYOUT INSTALLATION

- A. The base of the cantilever shall be securely fastened to the concrete foundation with the hardware provided for that purpose. The mast shall be plumb when the base assembly is fastened to the foundation. Shims, spacers, or other filler devices shall not be used to level and plumb cantilever layouts.
- B. The railroad crossing sign for the cantilever arm shall be securely fastened with the hardware provided for that purpose.
- C. The front lights of the main mast and cantilever unit shall be focused to provide maximum visibility for oncoming highway traffic. The back lights of the main mast and cantilever unit shall be focused to provide close up visibility for oncoming highway traffic from the opposite direction.
- D. Installation of cantilever shall provide a minimum clearance of 25 feet-zero inches above the roadway.

3.3 AUTOMATIC HIGHWAY CROSSING WARNING GATES

- A. The gate arm tip light shall be steadily illuminated and the other gate arm lights shall flash in unison with the mast or cantilever mounted lights.

- B. Sidewalk gate lights shall be steadily illuminated.
- C. Sidewalk gate lights shall be adjustable for installations not perpendicular to the tracks.
- D. Gate arm counterweights shall be adjusted in accordance with the manufacturer's standards for the length of gate arm specified.
- E. Masts shall be securely fastened within the junction box base in manner such as the distance between the split halves of the base shall be equal when tightened. (Ground mount gates)
- F. The heads of the bolts in the base assembly shall be squared with each other and facing oncoming highway traffic. (Ground mount gates)
- G. The base shall be securely fastened to the concrete foundation with the hardware provided for that purpose.
- H. The mast shall be plumb when the base assembly is fastened to the foundation. Shims, spacers, or other fillers shall not be used to level and plumb highway crossing warning gates.
- I. Gate operating mechanism, including counter-weight arms, shall be securely fastened to the mast with the hardware provided for that purpose.
- J. The mechanism shall be located on the pole in a position that shall allow for the gate arms, when in the down position, to be not more than four feet-six inches, nor less than three feet-six inches, above the crown of the roadway.
- K. Underground cables shall be installed in the split base junction box. The cables shall be potheaded, tagged and terminated as specified in SIGNAL WIRE AND CABLE.
 - 1. Wiring for the flashing light units, gate operating mechanism and the bell shall be 37 strand, No. 10 AWG in accordance with the requirements of AREMA Signal Manual, Part 10.3.1.
 - 2. Wiring from the gate arm shall be direct wired to the gate operating mechanism.
 - 3. Terminations for flasher unit gate operating mechanism and bell wiring shall be solderless compression type terminals as specified in SIGNAL MISCELLANEOUS PRODUCTS.
 - 4. Wiring for flashing light units and bell(s) shall be installed within the mast. Wiring shall be installed from the split base junction box to the gate operating mechanism within a flexible conduit of suitable length.
- L. Fiberglass gate arms shall be fastened to the gate arm mounting assembly with the hardware provided.
- M. The gate shall employ a drive down feature where the descending time shall be adjustably controlled to permit the gate arm to descend smoothly and evenly from clear to the horizontal position within 10 to 15 seconds. The gate arm shall ascend to the upright position in not more than 12 seconds.
- N. The operation of the mechanism shall be such that it will reverse its direction of movement to reflect a change in track occupancy.
- O. The gate mechanism shall operate smoothly and complete all movements without rebounding. It shall be securely held in the clear position until conditions require the gate to be lowered.
- P. The gate arm torque shall be adjusted in accordance with the manufacturer's standard.

3.4 TESTS

- A. Automatic highways crossing warning layouts shall be tested in accordance with the approved Installation Test Procedure and in accordance with the requirements specified in SIGNAL TESTING.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL RELAYS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section shall include furnishing, testing and installing all required relays.

1.2 QUALITY ASSURANCE

- A. Vital relays shall meet the requirements of AREMA Signal Manual Part 6.2.1, where the requirements of the AREMA Specifications do not conflict with any requirements specified herein. Vital Relays shall be of the type as designated in the NCDOT Standard Drawings.
- B. Factory testing of each relay shall be the manufacturer's standard.
- C. Before any relay is used, the Engineer's written acceptance shall be obtained. Acceptance will be based on the test results and the proper completion of the NCDOT Test Report Form.

1.3 SUBMITTALS

- A. The NCDOT's Test Report Form shall be completed for each vital relay installed under this Contract. The use of type written characters shall be used to fill in all information requested on the form.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Vital relays shall be shipped separately from the wired racks in which they are to be used. Relays shall be packaged individually; each in a sturdy corrugated cardboard carton with the drawing number of the relay printed on the outside of the carton. Relays shall be stored in a protected area until tested and installed.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Relays and equipment specified shall be capable of rated performance through an operating temperature range of minus 40 degrees F to plus 180 degrees F.
- B. Relays shall be in dustproof enclosures, except a provision shall be made for ventilation where required, for heat dissipation.

2.2 VITAL DC RELAYS

A. General:

1. Vital Relays shall be Alstom Type B, Safetran Type "ST", Ansaldo Type PN or accepted equal. Contractor shall use the specific relays shown on the Contract Drawings.
2. Vital DC relays, unless otherwise indicated on the Contract Drawings, shall be of the plug-in type and rack-mounted. Relays shall have a transparent dust cover made of a nonflammable composition that will not support combustion.
3. Vital relays, with a nominal operating voltage of 10 to 16 volts, shall be capable of operating continuously without resultant damage, with a minimum voltage range of 7 to 21 volts inclusive, applied to their operating circuits.
4. Vital relays shall have a test terminal to allow convenient measurement of the coil voltage.
5. Biased neutral vital relays shall be designed so that gravity alone will prevent the armature from picking up if the permanent magnet is de-energized or if no current is applied to the coil, due to interruption of the normal magnetic circuit.
6. All front contacts shall be silver-to-metal carbon, meeting the requirements of the AREMA Signal Manual Part 6.2.1.
7. When three DC vital relays, suppressed as specified herein, are connected in parallel and operated as a test load from normal working voltage, a vital relay front or back contact that breaks this load shall be capable of at least five million operations at this load without the contact resistance, measured with ten milliamp current, exceeding five ohms.
8. Arc suppression for vital relays shall be built into the relay or into its plugboard.
9. Vital plug-in relays, except vital time-element relays and special application relays, shall be equipped with front current testing facilities. Where required by the NCDOT and as shown on the Contract Drawings, facilities shall be provided to enable the testing of voltage from the front of the relay, without having to remove the relay or remove adjacent relays.
10. Vital relays shall be equipped with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plugboard.

2.3 IDENTIFICATION

- A. Facilities shall be included for mounting an approved typed or printed relay name tag for each relay, either on the relay cover or on the relay cabinet front plate, as applicable. The nametag shall be easily replaceable, but shall not come off during normal service.
- B. Identification shall be in accordance with SIGNAL MISCELLANEOUS PRODUCTS.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall ensure that the relay operating characteristics have not been altered due to damage during shipping procedures.
- B. Contractor shall ensure that all AC and DC power buses are open while installing relays. Buses shall not be reconnected until all relays have been installed.
- C. Contractor shall install and wire the relays as shown on the Contract Drawings.

3.2 SPARE PARTS AND SPECIAL TOOLS

- A. Contractor shall deliver to the NCDOT spare relays as directed, in amounts as shown on the Contract Drawings.
- B. Contractor shall provide and deliver to the NCDOT one test tool or relay wrench for each shelter where relays are installed.
- C. Contractor shall provide and deliver to the NCDOT 12 inserting/extracting tools for each type of contact requiring a special tool.

3.3 TESTING

- A. All DC vital relays shall be factory tested and inspected in accordance with AREMA Signal Manual Part 6.4.1.
- B. Perform tests in accordance with the requirements specified in SIGNAL TESTING.
- C. Tests measurements shall be recorded on NCDOT test form.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL EQUIPMENT HOUSINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section includes furnishing, transporting, installing and testing new factory-wired equipment HOUSINGS (CABINETS), as described herein, and as shown on the Contract Drawings.

1.2 QUALITY ASSURANCE

- A. The Contractor shall provide documentation of Factory Acceptance Testing before transporting new housings to the job site.
- B. Each housing shall be inspected after they have been installed and the Contractor shall correct any deficiencies noted. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Inspection and Acceptance Procedure.

1.3 SUBMITTALS

- A. Installation Test Procedures.
- B. Load calculations, indicating sizes of load center panel, voltage drops, and all other 240/120 VAC equipment.
- C. Contractor's Inspection and Acceptance Procedure.
- D. Housing equipment layout.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shipped within housings and cases shall be properly fastened and braced to prevent damage during transit. Any equipment damaged during transit or prior to in-service operation shall be replaced at no additional cost to the NCDOT.
- B. All vital relays, batteries, and electronic plug-in modules shall be packaged in separate containers for shipment and not installed until the housing is set at its final location.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Contractor shall supply all factory-wired equipment housings as described herein and as shown on the Contract Drawings. These housings shall be complete with all the equipment shown on the Contract Drawings. Wiring shall conform to the requirements of the AREMA Signal Manual, NEMA Standard ICS-70, or National Electrical Code (NEC), as applicable. All housings shall be furnished with the required number of manuals for equipment installed.
- B. Equipment housings shall be manufactured by P.T.M.W., Safetran Systems, GETS or an accepted equal.
- C. Equipment housings shall be the same size as shown on the Contract Drawings.
- D. Equipment housings shall be rain-tight and dust/tight, National Electrical Manufacturers Association (NEMA) 3R, ventilated, and have hinged doors with three point latch and handle.
- E. Equipment housings shall be constructed of 12-gauge galvanized steel for floors, walls, and doors. Roofs shall be no less than 14-gauge galvanized steel with a minimum of 50 lb/ft² loading.
- F. The entire structure shall be powder coated on the outside with TGIC Polyester Powder with a nominal thickness of four mils, but no less than three mils at any point on the surface of the enclosure. The exterior color shall be light gray.
- G. The housings shall be complete with moveable shelves, wire chase, and backboard.
- H. The equipment housings shall provide access to underground and aerial cable entrance behind the main terminal rack. The top and sides shall be lined with heat and cold insulating material and constructed to prevent sweating. Ventilation openings shall be provided as required for the size of the housing proposed. No ventilation opening will be made in the roof of the housing. Lift rings shall be provided to facilitate the movement of the housing.
- I. The housings shall be equipped with 2 lights, minimum to provide complete illumination for all passages and sides, and operated from a switch conveniently placed near each entrance door. Convenience outlets shall be furnished on each wall as a minimum.
- J. In each door, there shall be ventilation openings. The exterior of the ventilation openings shall be hooded to minimize the entrance of precipitation. The interior of ventilation opening shall be equipped with sliding plate to allow the adjustment of airflow and equipped with a replaceable dust filter. The doors shall be hinged and gasketed so that they will provide a dust proof and weatherproof seal. Doors shall be provided with exterior and interior handles, welded to a three point locking device to ensure that the door cannot be locked until it is in the fully closed position. Doors shall be provided with a two-position retaining device to secure the door when open.
- K. Door openings shall be 32" wide by 86" tall unless otherwise specified on the contract drawings.
- L. Thermostatically controlled exhaust fans, operated from 120 VAC and protected separately, shall be provided in each housing, as shown on the Contract Drawings. The thermostat that activates the fan control shall be adjustable and operate in the range of 70 degrees to 130 degrees Fahrenheit. Fans shall be located relative to the fresh air inlets to draw air over the equipment and sized to renew the air within the housing every 3 minutes. Exhaust fans shall have renewable dust filters.

- M. Hinges shall be separate castings, securely fastened to the housing and door. The hinges shall be equipped with bronze hinge pins, shall be lubricated by the manufacturer before the housing is shipped, and shall have grease fittings for later lubrication.
- N. Equipment housings shall be furnished with interior lighting and duplex 120-volt alternating current (AC) power receptacles. Receptacle loads shall have ground fault interrupt circuit protection used exclusively for these loads. Signaling logic and appliance power loads shall be fed from separate circuit breakers. The Contractor shall size circuit breakers and wiring.
- O. Housings shall be furnished complete with a 120/240 VAC load center, circuit protective devices, and all appurtenances necessary to supply the AC power required at each site.

2.2 EQUIPMENT MOUNTING

A. General

- 1. Electronic equipment and relays shall be rack mounted and AC distribution panel and rectifiers shall be wall mounted in accordance with the approved housing layout drawings.

B. Relay Plugboards

- 1. Plugboards shall be designed for insertion of removable type contacts. The method of attaching the wires to the removable contacts shall be solderless connections. The plugboard shall be designed so that the removable contact will have a direct connection with the contact and coil prongs. The plugboards shall be in accordance with the applicable sections of AREMA Signal Manual, Part 6.2.1.
- 2. All wires shall be of sufficient length to permit them to be moved to any contact on the same relay.
- 3. The plugboards for vital relays shall be equipped with a registration plate to prevent relays of the wrong type, contact arrangement, or operating characteristics from being inserted.

2.3 IDENTIFICATION

- A. A white identification number shall be stenciled at the top of the front and rear frames of each rack or panel.
- B. There shall be an identifying nameplate for each relay, or other instrument mounted on the rack or panel.
- C. The back and front of the relay plugboards shall be equipped with a tag, as specified in SIGNAL MISCELLANEOUS PRODUCTS. This tag shall indicate the nomenclature of the relay.
- D. Terminals and both ends of all wires shall be identified with a wraparound tag printed with the circuit nomenclatures and terminal designations as shown on the Contract Drawings.
- E. Wire and cable conductor identification tags for terminal board mounting shall be as specified in SIGNAL MISCELLANEOUS PRODUCTS.
- F. The wiring to each removable contact shall be identified with a wraparound tag as specified in SIGNAL MISCELLANEOUS PRODUCTS.

2.4 CABLE ENTRANCE TERMINAL BOARDS

- A. Cable Entrance Terminal Boards shall be fareaday cage type.
- B. Cable Entrance Terminal Boards shall be located as shown on the approved layout drawings.

- C. Multiple-unit terminal blocks for wire and cable conductors shall be in accordance with AREMA Signal Drawing 14.1.6. Each binding post shall be furnished with two binding nuts, one clamp nut, and three washers.
- D. Test links shall be provided on all conductors entering housings.
- E. Binding posts and exposed terminals of other apparatus for circuits exceeding 50 volts or greater (AC or DC) shall be equipped with insulating nuts and sleeves.
- G. Lighting arresters shall be as specified in SIGNAL MISCELLANEOUS PRODUCTS.

2.5 CABLE ENTRANCE PIPES

- A. Cable entrance pipes or chutes shall be supplied by Contractor as specified in SIGNAL MISCELLANEOUS PRODUCTS.

2.6 GROUNDING

- A. Housing shall be fitted with four 36 inch long #2 ground wires cadwelded to exterior of the housing at each corner. Cadwelding shall take place prior to powder coating the structure.
- B. Grounding material shall be supplied by Contractor and installed as specified in SIGNAL MISCELLANEOUS PRODUCTS.

2.7 INTERNAL WIRING

- A. Internal wiring shall be in accordance with AREMA Signal Manual Parts 10.4.1, 10.4.30, and 10.4.40, unless otherwise specified herein.
- B. Minimum wire conductor sizes shall be as shown on the Contract Drawings unless otherwise approved by the Engineer.
- C. Adhering to minimum wire size specifications does not relieve the Contractor's responsibility of using wire sized large enough to safely and effectively provide power to the circuit it serves.
- D. Solderless terminals, for stranded wire, shall be in accordance with SIGNAL MISCELLANEOUS PRODUCTS.
- E. Solid terminal connectors shall be used for all short terminal jumpers.
- F. Wire shall conform to the requirements in SIGNAL WIRE AND CABLE.

2.8 PAINTING - INSULATION

- A. All instrument enclosures shall be furnished complete with a layer of rigid insulation on the walls, doors, and ceiling. Instrument housings shall have a minimum 2-inch thick layer of insulation (R Value =13.0). Instrument cases shall have a minimum 1/2-inch thick layer of insulation (R value = 4.1). Insulation shall have an integral, durable acrylic-coated aluminum facer that provides a drainage plane and water-resistive barrier.
- B. The interior including the ceiling, walls, terminal boards, and shelves shall be finished with a primer and two coats of white latex enamel paint or coated with fire resistant paneling (FRP).
- C. All paint shall be fire-retarding type.
- D. Contractor shall consult with manufacturer of housing prior, to paint application.

2.9 EQUIPMENT RACKS

- A. Equipment racks shall be the manufacturer's standard for the type of equipment furnished and shall be sized in conformance to the Contract Drawings.
- B. Equipment racks shall include all necessary supports for wire and equipment.
- C. Equipment racks shall be secured by bolts attached to a threaded mounting plate structurally secured to the floor of the housing. Stabilizing straps shall be attached to the

top of the racks as needed.

2.10 OTHER EQUIPMENT

- A. Wiring Raceway (Wire Routing): Internal case wiring shall be contained within surface-mounted plastic raceway. Raceway shall be of a polycarbonate, low smoke type with a solid snap on cover and flexible sidewalls. The sidewalls shall be of "finger" type construction allowing for insertion and removal of wire runs with termination's attached. The manufacturer shall determine sizes. Fill capacity shall not exceed 60%.
- B. Load Center: Furnish a single-phase, three-wire 120/240 VAC, 60 Hz load center for each housing furnished under this Contract. The load center shall be sized as shown on the Contract Drawings. The capacity rating shall be in accordance with the Contractor's load calculations and the Contract Drawings.
- C. Service meters shall conform to local codes.

2.11 GALVANIZED HOUSING FOUNDATIONS

- A. All housings shall be equipped with telescoping foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Specifications SIGNAL WIRE AND CABLE and AREMA Signal Manual, Part 15.3.1.
- B. Galvanized steel foundations for cases shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4-inch steel plate.
- C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.
- D. The Contractor is to furnish and install all foundations, including telescoping foundations in Owner Furnished housings which will accommodate telescoping foundations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The housings and cases shall be mounted level and plumb and secured thereon with the hardware provided. Shims, spacers, or other filler devices shall not be used to level and plumb the housings or the cases.
- B. Cable entrance pipes shall be installed through the cable knockout holes provided in the floor of the housing behind the terminal board(s) as shown on the approved layout drawings. Pipes shall be filled with a substance designed for the purpose that prevents entrance of debris and rodents and other pests.
- C. Housings shall be grounded as specified in SIGNAL GROUNDING OF EQUIPMENT.
- D. Housing shall be located as per the Contract Drawings. If conditions do not allow placement as shown on the Contract Drawings, then the Contractor shall submit alternate placement.
- E. Relays shall be installed on the relay plugboards corresponding to the relay nomenclature and identification plate, and securely fastened in place with the hardware provided by the relay manufacturer.
- F. Batteries shall be placed on rubber matting on the floor of the house or bottom shelf of the case. Battery posts shall be coated with approved grease and battery connectors shall be securely fastened to the battery posts. Batteries shall be strapped, or otherwise secured in a method approved by the manufacturer so that they will not tip or move in the event of an earthquake.

- G. The Contractor shall mark each grade crossing warning device housing with the street name, milepost location, emergency response number and DOT inventory number per NCDOT Standards.

3.2 AC POWER

- A. Load center shall be wall mounted. Mounting height from floor, wire terminations, and clearances shall be in accordance with the NEC.
- B. Service meters shall be installed as described in METER SERVICE.

3.3 TESTS

- A. The functioning of the equipment contained within the instrument housing shall be tested in accordance with the requirements of SIGNAL TESTING, CFR Title 49 Parts 234 and 236, and AREMA Signal Manual Part 2.4.1.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL RECTIFIERS, BATTERIES, AND BATTERY CHARGING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work in this Section shall consist of furnishing and installing rectifiers, batteries, and battery charging equipment as specified herein and as shown on the Contract Drawings.

1.2 QUALITY ASSURANCE

- A. Batteries and battery chargers shall be tested in accordance with the Manufacturer's standard.

1.3 SUBMITTALS

- A. Load calculations of each DC and AC load. The calculations shall identify normal and worst-case conditions for each load. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal rectifier, batteries, and battery charging equipment installed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MATERIALS

- A. The Contractor shall calculate the loads based upon the equipment proposed. All batteries shall be sized to provide a minimum 48 hours standby capacity for all systems based on normal operating conditions. The Contractor shall verify the ampere-hour capacity shown on the Contract Drawings is adequate to provide a minimum of 48 hours standby capacity.
- B. GNB Maintenance Free Batteries - Manufactured by GNB (no other alternate products available).
 - 1. Model GNB 472, 472AH

- C. Automatic Battery Charger- manufactured by Exide Corp, National Railway Supply, LaMarche or accepted equal in the sizes listed below.
 - 1. Model 24/30 1/36V, 30A
 - 2. Model 12/40 1/20V, 40A
 - 3. Model 12/20 1/20V, 20A

2.2 EQUIPMENT DETAILS

- A. Battery charging equipment shall be designed for continuous operation.
- B. Battery charging equipment shall be designed to deliver rated outputs with input voltage of 100 to 130 VAC at 60 Hz, single phase, two wire input.
- C. Battery charging equipment shall have a reserve capacity of at least 25 percent above the calculated high load requirements.
- D. Each charger shall be provided with programmable output voltage adjustment.
- E. Terminal markings for AC and DC terminals shall be permanent.
- F. The charger shall provide a stabilized output voltage, temperature compensated with output current limiting. The capacity of the battery charger shall be determined by the Contractor and approved by the Engineer. The charger shall adjust its output current automatically, according to the load and to the demand on the battery.
- G. Battery charger shall conform to requirements in AREMA Signal Manual Part 9.2.1. The output of the charger shall be sufficiently filtered to be compatible with the input voltage requirements of the solid state interlocking units, and all other electronic equipment provided by the Contractor for the signaling system.
- H. Battery to be sized to provide a minimum of 48 hours of uninterrupted power to the signal systems at the normal operating load.
- I. Batteries shall be recombination pocket plate nickel cadmium, or accepted equal.
- J. Batteries shall be capable of a minimum of 1,500 charge-discharge cycles to 80% discharge without loss of capacity. Totally discharged batteries, even if polarity has reversed shall be capable of being recharged to rated capacity with charging voltage of no more than 2.2 volts per cell.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all batteries and battery charging systems as shown on the Contract Drawings.
- B. Furnish all mounting hardware, terminals, and terminators, etc., for mounting chargers and batteries in wayside cases, signal instrument shelters.

3.2 TESTS

- A. Perform all tests specified in SIGNAL TESTING, ensuring system operation.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the AHCW systems provided.

END OF SECTION

SIGNAL MISCELLANEOUS PRODUCTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section shall include furnishing miscellaneous components and products to be used on this Contract.

1.2 QUALITY ASSURANCE

- A. All miscellaneous components and products used on this Contract shall be:
 - 1. New and free of manufacturing defects.
 - 2. Clearly and permanently labeled with value or type identification.
- B. All electrical components shall be rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those, which the components will be subject to in service, unless otherwise specified herein.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, material descriptions, specifications, and other data pertinent to the miscellaneous products required. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal and miscellaneous products purchased under this contract.
- B. Samples of solderless terminals conforming to article 2.11.B herein.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS, FUSES

- A. Fuses and circuit breakers shall be of suitable capacity to protect the various pieces of signal apparatus from the effects of short circuits or overloads. All circuit breakers and fuses required for the equipment and systems shall be in accordance with these Specifications.
- B. Circuit fuses shall be non-renewable, and shall be of the fiber-case, time lag, fusion type. The circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
- C. Fuse clips shall be constructed so that they shall retain their resilience under all installation and service conditions, to ensure a positive contact between the clips and the fuse.

2.2 DIODES

- A. All diodes to be furnished under this Contract shall carry a JEDEC number or shall be available from more than one manufacturer, and shall be used within the published specifications for such number. All diodes shall be silicon type, unless otherwise accepted by the Engineer.

2.3 RESISTORS

- A. All resistors, other than those required for electronic circuits, shall be in accordance with AREMA Signal Manual Part 14.2.15.

2.4 REACTORS

- A. All reactors, other than those required for electronic circuits, shall be in accordance with AREMA Signal Manual Part 14.2.20.

2.5 SIGNAL TERMINAL BLOCKS

- A. Signal system terminal blocks shall be in accordance with the applicable requirements of AREMA Signal Manual Part 14.1.5.

2.6 TERMINAL BINDING POSTS

- A. Signal system terminal binding posts shall be in accordance with the applicable requirements of AREMA Signal Manual Part 14.1.10.
- B. Terminal binding posts for interface with plug coupled wires to rack mounted electronic equipment shall be in accordance with the AREMA Signal Manual, Part 14.1.2.

2.7 TERMINAL POST INSULATORS

- A. All terminal posts, located on terminal boards in the wayside cases, signal instrument shelters used to terminate 50V, or greater, AC or DC circuits shall be provided with a protective insulator.
- B. The type of insulator shall be individual for each terminal post, and shall be fire-resistant.

2.8 INSULATED TEST LINK

- A. All insulated test links terminals shall be in accordance with the AREMA Signal Manual, Part 14.1.15, .

2.9 LIGHTNING ARRESTERS AND EQUALIZERS

- A. All lightning arrestors and equalizers, other than those required for electronic circuits, shall be in accordance with AREMA Signal Manual Part 11.3.1.. Lightning arresters and equalizers shall be mounted on accepted type base and shall be in accordance with AREMA Signal Manual Part 11.3.1.

2.10 SURGE PROTECTORS

- A. Surge Protectors shall be in accordance with AREMA Signal Manual Part 11.3.3.

2.11 TERMINALS FOR WIRES AND CABLES

- A. All solderless terminals shall be in accordance with the AREMA Signal Manual, Part 14.1.1, unless otherwise specified herein.
- B. Terminals shall be of the solderless crimp-on type. Samples of all solderless terminals shall be submitted for approval.
- C. All stranded copper wire shall be fitted with an approved type of terminal at all points where the wires are to be terminated on terminal binding posts.
- D. The terminating means shall be of four types:
 1. A lug for terminating heavy wires or signal power wires.
 2. A solderless type of terminal, for terminating No. 16 and No. 14, American Wire Gauge (AWG) stranded wires.
 3. A "Ring Tongue-Flat" terminal, for terminating wires larger than No. 14 AWG to a maximum diameter over the insulation of 0.40 inch.
 4. A diamond grip ring nylon insulated wire terminal shall be used for terminating other stranded wires, No. 20 and No. 18 AWG, having maximum diameter of 0.125 inch.
- E. Terminals shall be for attaching to the ends of the conductor in such a manner that the flexibility of the conductor will not be destroyed and the possibility of breakage at the terminal will be reduced to a minimum.
- F. Terminals shall be for attaching to the wire with a tool made by the manufacturer of the terminal and recommended by the manufacturer for the terminals being furnished.

- G. The tool shall be equipped with a ratchet device to ensure proper indentation of the terminal, which will not release until proper indentation is complete.

2.12 TAGGING FOR CABLES, WIRES, AND EQUIPMENT

- A. Except as otherwise specified in this Section, both ends of each cable, each cable wire, and all single wires that terminate in the junction boxes, switch mechanisms, signal instrument shelters, on equipment racks, relay bases, shelter and any equipment of the signal system outside of such locations shall be permanently identified with a tag. Tags shall be installed so that they may be read with a minimum of disturbance of the tags. Each conductor of the cable shall be rung out and identified before applying the tag. Tagging will follow the three line convention with the termination in the first line, nomenclature in the second line and termination of the other end of the wire in the third line. (From-To)
- B. Tags for wire and cable identification and for identification of transformers, resistors, reactors and other components shall meet the following requirements and shall be subject to NCDOT acceptance:
 - 1. Sleeve Type Tags:
 - a. Tags for identifying individual cable conductors and field-installed wires within the signal instrument shelters, wayside cases, switch mechanisms, switch layout junction boxes, base of signal junction boxes, and similar applications, shall be the sleeve type as manufactured by Raychem Corporation, Thermofit Marker System (TMS), Twinco Mfg or accepted equal. The application of the conductor nomenclature shall be in accordance with the manufacturer's instructions and shall result in a permanently bonded and legible identification.
 - 2. Flat Plastic Tags:
 - a. Tags for identification of vital relay plug boards, individual transformers, resistors, reactors, terminals, and other miscellaneous components within the signal instrument shelters, wayside cases, and outside terminal cases, shall be the flat plastic laminated type.
 - b. These tags shall be 1-1/2 inches long by 1/2-inch-wide. The untreated tag shall be milk white "vinylite", or accepted equal.
 - c. The identifying nomenclature space shall allow for two rows of lettering, and the tag material shall be capable of receiving typed-on characters by conventional means. The height of the lettering shall not be less than 1/8 inch.
 - d. After lettering, both the face and backside of the tag shall be covered with a clear plastic coating, "vinylite", or accepted equal.
 - e. Wrap-around tags: Tags for identification of the individual wires of plug-in relays, within the signal instrument shelter, and the wayside cases shall be the wrap-around, self-adhesive type.

2.13 HARDWARE

- A. Mounting hardware exposed to the elements and used for signal equipment, cases, conduit, hangers, brackets, clamps, etc., shall be hot-dip galvanized, except as otherwise accepted by the NCDOT.
- B. Galvanizing:
 - 1. The hot-dip process of galvanizing shall be used. All parts shall be picked so that all scale and adhering impurities are removed. The zinc coating shall be of commercially pure zinc, and shall be continuous and thorough. It shall not scale,

blister, or be removable by any of the processes of handling or installation. The finished surface shall be free from fine line cracks, holes, or other indications of faulty galvanizing. It shall be smooth and free from adhering flux and other impurities. The edges and ends of parts shall be free from lumps and globules. Parts shall be coated with at least two ounces of zinc per square foot of galvanized surface, after all bending, cutting, drilling, and final fabrication.

C. Cadmium Plating:

1. All nuts, bolts, and washers shall be cadmium plated or stainless.
2. Cadmium plating shall be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries and shall completely cover the surface of the part in a smooth, bright layer. Plating on raised or prominent portions shall show no evidence of blackness or loose crystalline structure. It shall have a minimum thickness of six ten thousandths of an inch and shall withstand the salt spray test for at least 1,000 hours or an equivalent test accepted by the NCDOT.

2.14 CONDUIT

A. Rigid conduit shall conform to ANSI C80.1 and shall be installed as shown on the Contract Drawings.

1. Polyvinyl Chloride (PVC) Conduit: Thick wall polyvinyl chloride conduit, high impact schedule 80, herein referred to as PVC conduit, shall be furnished per Contract Drawings. Where elbows are used, they shall be the long radius type.

B. Flexible Conduit

1. Conduit for track circuit leads, switch-and-lock movements, and electric lock layouts shall be Braided Cordura Rayon, vari-purpose hose, internal tube neoprene cover, or accepted equal. The conduit shall be clamped at both ends with stainless steel clamps. Clamps are not required for track wire risers.
2. Metallic Flexible Conduit: Where acceptable to the Engineer, metallic flexible conduit, Type UA, or accepted equal may be used.

C. Fittings

1. Stainless steel clamps: Clamps for clamping conduit at each end shall be stainless steel.
2. Approved fittings for PVC conduit shall be used.

2.15 PADLOCKS

- A. The NCDOT will provide switch padlocks.
- B. Signal padlocks will be provided and installed by the Contractor. The Contractor shall provide temporary padlocks until such time the equipment is placed in-service.

2.16 SEALING COMPOUND

- A. Sealing compound for use in sealing cable entrances shall be in accordance with AREMA Signal Manual Part 15.2.15.

2.17 CABLE ENTRANCE PIPES

- A. Cable entrance pipes for wayside signal shelters shall be 4-inch PVC, Schedule 80, and 3-ft 6-inches long and extend 18" below the final grade.
- B. Cable entrance for wayside signals shall be 4" liquid-tight flex conduit. Entrance pipe shall extend 18 inches below finished grade around signal.

2.18 JUNCTION BOXES

- A. All junction boxes shall be provided with gaskets to prevent the entrance of moisture and dust, in accordance with AREMA Signal Manual Part 15.2.10.
- B. Junction boxes shall be provided to terminate underground cables at all switch and lock movements and all switch circuit controllers.
- C. Junction boxes shall be provided with means for applying padlock.

2.19 LUBRICATION

- A. Lubrication for switch tie plates for all switch and lock movement layouts installed by the Contractor shall be an accepted railroad graphite lubricant

2.20 ENVIRONMENTAL PROTECTION

- A. Protection, as hereinafter specified for machine-finished surfaces, threaded rods, nuts, and other parts that are susceptible to rusting or corroding, shall be a corroding preventive compound, like a no oxide grease, or accepted equal. The product must have sufficient body to resist weather and rusting for at least 6 months. Two gallons or equivalent volume shall be furnished by the Contractor.

2.21 DC TRACK CIRCUITS

- A. DC Track Circuits shall be in accordance with the applicable requirements of AREMA Signal Manual Part 8.1.1.

2.22 STYLE C TRACK CIRCUITS

- A. Transmitter shall be a TD-1A driven by an ACG-2T manufactured by Harmon Industriesor, Safetran Model 12/6/3A AC/DC Inverter (no more alternate products available).

2.23 AUDIO FREQUENCY ISLAND TRACK CIRCUITS

- A. Audio frequency island track circuits shall be AFTAC-II manufactured by Harmon Industries, PSO manufactured by Safetran systems, AFTAC manufactured by Alstom Signal or an accepted equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Material and apparatus specified herein shall be installed in accordance with the details of respective Sections of these Specifications, manufacturer's recommendations, and in accordance with the Contractor's accepted installation drawings.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL RAIL BONDING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section shall include furnishing and installing all rail bonds, fouling bonds, frog bonds, track circuit connections, and all other material required for bonding of track circuit joints, track frog and switch bonding, and track circuit connections as

specified and as shown on the Contract Drawings.

- B. Rail track joints shall be bonded with welded railhead bonds per AREMA Section 8.1.20 and applicable sections.
- C. Track switch, frog fouling bonds, and track connections shall be stranded bonds.

1.2 QUALITY ASSURANCE

- A. Welded Bonds and track connections shall be in accordance with the requirements of AREMA Section 8.1.20 and applicable sections..

1.3 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, material specifications, installation and maintenance instructions, and other data pertinent to the bonding material, staples, and circuit connections, specified herein and as shown on the Contract Drawings. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal bonding products purchased under this contract.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rail Head Bonds: Railhead bonds shall be 3/16 inch in diameter with steel terminals welded to the conductors. They shall have a nominal length of 6 1/2 inches.
- B. Web Bonds: Web Bonds shall be 3/16 inch, 12 inch long welded to the web.
- C. Track Circuit Rail Connectors: Track circuit connectors shall be 3/16-inch stranded bronze conductor, 1-inch tap for welded connection on one end and compression sleeve on the other end for a direct crimp type connection to the track wire, and shall have a nominal length of 12 inches.
- D. Bond Strand: Bond strand for fouling wires shall be 3/16-inch single strand with 1/16-inch black PVC insulation.

PART 3 - EXECUTION

3.1 INSTALLATION OF WELDED BONDS

- A. Welded bonds shall be installed at all non-insulated rail joints within the limits of this Contract that are not equipped with a bond.
- B. The surfaces of the rails where the bond is to be applied shall be ground clean with a vitrified grinding wheel. After grinding, the surface shall be cleaned with an approved non-toxic solvent to remove all traces of grease and dirt. After the surface has been ground and cleaned, the bond wire shall then be welded to the rail in a manner that will ensure a thorough mechanical and electrical connection.
- C. Before beginning work on these bonds, the Contractor, at no additional expense to the NCDOT, shall weld in the field, under conditions similar to those of the regular installation, not less than three complete bond connections, and as many more as the NCDOT considers necessary to determine that the welds are being made satisfactorily. Such welds shall be subject to inspection and testing by the NCDOT, and acceptance as to the method and quality of workmanship will depend on the results of these inspections and tests.
- D. Ensure that each bond connection is thoroughly welded to the rail. The NCDOT reserves the right to require a test of each weld by hammer and striker, or in any other manner, which in the opinion of the NCDOT is reasonable.
- E. Any welded bond installed by the Contractor that is found to be defective prior to acceptance, shall be removed and a new bond shall be installed at no additional cost to the NCDOT.

3.2 INSTALLATION OF TRACK CIRCUIT CONNECTIONS

- A. The welded end of the track circuit connector shall be as specified herein, at a maximum distance of 3 inches from the end of the insulated joint.
- B. The underground cable shall be stripped back a sufficient distance for the exposed conductor to be fully inserted into the compression sleeve. The sleeve shall then be compressed with the type of compression tool designed for that purpose.
- C. All track circuit connections shall be installed by the Contractor, and any found to be defective prior to acceptance shall be removed, and a new track circuit connection installed at no additional cost to the NCDOT.

3.3 TESTING

- A. Test all track circuits for continuity of circuit and ensure main line track circuit is de-energized with 0.06-ohm shunt at any point within the track block.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL WIRE AND CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section includes furnishing and installing all cable and wire required for signal and signal power system wiring to signal housings, junction boxes, and factory wired mechanisms.
- B. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. Cables to be furnished and installed shall be suitable for use in the environment to be encountered on a railroad signal system, and shall be certified for continuous operation, in wet or dry locations, with no conductor failing in continuity or with loss of insulation to cross or ground less than one megaohm.
- C. Cables shall be furnished and installed as specified herein and as shown on the Contract Drawings.

1.2 QUALITY ASSURANCE

- A. Cable manufacturer's qualifications shall be as follows:
 - 1. Past Performance and Experience: Demonstrated previous successful experience in supplying cable to the railway or transit industry for use as vital signal control cables. A list of such installations shall be provided for each cable manufacturer to be considered.
 - 2. Quality Assurance Program: The manufacture of cables in accordance with the requirements of this Specification shall be accomplished in compliance with a Quality Assurance Program that meets the intent of the ASQC Standard C1; general reinstatement provided for in this subparagraph shall apply only to the first replacement or repair of any such item and, in the case of failure of major importance, to the first extension of the said warranty to said affected items.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, material descriptions, and specifications for each type of wire and cable the Contractor proposes to provide. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal wire and cable products purchased under this contract.

1.4 INSPECTION

- A. The NCDOT shall have the right to make inspections and tests, as necessary, to determine if the cable meets the requirements of this Specification. The inspector shall have the right to reject cable, which is defective in any respect.
- B. The manufacturer shall provide, at the point of production, apparatus and labor for making any or all of the following tests:
 1. Conductor size and physical characteristics.
 2. Insulation HV and IR tests.
 3. Physical dimension tests.
 4. Special tests on materials in coverings.
 5. Final HV, IR, and conductor resistance tests on shipping reels.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Shipping, storage, and handling shall be in accordance with AREMA Signal Manual, Part 10.4.1.
- B. During storage and handling, prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.
- C. Any instance of damaged cable observed at any time, whether prior to installation, occurring during construction, or discovered by test observation after installation, shall be immediately called to the Engineer's attention. The method of correction shall be in accordance with the NCDOT's written instruction. The Contractor shall promptly repair such damage.

PART 2 - PRODUCTS

2.1 INTERNAL WIRE AND CABLE

- A. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.
- B. Internal wire and cable shall conform to AREMA Signal Manual, Part 10.3.14, and the following requirements:
 1. Conductors shall be soft and annealed copper per ASTM B3 and tin coated in accordance with ASTM B33-94.
 2. Stranded conductors shall be in accordance with ASTM B8, Class B.
- C. Internal wire and cable insulation shall conform to AREMA Signal Manual Part 10.3.24 and the following requirements:
 1. Insulation shall be modified ethylene tetrafluoroethylene (ETFE) conforming to ASTM D3159 and NEMA HP-100, unless otherwise specified.
 2. The minimum insulation rating shall be 600 volts.

2.2 EXTERNAL WIRE AND CABLE

- A. General
 1. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.

2. Conductors shall be soft and annealed copper per ASTM B3 and tin coated in accordance with ASTM B33-94.
 3. Stranded conductors shall be in accordance with ASTM B8, Class B.
- B. Track Wire
1. Track wire shall meet the requirements of AREMA Signal Manual, Part 10.3.15.
- C. Signal, Switch, and Express Cable
1. Wire and cable to signals, to switches and express cable shall be Armored Underground Signal Cable and shall meet the requirements of AREMA Signal Manual, Part 10.3.17.2. Conductors number six(#6AWG) and smaller shall be solid. Conductors number 4(#4AWG) and larger shall be stranded.
 3. Cable shall be furnished with a 10-mil flat bronze tape between the conductors and the outer jacket, helically applied, and adequately cushioned from the conductors.
 4. Any cable installed in conduit or trough for its entire run need not be armored, but must meet all other specifications herein.
- D. AC Power Cable
1. Cable shall meet the requirements of AREMA Signal Manual, Part 10.3.16.
- E. Modem Cable
1. Modem cable shall meet the requirements of AREMA Signal Manual, Part 10.3.17.
 2. Modem cable shall be protected by a moisture impervious, continuously welded, corrugated, aluminum sheath with an overall PVC jacket.
 3. Individual twisted pairs shall be separately shielded with an aluminum polyester tape to provide shield isolation between pairs of 100 megohms per 1000 ft. minimum.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. General

1. The installation of wire and cable shall conform to AREMA Signal Manual Parts 10.4.1, 10.4.30, and 10.4.40, except as specified herein.
2. All external cable runs shall be direct burial or in conduit in accordance with the NCDOT Communication & Signaling Standard Drawings, and as called for in the Contract Drawings.
3. The Contractor shall separate signaling cables from parallel run of AC feeder cables, with a minimum of 12 inches physical separation.
4. Give the NCDOT 24 hours notice prior to installing cables.
5. Provide sufficient slack in cable conductors at all terminating posts to enable three terminations of the conductor, due to broken eyelets without re-servicing or re-terminating the cable.
6. In certain types of installation, the cable cannot be constrained; therefore, ample cable slack shall be provided for additional flexibility due to vibration of such equipment.
7. Cables shall not be bent to a radius less than manufacturer's recommendation.
8. Distribution cable runs shall be continuous without splices between cable terminating locations. Express cable runs longer than cable lengths shall be spliced together in junction box, instrument case, or other acceptable shelter. Prior to any cable or wire splicing, the Contractor shall obtain the Engineer's approval. Approval

will not be granted for cables damaged by the Contractor or vandalized by others. It is the responsibility of the Contractor to protect all cables until final installation.

9. Individual cable conductors shall be identified at each cable termination with plastic tags, as specified in SIGNAL MISCELLANEOUS PRODUCTS. All spare conductors in each cable shall be identified and terminated.
10. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with either compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit or pipe. All spare conduits shall be sealed or plugged.
11. Wherever multiple conductor cables are terminated, the outer sheath of the cable shall be carefully removed to a minimum point of 3 inches from the cable entrance. At the end of the cable sheath or covering, two layers of plastic electrical tape shall be applied.
12. All cable conductors shall be terminated in conductor sequence from top to bottom.
13. Cable shields or sheaths shall be grounded at the entrance to signal shelters and shall float when terminated in field apparatus.

B. Underground Buried Installation

1. Cable must be buried to a uniform minimum cover depth of 30 inches as measured from bottom of tie to top of cable, unless installed in a cable trough when paralleling the tracks, cable must be buried a minimum cover depth of 30 inches as measured from the finished grade to top of cable. Cable shall be laid loosely in trench with a sand bed and backfill as specified in these Specifications. Cable shall be installed within four inch PVC schedule 80 conduit at a uniform minimum cover depth of 30 inches below grade when passing under tracks.
2. Upon request and only under extreme circumstances because of installation hardship will installation of a cable be allowed to a depth of less than 36 inches, subject to the NCDOT's acceptance. The cable shall be protected in a manner acceptable to the NCDOT.
3. Whenever any signal cable is to pass under pavement, or roadway, if existing conduit is not provided, the cable shall be installed in a 4 inch PVC Schedule 80 conduit, and the conduit shall extend 2 feet beyond the edges of the pavement. It shall be the Contractor's responsibility to restore the pavement or roadway to its original condition, subject to the NCDOT's acceptance.
4. Where cable leaves the ground at other than buildings or in foundations, it must be protected by a bootleg or other covering extending above the ground line. Top of such protective coverings shall be filled with a sealing compound.
5. Where buried cables enter a concrete foundation, junction box, housings, sufficient slack shall be left in each cable to allow an additional one foot of cable to be pulled into the housings or junction box.
6. Cables shall not cross one another when they are pulled into a conduit or pipe, and care shall be taken not to have the conductors pulled tight or kinked in conduit fittings or boxes. All cables to be installed in a conduit or pipe shall be pulled and installed simultaneously.
7. Cables, track wire, and conduits shall be installed per contract drawings and 18300 Signal Earthwork.

- C. Special Protection
 - 1. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as vibration or sharp corners on equipment. The Contractor shall be responsible for replacing, at no additional cost to the NCDOT, any cable that is installed but subsequently damaged prior to acceptance as a result of the Contractor's failure to provide such special protection.
- D. AC Power Cable
 - 1. AC power cable shall be installed in dedicated conduit from the service meters to the signal housings.

3.2 TESTING

- A. All installed external cable shall be tested in accordance with the requirements of Section 18228 and AREMA Signal Manual, Part 10.4.30.

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL TESTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section includes: Tests and inspections to demonstrate that systems, subsystems, assemblies, subassemblies, and components supplied and installed under this Contract are in compliance with these Specifications and with all applicable regulatory requirements.
- B. Tests and inspections shall be made both during the progress of this Contract and after completing installation of equipment, and shall consist of factory tests of Contractor Furnished equipment, circuit breakdown tests, wiring verification tests, continuity tests, resistance tests, voltage and current tests, applicable locking tests, operating tests, simulation tests, and other electrical and mechanical tests and inspections.
- C. Work shall include costs of the Contractor's personnel and any special equipment and assistance required to conduct all tests with complete documentation.
- D. In the event that the system does not meet requirements, necessary corrections and retesting shall be made by the Contractor, at no additional cost to the NCDOT. The Contractor shall successfully complete all tests and inspections possible prior to performing final in-service tests.
- E. Work shall include all necessary test purpose disconnecting and reconnecting.
- F. Test work specified elsewhere in these Specifications shall be construed as related to and inclusive with the testing described herein.
- G. All field tests shall be coordinated with the NCDOT. As many tests and inspections as possible shall be completed prior to the final cutover to avoid train delay. The Contractor shall place systems in-service in phases where possible, thus reducing the actual cutover period.
- H. All tests shall ensure conformance with CFR 49, Parts 234 and 236 and shall be

recorded on forms approved by the NCDOT and signed by the Contractor's signal engineer directing each test and inspection

- I. An appropriate meter must be used when testing circuits. Visual observation of a relay is only valid when coil voltage or current or contact voltage, as applicable, is also measured.

1.2 STANDARDS AND REGULATIONS

- A. Standards - Association of American Railroads, Signal Manual, Part 2.4.1 and 3.3.1.
- B. Regulations - Code of Federal Regulations, Title 49, Parts 234 and 236.

1.3 QUALITY ASSURANCE

- A. Test and inspection procedures shall be subject to the NCDOT Signal Manager or NCDOT Signal Engineer's acceptance and shall comply with all regulatory requirements and the manufacturer's recommended test procedure.
- B. Test equipment of proper type, capacity, range, and accuracy shall be supplied by the Contractor to perform required tests and inspections.
- C. Test equipment used shall be in good working order and properly calibrated within 6 months of the date of the tests. This equipment shall display a sticker indicating its calibration date and the agency that performed the calibration.
- D. Each component and unit of the wayside signal and highway grade crossing system shall have an inspection performed at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.
- E. The NCDOT shall have the right to witness any or all field tests conducted. The NCDOT shall be notified in writing at least 48 hours prior to each field test. No part of the signal system shall be placed in service without an authorized representative of the NCDOT being present and witnessing the in-service tests.
- F. The work shall include all tests required to ensure proper and safe operation of all systems and subsystems, and to prove the adequacy and acceptability of the total installation specified herein. Tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.

1.4 SUBMITTALS

- A. The following pre-test information shall be submitted to the NCDOT Signal Manager or NCDOT Signal Engineer for acceptance:
 - 1. The Contractor shall submit a Pre-testing authorization request fifteen (15) calendar days in advance of proposed pre-testing. Such request shall include:
 - a. Names of Contractor's Signal Engineer in charge of pre-testing.
 - b. Other personnel assigned to the pre-test who will be performing the tests or assisting with the tests.
 - c. List the assigned location(s) of the Contractor's personnel and their designated duties during the pre-test.
 - d. An outline of the tests to be performed on each type of component, unit, or system, together with samples of the corresponding test records. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit. In addition, the date and time will be shown for each test.
 - e. Description of each test to be performed, including the operating parameter to

- be tested. Test equipment to be used for the test, including the model number, serial number, calibration period, last calibration date and a brief description of the purpose of the test equipment.
- f. Description of equipment to be used for communication purposes.
2. Schedule of pre-testing Contractor purposes to perform which included beginning and ending dates, times, and locations in a time-line format.
 3. Identify any test or operation that may disrupt or disarrange the existing signal circuits or systems. Include description of proposed safety provisions and back-up contingency plans.
- B. The following in-service testing information shall be submitted to the NCDOT for acceptance:
1. The Contractor shall submit, thirty (30) calendar days in advance of any in-service testing, a detailed cutover and in-service test procedure. This procedure shall indicate the Contractor's personnel involved, their assigned location, and responsibility during the in-service testing. The following does not apply to Owner-directed signal cutovers: The test procedure shall adequately reflect the test to be performed and the sequence in which the tests shall be performed.
 2. The test procedure shall include an outline of the tests to be performed on each type of component, unit, or system, together with corresponding samples of test record forms and cards. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit. The numbers of each type of component or unit to be tested to demonstrate adequacy of design and quality control. A line diagram showing the grouping and sequencing of system and subsystem tests showing both factory and field tests.
- C. The results of each test, as herein specified, shall be recorded and copies of the field test reports immediately furnished to the NCDOT at the completion of the cut-over testing. A final type-written test reports(s) shall be prepared by the Contractor as indicated herein and submitted to the NCDOT within five (5) calendar days after the completion of each test and shall include complete details of the test results and corrections or adjustments performed or which remain to be completed. The copies of the field test reports and the type-written test reports shall be signed and dated by the Contractor's responsible employee. Certified test results shall also be furnished for tests performed by any subcontractors, when such tests are required within these Specifications.
- D. Where required in this section, submit test results on completed approved test record forms.
- E. Test reports shall document the calibration date of each instrument used during the test. Calibration of each instrument shall be certified by a recognized testing facility. Instruments with out of date calibrations will be considered non-certified. Tests conducted with non-certified instruments will be rejected.
- F. Any additional tests required by the Contractor to ensure the safe operation of the system shall be submitted to the NCDOT Signal Manager or NCDOT Signal Engineer.
- G. Upon completion of all tests, submit a letter certifying that all tests necessary to comply with all current regulatory requirements of these specifications have been performed.
- H. Contractor's testing procedures and cut-over plan must pass the NCDOT Signal Manager or NCDOT Signal Engineer's and the Operating Railroads review. Contractor shall allow 30 calendar days for this approval process.

PART 2 - PRODUCTS

2.1 SITE TEST EQUIPMENT AND MATERIALS

- A. Test instruments and equipment necessary to conduct the tests specified herein shall be available, ready for use not less than one week in advance of test need. "Ready for use" shall mean properly matched for test parameters, properly calibrated, sufficiently supplied with leads, probes, adapters, stands etc., necessary to conduct the particular test in a completely professional manner.

2.2 TEMPORARY TEST MATERIALS

- A. Temporary or interim test related materials, special tools, connections, jumpers, etc., shall be furnished and available not less than one week in advance of the test need.

PART 3 - EXECUTION

3.1 FACTORY TESTS AND INSPECTIONS

- A. All wiring and equipment shall be checked to verify conformance to the Contract Drawings and the Specifications.
- B. Each control point or grade crossing warning system shall be tested to verify that it functions properly before it is shipped to the field for installation. These tests shall involve connecting all control systems (excluding signals, switches, etc.) that make up a control point or grade crossing warning system, applying power, and then exercising each function of the system and verify proper result.
- C. Confirmation shall be provided by the Contractor that all required factory tests of Systems, sub-systems, assemblies, sub-assemblies and components supplied under this Contract have been performed. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated. Certified test reports shall be furnished.

3.2 FIELD TEST PROCEDURES

- A. As many pre-tests as possible shall be performed in advance of in-service testing. This should include, at a minimum, the adjustment of tunable joint couplers, microprocessor based coded track circuits, verify signal aspects against received and transmitted codes. The Contractor shall verify operation of, calibrate grade crossing prediction units and adjust grade crossing signal control equipment as required to assure proper operation. In order to have a successful cut-over, it is essential that as much pre-testing and advance wiring be completed on the Main tracks before in-service testing begins.
- B. The field tests performed shall cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.
- C. The quality of installation shall be demonstrated by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection, and any other tests required by this Specification. These tests shall be performed prior to any operational testing of systems or subsystems.
- D. The Contractor's test procedures shall consist of preprinted data sheets or inspection. Where applicable, results of test results shall be recorded on test forms. When completed by the field test personnel and checked for accuracy and completeness, the sheet shall be submitted as the test report.
- E. When tests require specific meter or test instrument readings, the preprinted data sheet shall show the allowable range of values, for each part of the test. The test report shall

also contain a check off system for each action and a blank space adjacent to the expected value in which to record the test readings.

- F. All test reports shall be dated and signed by the responsible employee of the Contractor or subcontractor on the day the test is performed. Space also shall be provided for the signature of the witnessing inspector.
- G. The report shall show the specific test instruments used on each test, with instruments identified by name, type, serial number, and calibration due date.
- H. Should an error be discovered during field testing due to field wiring and connections that do not agree with the accepted circuit plans, the Contractor may correct such errors without prior acceptance of the NCDOT. The Contractor shall not, however, make any changes that deviate from the Contract Drawings without prior written acceptance of the NCDOT.
- I. The NCDOT will make all final determinations as to whether only a part, or the whole test, shall be rerun when any specific field test does not meet the requirements specified for the test.
- J. Any changes made after completion of test procedure shall be re-tested in accordance with the applicable test procedure and regulatory requirement.

3.3 FIELD TESTS AND INSPECTION

General field tests shall be performed by the Contractor and include the following:

- A. Ground verification test.
- B. Dielectric Breakdown test of all vital circuitry.
- C. Wiring verification of all non-vital circuitry.
- D. Vital function tests.
- E. Operating tests.
- F. All applicable tests prescribed by AREMA Signal Manual Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these Specifications.
- G. All applicable tests as required to ensure systems comply with CFR 49, parts 234 and 236.
- H. Specific field tests shall be performed by the Contractor and include the following.
 - 1. Grounds
 - a. Ground resistance shall be tested and reported as described in Section 18450.
 - b. All low voltage DC circuits shall be tested to verify that they are free of grounds.
 - c. Contractor shall record test results on the appropriate test form and submit this completed form to the NCDOT in order to obtain acceptance of this test requirement.
 - 2. Insulation Resistance Tests
 - a. Insulation resistance tests shall be made between all conductors and ground, and between conductors in each cable in accordance with FRA rule 236.108. The insulation resistance of wires and cables installed by the Contractor shall provide an "infinite" reading when using a direct reading instrument (megger) having a self-contained source of direct current test voltage. The megger scale shall have a minimum range of zero to 20 megohms and be rated at 250 volts minimum and 650 volts maximum.
 - b. All insulation tests shall be performed after the equipment and cables are

installed in the field.

- c. Contractor shall record test results on the appropriate test form and submit this completed form to the NCDOT in order to obtain acceptance of this test requirement.
3. Vital Relays
- a. All DC vital relays shall be tested for pick-up and drop-away values. These values shall be in accordance with field requirement values stated in Table I of AREMA Signal manual, Part 6.4.1.
 - b. Contractor shall perform all tests required to complete the appropriate test form.
 - c. These tests shall be performed at the shelter locations after the shelter has been set.
 - d. Contractor shall record test results on the appropriate test form and submit this completed form to the NCDOT in order to obtain acceptance of this test requirement.
4. Energy Distribution
- a. Energy-Off Tests: With all power to the signal instrument shelter or wayside case off, the following checks and tests shall be performed. These tests shall include:
 - 1. Removing all fuses.
 - 2. Verifying that circuit breaker size compares to that of Contract Drawings.
 - 3. Comparing wire gages with those called for on the Contract Drawings. All discrepancies in wire sizes shall be replaced with the proper size wire.
 - 4. During energy distribution breakdown, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the Contract Drawings is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected and additional wires, if found, shall be removed.
 - 5. Verify proper system voltage for each power supply, AC and DC.
 - 6. Verify all power supplies for correct setting quantities.
 - 7. Verify that no cross, shorts, or grounds exist.
 - 8. Tags shall be verified for proper nomenclature and terminal location.
5. Breakdown of Control Circuits
- a. All circuits shall be tested in their entirety for the correct operation of and response to each contact on each circuit element, such as relays and contactors. Where parallel paths exist, the tests shall validate each path, and circuits shall be opened when required to ensure the proper test.
 - b. Each circuit shall be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and accepted plans.
6. Electric Switch and Lock Movements (when applicable)
- a. Continuity checks of field wires to switch-and-lock movements to verify all nomenclature.
 - b. Adjust throw bar so that proper tension is placed on switch points in both directions.
 - c. Manually operate switch machine normal and adjust lock rods and point detector rods to allow switch machine to lock up with no obstruction. Repeat

- above for switch machine in reverse position.
- d. Turn on switch machine power, call switch machine normal and observe in field that switch machine corresponds to position called, and observe in wayside instrument shelter that proper switch correspondence relay is energized.
 - e. With switch machine called normal, check gaps on circuit controller contacts to see that they meet equipment specifications. Operate machine reverse and repeat.
 - f. Break down each contact in switch circuit controller and observe that proper switch correspondence relay drops. Repeat this procedure for both positions of the switch.
 - g. Place ammeter in series with motor control energy and adjust clutch such that it causes overload relay to pick up in less than ten seconds with 1/4-inch obstruction in switch point. Record current reading. Repeat for opposite position.
 - h. Place switch and lock movement in "hand" operation and observe switch mechanism cannot be operated by power. Place back in "motor" and verify that switch mechanism can be powered.
 - i. Operate switch, then shunt detector track circuit and observe that switch machine is stopped in middle of stroke and not allowed to complete movement. Remove shunt and verify switch completes movement.
 - j. Contractor shall record test results on the appropriate test form and submit this completed form the NCDOT in order to obtain acceptance of this test requirement.
7. Signal Layouts: Tests shall be performed on all signal layouts. These tests shall include the following:
- a. Continuity check of field wires and verification of all nomenclature.
 - b. Apply energy to signal lighting circuits and adjust all lamp voltages to 10 percent less than the lamp rating.
 - c. Sight signals for maximum visibility.
 - d. Check that light-out feature, where used, complies with FRA Rule 236.23(f).
8. Line Circuits: The purpose of this test procedure shall be to verify the integrity of line circuits between wayside instrument locations. These tests shall include the following:
- a. All nomenclature shall be verified and line circuits tested for continuity.
 - b. Each repeater relay shall be tested to determine that it follows all the proper track relays de-energized in the signal house.
9. Control Office to Wayside Interface (when applicable)
- a. Upon completion of the wayside tests, a system test shall be performed to ensure continuity of operation of wayside equipment by the supervisory control system. This test shall consist of controlling all office wayside functions from the supervisory control console, and the transmission back to the Control office of all indications from the field stations. The functions to be tested shall include the following:
 - i. Controls from Supervisory Control Console
 - a. Control of switch machines.
 - b. Lining of routes.

- ii. Indications to Supervisory Control Console
 - a. Switch machine positions.
 - b. Track circuit occupancy.
 - c. Signal indications.
 - d. Power-off and alarm indications.
 - iii. All design changes found necessary to obtain proper operation shall be submitted to the NCDOT Signal Manager or NCDOT Signal Engineer for acceptance.
- 10. Local Panel Test (when applicable)
 - a. Verify proper operation of all controls and indications.
- 11. Switch Circuit Controllers (when applicable)
 - a. Each switch circuit controller shall be tested to verify wiring, mechanical connectors, point obstruction, and point detection in accordance with AREMA Signal Manual, Part 12.5.1.
 - b. Contractor shall record test results on the appropriate test form and submit this completed form to the NCDOT in order to obtain acceptance of this test requirement.
- 12. Track Circuits
 - a. Each track circuit shall be tested for shunting sensitivity and polarity in accordance with the AREMA Signal Manual, Part 8.6.1.
- 13. Insulated joints
 - a. Each insulated joint installed by the Contractor shall be tested with an insulated joint tester, and shall measure no less than 100 ohms across the joint.
- 14. Interlocking and Control Point Tests (when applicable)
 - a. A detailed list of the tests and complete test procedures shall be provided by the Contractor to establish safe and proper operation of interlockings. The Contractor shall provide the necessary personnel and equipment, along with support functions, as part of the Signal Test Crew. The test sequence shall be designed to test each function for correct performance, in accordance with these Specifications and the accepted plans. Furthermore, the test sequence shall include simulated unusual conditions to determine that the interlocking circuits will respond in a safe and desirable way.
 - b. The functions to be tested shall include the following:
 - i. Time locking.
 - ii. Route locking.
 - iii. Verification of timing of time releases.
 - iv. Bridge locking.
 - v. Indication locking.
 - vi. Signal operation in accordance with route and aspect charts.
 - vii. Interconnection with existing block signal systems.
 - viii. Interconnection with existing interlockings. With an established direction of traffic, the controlled signal governing entrance to that particular route shall be put to stop. Traffic in the opposite direction shall not be established until a predetermined time has passed. This predetermined time shall be as indicated on the accepted plans. It shall be ascertained that time locking is

effective for this test.

- c. Time tests shall be as follows:
 - i. Loss of shunt.
 - ii. Time locking.
 - iii. Flashing rate time.
- d. Contractor shall record test results on the appropriate test forms. Submit these completed forms to the NCDOT in order to obtain acceptance of these test requirements.

PART 4 – MEASUREMENT AND PAYMENT

4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL EARTHWORK

PART 1: GENERAL

1.1 DESCRIPTION:

A. Work Includes:

- 1. Excavation, trenching, and back-filling for cable, conduits, signals, footings and foundations for instrument housings, and other signal facilities at the various locations indicated on the Contract Drawings.
- 2. Rock excavation, if encountered, shall be included in this Section and is defined as removal and disposal of materials, which cannot be loosened or broken down by ripping, or by the use of modern earth excavating equipment.
- 3. Special rock excavation, and the removal of solid rock, masonry, and concrete pavements.
- 4. Sheeting, shoring, and de-watering of excavated areas and trenches as necessary for work described herein.
- 5. Back-filling with suitable on-site and imported earth excavation, crushed stone, sand, and gravel borrow as specified herein.
- 6. Construction of signal berms, cribbing, and retaining walls for placement of signal and signal housing foundations.

B. Related Work Specified Elsewhere:

- 1. SIGNAL EQUIPMENT HOUSINGS
- 2. AUTOMATIC CROSSING WARNING SYSTEM LAYOUTS
- 3. SIGNAL MISCELLANEOUS PRODUCTS
- 4. SIGNAL WIRE AND CABLE

1.2 QUALITY ASSURANCE:

Back-fill materials shall be as specified herein and shall be accepted by the Engineer prior to placement. Contractor shall arrange for material analysis and certifications as directed by the Engineer, at no additional cost to the Project.

1.3 SUBMITTALS:

- A. Description of materials to be furnished for Engineer's review and acceptance.
- B. Certified compaction test reports for material required to be compacted, as specified in FOUNDATIONS AND PADS, SIGNAL EQUIPMENT HOUSINGS, and SIGNAL WIRE AND CABLE of these Specifications. The percent compaction shall be in accordance with applicable sections of these Specifications.
- C. Type of protective covering to be used to prevent contamination of existing ballast during excavation.
- D. Where cribbing or retaining walls are required, indicate proposed timber, materials, type of crib or wall, and other pertinent material (e.g., fasteners, sealing material, geotex fabric, etc.), and method of construction.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Fill materials delivered to the site for berms, cribbing or retaining walls, and excavated materials suitable for back-fill shall be stored in areas designated by the Engineer in neat piles which will not interfere with Railroad operating traffic movements or work being performed by other Contractors. Surplus excavated materials not required for back-fill shall be removed from the site for legal disposal as soon as practicable.
- B. Transportation of back-fill materials and dust control on or near the work shall be in compliance with applicable environmental codes and regulations.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General requirements pertaining to trenching and back-fill materials are as follows:
 - 1. On-site materials obtained from trench and other excavation, to be used as ordinary back-fill under this Contract, shall have physical characteristics of soils designated as Group A-1, A-2-4 or A-3 under AASHTO M-145.
 - 2. Crushed stone base for foundations and replacement of excavated ballast shall be AREA size No.5 having the following gradation:

Size of Opening	Percent Passing by Weight
1-1/2 inch	100
1 inch	90 - 100
3/4 inch	40 - 75
1/2 inch	15 - 35
3/8 inch	0 - 15
No. 4	0 - 5

- 3. Sand for cable bedding shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings, and deleterious materials. The allowable amount of material passing a No. 200 sieve as determined by AASHTO T-11 shall not exceed ten percent by weight.
- 4. Gravel back-fill shall consist of inert material that is hard, durable stone and coarse sand, free from loam or clay, surface coatings, and deleterious materials. Gradation requirements for gravel shall be determined by AASHTO T-27 and shall conform to:

Sieve	Percent Passing
1/2 inch	50 - 85
No. 4	40 - 75
No. 50	8 - 28
No. 200	0 - 8

5. The maximum size of the stone shall not exceed 3 inches.

B. Berms, Cribbing and Retaining Walls:

1. Furnish pressure-treated timbers or interlocking stones, and fastenings for berms, cribbing and retaining walls. All ferrous hardware shall be hot-dipped galvanized in accordance with AREMA Signal Manual, Part 15.3.1, and SIGNAL MISCELLANEOUS PRODUCTS of these Specifications.
2. Crushed stone, gravel, or other coarse granular material, in accordance with SIGNAL EARTHWORK of these Specifications, shall be used as fill for cribbing, berms and retaining walls.
3. Proper drainage behind the walls will be required for berms, cribbing and retaining walls more than 3 feet high.

PART 3: EXECUTION

3.1 CONSTRUCTION

A. Excavation work shall be conducted as follows:

1. Provide protective covering over track ballast to prevent contamination during excavation and back-fill operations. Where it is not possible to provide a protective covering, remove the contaminated ballast and replace with new ballast compacted as described herein.
2. Soft or unsuitable material existing below the required sub grade shall be removed and replaced with gravel, crushed stone, or other suitable material, as directed by the Engineer, and thoroughly compacted. Rock or boulders shall be removed below the sub grade to a minimum depth of one foot below the bottom of foundations.
3. Where cross pipes, drains, cables, or other unforeseen obstacles are encountered, or when clearances are not in conformance with national and local codes, the proposed line and grade of the cable trench or foundation may be altered with the Engineer's prior acceptance.
4. Where cable trenches are to be dug in ballast areas, carefully remove the ballast from the location before trenching. Spread a polyethylene or canvas sheet over the adjacent ballast so as to deposit the excavated earth without contaminating the ballast. When the cable is installed, as described above, refill the trench with earth to the proper level and tamp it at 8-inch lifts before spreading and tamping new ballast to the level of the adjacent ballast.
5. All obstructions, such as rocks, concrete, pipes, etc., which extend into the trench shall be removed unless such projections are part of a permanent structure, in which case they shall be called to the Engineer's attention and corrective action will be provided.
6. All open trenches shall be kept free from water by draining or pumping.
7. Trenches shall be promptly back-filled with earth and/or ballast and mechanically tamped at 8-inch lifts so that the site is restored to original grade.

8. Tracer tape (detection tape) shall be placed one foot above new and recently exposed buried utilities including conduits, fiber optics, communication and signal cables, gas lines, petroleum lines, water lines and electrical lines. Lay tape flat with three foot of overlap at the end of rolls.
- B. Back-fill:
 1. After excavation to sub grade has been completed, the specified fill shall be placed and compacted as described herein.
 2. Backfill operations shall not commence without the Engineer's acceptance of the excavation.
 - C. Crushed Stone: At locations where pre-cast concrete or steel foundations are installed, a crushed stone base shall be placed and compacted on accepted sub-grade to a total depth not less than 8 inches after compaction. Crushed stone shall be placed and compacted at locations where track ballast has been removed and fouled by the Contractor's operations and as directed by the Engineer.
 - D. Gravel: In the event that the on-site excavated soil materials, or any part thereof, do not conform to the soil characteristics specified in this Section, gravel material shall be placed and compacted in uniform layers not exceeding 8-inches for back-filling trenches beyond the specified limits for crushed stone and sand back-fill.
 - E. On-site Material: Only suitable soil material, excavated for cable trenches and foundations and conforming to the material specification of this Section, shall be used for back-filling trenches and foundations beyond the specified limits for crushed stone back-fill. Material shall be placed and compacted in uniform layers not exceeding 8 inches.
 - F. Compaction:
 1. Sand, gravel, and on-site back-fill shall be compacted to not less than 95 percent of the maximum dry density of the respective materials, as determined by AASHTO Test Designation T-99. Crushed stone shall be compacted with vibrator compactors to distribute the particle sizes and to provide a compact base with free-draining characteristics.
 2. All mechanical equipment for compaction of back-fill shall be subject to the Engineer's acceptance.
 - G. Clean-up and Disposal: Immediately upon completion of the work of this Section or any segments thereof, and as directed by the Engineer, legally remove and dispose of all debris and surplus excavated material away from the site.

PART 2: PRODUCTS

Not Used

PART 3: EXECUTION

Not Used

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Includes: Furnishing and painting any signal equipment that is part of the signal system, with the exception of aluminum alloy and galvanized material.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with state and local regulations regarding use of paint materials.
- B. Number of Coats: Number specified is minimum number acceptable. If full coverage is not attained with specified number of coats, apply additional coats as necessary to produce required finish.
- C. Coats and undercoats: Comply with coating manufacturer's recommendations.

1.3 SUBMITTALS

- A. Material List: Immediately after award of Contract, submit letter listing brand and quality of each material for use on Project.
- B. Claims by applicator conceding unsuitability of any material specified or inability to produce first class work with same, will not be entertained unless such claim is made, in writing, with material list submitted.
- C. Obtain acceptance of material list before ordering material.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver material required for painting in unbroken packages bearing brand and name of manufacturer. Order materials sufficiently in advance for delivery to site when needed and in sufficient quantities so work will not be delayed.
- B. Existing Conditions: Surfaces dry and clean.
- C. Environmental Requirements: Comply with manufacturer's recommendations. Exterior painting not allowed while dust is blowing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable Manufacturers: Best quality material as manufactured by one of the following manufacturers:
 - 1. Benjamin Moore
 - 2. Dutch Boy
 - 3. Kelly Moore
 - 4. Glidden
 - 5. Sherwin-Williams
 - 6. Sinclair
 - 7. Acceptable substitute
- B. Quality: Products not specified by name shall be "Best Quality" or "First Line" products of acceptable manufacturers. Where possible, provide materials of single manufacturer.
- C. White gloss paint for interior of housings and terminal boards shall be fire retardant paint as manufactured by one of the above listed manufacturers.
- D. Non-reflective black paint as manufactured by one of the above listed manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: Examine surfaces scheduled to receive paint and finish for conditions that will adversely affect execution, permanence or quality of work, and which cannot be put into an acceptable condition through preparatory work as included under Article 3.02, Preparation, below.
- B. Notification: Notify Engineer of unsatisfactory conditions in writing.
- C. Acceptance: Beginning work means acceptance of existing conditions.

3.2 PREPARATION

- A. Surfaces: Perfectly dry, clean, and smooth before starting work. Sand finishes on metal surfaces between coats to ensure smoothness and adhesion of subsequent coats. Use extra fine sandpaper; avoid cutting edge when sanding.
- B. Metals: For primed ferrous metals, remove foreign material from unprimed metal. Touch up abrasions with ferrous metal primer. Sand shop primer on metal work immediately before painting; remove grease and dirt film from surfaces.
- C. Protection: Protect adjacent surfaces from paint smears, splatters, droppings, and over spray.
- D. Damage to other work: Be responsible for resulting damage to adjacent work. Repair damaged work to Engineer's satisfaction and replace materials damaged to extent materials cannot be restored to original condition, at no additional cost to the Project.

3.3 APPLICATION

- A. Surfaces: If surfaces are not in proper condition for painting, then repair, rebuild, or refinish before proceeding with work. The Contractor will be responsible for poor work caused by improper surfaces. Application of final coat does not relieve responsibility for base coat. Do not apply finish on damp or wet surfaces. Factory primed surfaces: Finish with material compatible with primer.
- B. General: Apply material evenly without runs, sags, crawls, holidays, or other defects. Mix paint to proper consistency, brush out smooth, leaving minimum of brush marks. Allow each coat to dry thoroughly before starting application of next coat. Sand work between coats on metal.
- C. Application: Apply material by brush, roller, or spray. Where paint is rolled on, use fine nap roller so a nearly flat or orange peel texture is obtained.
- D. Colors: Finish coat to be white, aluminum or flat black, as specified herein.
- E. Painting to be in accordance with AREMA Signal Manual Part 1.5.10.

3.4 ADJUSTING AND CLEANING

- A. Touch up: Touch up and restore abraded, stained, or otherwise painted finishes. Refinish areas as required to provide indicated and specified finishes.
- B. Cleaning: Remove spilled, splashed, and splattering paint from finished item and surfaces without marring, damaging, or disfiguring surface.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

METER SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section consists of furnishing and installing 120/240, 100A three wire, single phase meter service.
- B. Providing all interface with and in conformance to the standards of the Local Power Company (LPC), in order to obtain the commercial metered power service at the locations shown on the Contract Drawings and as directed by the NCDOT.

1.2 QUALITY ASSURANCE

- A. Electrical service shall conform to the provisions in NFPA 70 "National Electrical Code" and these Specifications.
- B. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations, and the latest edition of the National Electrical Code (NEC).

1.3 SUBMITTALS

- A. Meter Service Drawings, indicating mounting pole, meter base, breaker box, and grounding.
- B. Peak load calculation for each meter location. Load calculation shall be submitted within 90 days of Notice to Proceed.
- C. Letter certifying that the installation of the meter service has been approved by the local electrical inspector.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Circuit Breakers
 - 1. Circuit breakers shall be sized by the Contractor for the projected loads. Circuit breakers for 120 VAC power shall be 2 pole rated for 240 VAC. Panels shall contain 25 percent spare circuit breaker space.
 - 2. One double pole circuit breaker shall be provided for future use, in addition to the 25 percent space circuit breaker space, specified herein.
- B. Meter Bases: Shall meet the requirements of LPC.
- C. Ground Rods and Ground Rod Clamps: Ground rods and ground rod clamps shall meet
- E. Wood Poles: Shall meet the requirements of LPC.
- F. Meter Pedestals and Bases: Shall meet the requirements of LPC.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall, make the necessary arrangements with LPC and pay all fees in connection with having the new meter service hooked up at least one month prior to placing signal system in service.
- B. The Contractor shall arrange to obtain the service connection from LPC. Contractor shall be responsible for paying LPC charges for this service connection and power usage fees. There will be no other considerations for profit, supervision, overhead, management, or any other similar items.
- C. At time of signal system acceptance the Contractor shall coordinate with NCDOT to

transfer billing of power usage and monthly fees.

3.2 COORDINATION

- A. Coordinate the connection and interface of new cables and equipment with LPC in accordance with their standards.

3.3 INSTALLATION

- A. The installation of the various equipment and materials for the signal power distribution system that are specified herein shall be in accordance with LPC's requirements and the NEC.
- B. The requirements included within this Section shall cover all incidental installation work necessary to effect an integrated, tested, and operable signal power system for the project, as shown on the Contract Drawings.
- C. The Contractor shall be responsible for arranging utility power service at all equipment housing locations requiring such services. Connections to equipment shelters from meter may be by underground connection.

3.4 GROUNDING

- A. Meter service grounding shall be in accordance with SIGNAL GROUNDING OF EQUIPMENT of these Specifications, the latest edition of the NEC, and the LPC's requirements. If there is a conflict between the above specifications, LPC's requirements shall govern.

3.5 TESTING AND INSPECTION

- A. Simulated load tests, in accordance with approved signal power system test procedure, shall be satisfactorily completed prior to final connection of signal facilities at each equipment location.
- B. Prior to final acceptance by the Department, the Contractor shall have the new AC power service inspected by state and local jurisdictional authority(s) as required.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

SIGNAL GROUNDING OF EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section consists of furnishing and installing a grounding system for the equipment housing and all other wayside equipment apparatus, as specified herein and shown on the Contract Drawings.

1.2 QUALITY ASSURANCE

- A. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations and the latest edition of the National Electrical Code (NEC).

1.3 SUBMITTALS

- A. Schematic Drawings showing the design and detail of the proposed grounding system for the signal and power equipment proposed to be furnished and installed.
- B. Catalog cuts or drawings showing the type of components to be used for the proposed grounding system(s).
- C. Installation and Test Procedure proposed for all equipment grounding.
- D. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal wire and cable products purchased under this contract.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground rods shall meet the requirements of AREMA Signal Manual, Part 11.3.4 unless modified within this section..
- B. External Ground wire shall be non-insulated solid conductor # 6 AWG copper wire.
- C. Cadweld connections -

2.2 GENERAL

- A. Ground rods shall be copper-clad stainless steel. The rod shall be at least 10 feet in length and at least ¾ inch diameter.
- B. Ground rod clamps shall be made of a cast bronze clamp body, with non-ferrous set-screws.
- C. Internal ground wire, from the equipment to the ground bus, shall be insulated No. 6 AWG standard copper wire, as specified within Section 18226. Insulated ground wire shall be colored green.
- D. A grounding bus of nickel-plated hard drawn pure copper shall be provided in the equipment housings.
- E. Bare Ground Wire: Soft drawn copper, Clasp A or Class B stranded, shall meet the requirements of ASTM B8. Sizing of ground wire shall be in accordance with the NEC, except where sizes specified herein or shown on the Contract Drawings are **larger than** those required by NEC; UL listed, Label A for lightning protection conductors. Grounding cable shall be continuous without joints or splices throughout its length.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

- 1. Service equipment, motor frames, switchgear and equipment enclosures, lighting and load centers, transformers, raceways, fences and gates, building or structure steel frames, lighting standards, floodlight poles, power/light pullboxes/maintenance holes, shall be grounded as described herein and in accordance with the applicable requirements of the National Electrical Code (NEC) and local city electrical codes.
- 2. The grounding system shall preclude any closed loop grounding arrangements.
- 3. Ground connection(s) to the track rails or use of the neutral conductors of the AC Power Supply shall not be permitted.
- 4. Grounding under these specifications will conform to AREMA Signal Manual, Section 11. In cases where these instructions differ, the NCDOT will make final decision.

5. Ground wire/cable runs shall be as short and straight as possible and shall not be interrupted by any device.

B. Exterior: Equipment Housing Grounding

1. At equipment housings, four ground rods shall be driven into the ground, one near each corner of a structure. At equipment cases, two ground rods shall be driven into the ground, at opposite corners of the structure. The ground rods shall be a minimum of 6 feet apart and shall be driven below ground level. A trench, 30 inches deep, shall be dug between the ground rods. Each of the ground rods shall be electrically connected to the others, using a #2 AWG bare stranded copper cable, welded using "Cadweld" or an equivalent thermal process. Cadweld connections shall be coated with epoxy resin. The ground wires shall be placed in the bottom of the trench. The trench shall be backfilled, returning the soils removed during construction of the trench.
2. The housing's copper ground cables shall be Cadwelded to the ground rods.
3. Ground resistance, as measured by the "Fall-Of Potential" method, shall not exceed 15 ohms.
4. Where flexible conduit is used, a bonding jumper shall be provided.

C. Interior: Equipment Grounding

1. All housings shall be equipped with a prime ground terminal securely attached electrically to the housing structure and to the made ground network.
2. Ground connections from lightning arresters and equipment chassis shall run separately to ground buses in the housings, as shown on Contract Drawings. Ground buses shall be connected to the prime ground with green insulated No. 2 AWG stranded wire.
3. All equipment that is powered by or switches voltages greater than 35 volts AC or DC shall be properly grounded.
4. All equipment that has conductors that leave the housing shall be properly grounded.

3.2 TESTING AND INSPECTION

- A. Ground Resistance Testing: Verify that resistance between ground buses and absolute earth, as measured by the "Fall-Of Potential" method, does not exceed 15 ohms without benefit of chemical treatment or other artificial means.
- B. Test Reports: Provide test reports to the NCDOT upon completion of ground tests that completely describe ground resistance test procedures and test results. Test reports shall be signed by a technician and witnessed by a representative of the NCDOT.
- C. Prior to final acceptance by the NCDOT, the Contractor shall have the new AC power service inspected by state and local jurisdictional authority(s) as required.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

WOODEN POLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of the Section includes: furnishing, transportation, labor, materials, equipment and incidentals necessary to install wooden poles.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The wood poles shall conform with the local power company specifications and/or the American National standard Institute, Standard 05.1 of the latest revision, and dimension for Class 2, Douglas Fir 40 foot wooden utility poles.
- B. Pole wood preservation treatment shall comply with the requirements of “Manual of Recommended Practice” of American Wood Preservers Association (AWPA) Standard C4. Preservation shall be one of the following listed:

<u>Treatment</u>	Relative lbs. <u>per cu. ft.</u>
Pentachlorophenol, Volatile Petroleum Solvent LPG Koppers Cellon	0.50
Pentachlorophenol Methylene Chloride WTG (Dowicide 7 Penta	0.50
Ammoniacal Copper Arsenite (Chemonite, J. Baxter)	0.50

Pole shall be protected in transit and during installation.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Poles shall be set for meter services as shown on the contract drawings and coordinated with the utility company..Final location of poles shall be determined by the Contractor.
- B. Compact sand around pole to a minimum 95 percent relative compaction.

PART 4 – MEASUREMENT AND PAYMENT

- 4.1 No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be included in the Contract Lump Sum Price for each of the Automatic Highway Crossing Warning Systems provided. See AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS section for applicable payment items.

END OF SECTION

AUTOMATIC HIGHWAY CROSSING WARNING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this Section consists of furnishing: transportation, labor, material, and

equipment required for the detail design, fabrication, planning, installation, testing, placing in service, and documenting as-built conditions of crossing warning equipment and systems to provide the new automatic highway crossing warning systems as shown in the Contract Drawings.

- B. Perform and document all tests and inspections in accordance with CFR 49 regulations and these specifications.
- C. A key numbered parts list and complete material ordering reference numbers shall be included for each type of signal grade crossing warning system products purchased under this contract. This shall include a minimum, the products shown in Part 2 of this Section.

PART 2 - PRODUCTS

2.1 EQUIPMENT - GENERAL

- A. Contractor provided materials and equipment for installation and for interconnection of the highway crossing warning shall be fabricated, furnished, and installed as indicated on the Drawings and specified herein. Materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. Signaling materials and equipment shall be of a type and model that are in standard operation on major railway systems.
- B. Materials and equipment provided by the Contractor shall be new and shall conform to the provisions of AREMA Signal Manual, except as modified in this Section.

2.2 ELECTRICAL AND ELECTRONIC COMPONENTS - GENERAL

- A. This Article specifies the requirements for the various electrical and electronic components to be incorporated within the signaling systems.
- B. The Contractor shall design fusing of all DC power supplies and circuitry according to the following requirements:
 - 1. Circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
 - 2. Fuses shall be sized to protect the wire.
 - 3. Fuses shall be in the positive leg of the power supply.
 - 4. Fuses shall be of the nonrenewable indicating type.
 - 5. Branch feeds for a circuit shall be from the same fuse to prevent fuse cascading due to branch fusing carrying loads for other circuits.
 - 6. Fuses shall be no smaller than 5 amperes unless otherwise shown on the Drawings.
 - 7. Loads shall be divided so that no normal operating current is more than 75 percent of the fuse rating.
 - 8. Fusing shall be functionally oriented to minimize the equipment affected by a blown fuse (i.e., per track, switch control circuits, etc.)
 - 9. Fuse clips shall be constructed to retain their resilience under all installation and service conditions and to ensure a positive contact between the clips and the fuse.
- C. Printed Circuit (PC) Cards and Connectors shall be as followings:
 - 1. The PC cards shall be mounted in 19-inch card files unless otherwise approved by the NCDOT.

2. The PC wiring shall be organized so that wires serving the same function shall be connected to the same terminal of PC cards. PC cards containing the same circuitry and programming, where applicable, shall be interchangeable between subsystems.
 3. The design and construction of PC cards of the same subsystems shall be the same. Cards of different subsystems shall be of the same design and construction wherever practicable.
 4. PC cards shall be of glass epoxy construction. Card material shall meet the requirements of NEMA, Type FR-4. Cards shall have sufficient thickness to permit easy insertion and removal, and shall be physically keyed to protect against incorrect interchange. Circuits shall be formed by etching. Conductor material shall be copper and shall be protected from exposure to air.
 5. PC cards containing components that may be damaged if a plug connector or plug-in unit is removed while the equipment is energized shall be clearly identified in the equipment maintenance manual. PC cards shall be marked or labeled with a warning note on the individual board or conspicuously located on the module, or by an alternate means as approved by the NCDOT. A means shall be provided to remove power from the module or card file.
 6. Components mounted on the PC card, weighing more than 1/2 ounce or with a displacement of more than 1/2 cubic inch, shall have a mechanical supporting attachment to the card separate from all electrical connections.
 7. Stacking or piggybacking of PC sections in order to accomplish changes or modifications to wiring or components on printed circuit cards shall not be allowed.
 8. Connectors shall have plating with a minimum thickness of 0.00005 inch.
- D. Printed Circuit card files shall be as follows:
1. There shall be not more than one type of card file for each size of PC card. The card file plugboards shall be registered to agree with the registry of the associated PC card. PC cards shall not project beyond the front of the equipment rack when mounted in the card file.
 2. Card files shall be installed in dustproof cabinets and protected with dust covers.
 3. Insulated cable clamping devices shall be located on the back of the file in such a way that wires terminating in the files shall be installed in a neat and secure bundle, rigidly supported, and protected to prevent chafing of insulation. Cabling provision on the file shall permit wires to enter or leave the file from both the right and left sides. Such cabling shall not restrict access to the card file when the rear covers of the card files are removed.
- E. Diodes to be furnished under the Contract shall carry a Joint Electron Device Engineering Council (JEDEC) number or shall be available from more than one manufacturer and shall be used within the published specifications for such numbers. Diodes shall be silicon type unless otherwise approved by the Engineer.
- 2.3 CROSSING WARNING TRAIN DETECTION EQUIPMENT
- A. Constant warning time (CWT) type crossing train detection equipment, terminating shunts, surge panels, and arresters shall be furnished by the Contractor for the crossing configurations shown on the Contract Drawings.
 - B. Each CWT unit shall be furnished complete with the basic compliment of printed circuit cards and additional circuit card(s) for functions but not limited to upstream

detection, downstream detection, preemption initiation, event recording, as shown on the Contract Drawings.

- C. CWT units shall conform to the applicable parts of Article 2.3 of this section for electronic components.
- D. CWT unit audio frequency assignments shall be made following manufacturers' application guidelines with special attention being paid to frequency versus approach length and placement of adjacent channel narrow band termination shunts. Acceptable primary frequencies in Hz are 86, 114, 156, 211, 285, 348, 430, 525, 645, 790, and 970. Constant warning time systems shall include a high frequency, AFO track circuit for the island circuit. Acceptable island frequencies are 10.0, 11.5, 13.2, and 15.2 kHz or the Random Signature Island frequency.
- E. Each highway grade crossing unit shall consist of a primary grade crossing CWT controller and a redundant standby grade crossing CWT controller. An automatic transfer unit shall be provided to transfer the approach control function from the primary CWT controller to the standby CWT controller in event of the failure of the primary unit and back to the primary unit if the standby unit were to fail. The automatic transfer unit shall be housed in the same cabinet as the CWT normal and standby controller.
- F. Constant warning time controller shall be capable of detecting train movements on two separate track sections. The CWT unit shall allow selection of a different frequency for each track.
- G. Constant warning time crossing train detection equipment shall be Harmon Electronics' Model HXP-3R2 or Safetrans Model 4000 (no other alternatives are available). Termination shunts shall be the CWT manufacturers recommended type shunt for the frequency and application used. Multi-frequency selectable termination shunts shall be furnished.
- H. Termination shunts, adjustable inductors, filters, code isolation units, and the like, as recommended by the CWT controller equipment manufacturer, shall be provided as shown on the Drawings.
- I. Solid-state vital "AND" gate or acceptable equal shall be provided as shown on the Drawings.
- J. Printed circuit cards shall be packaged separate from the CWT unit for shipment to the field. Each CWT unit and printed circuit cards shall be protected from damage or loss during handling and shipment.
- K. The placement of the crossing approach start shunts shown on the Drawings is based upon the maximum authorized train speed of 25 MPH and 10MPH a crossing warning time of 30 seconds. Five seconds has also been added to account for equipment reaction time.
- L. A CWT cabinet complete with modules for a two-track operation, associated surge panels, and programming keypad will be furnished for spares.
- M. The data recorder furnished with the CWT unit shall be capable of recording train speed, warning time, time and date, adjacent and auxiliary crossing detection times, and equipment errors. The recorder shall be capable of furnishing a report with only warning time, train speed, and time and date information and a separate report that includes error data.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install and adjust equipment and materials in accordance with the appropriate requirements and recommendations of the equipment manufacturer, in conformance with the recommendations of the applicable parts of the AREMA signal Manual, as required by CFR 49, Parts 234 and 236, , or as otherwise specified herein.

PART 4 – MEASUREMENT AND PAYMENT

4.1 SAND CLAY ROAD

- A. Grade crossing warning system at Sand Clay Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

- B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Sand Clay Road	
Railroad Warning Devices	

4.2 HULL ROAD

- A. Grade crossing warning system at Hull Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

- B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Hull Road	
Railroad Warning Devices	

4.3 DOBBS FARM ROAD

- A. Grade crossing warning system at Dobbs Farm Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

- B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Dobbs Farm Road	
Railroad Warning Devices	

4.4 SHACKLEFORD ROAD

- A. Grade crossing warning system at Shackleford Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Shackleford Road Railroad Warning Devices	

4.5 C F HARVEY PARKWAY

A. Grade crossing warning system at C F Harvey Parkway will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Harvey Parkway Railroad Warning Devices	

4.6 ROUSE ROAD (1)

A. Grade crossing warning system at Rouse Road (1) will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Rouse Road (1) Railroad Warning Devices	

4.7 AIRPORT ROAD / JETPORT ROAD

A. Grade crossing warning system at Airport Road / Jetport Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Airport Road Railroad Warning Devices	

4.8 ROUSE ROAD (2)

A. Grade crossing warning system at Rouse Road (2) will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Rouse Road (2)	
Railroad Warning Devices	

4.9 JOHN MEWBORNE ROAD

A. Grade crossing warning system at John Mewborne Road will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Mewborne Road	
Railroad Warning Devices	

4.10 AEROSYSTEMS BOULEVARD

A. Grade crossing warning system at Aerosystems Boulevard will be measured and paid for at the contract lump sum price. Such price and payment will be full compensation for all work covered by these provisions including but not limited to furnishing, installing and all incidentals necessary to complete the work.

B. Payment will be made under:

Pay Item	Pay Unit
Generic Signal Item (LS)	Lump Sum
Furnish & Install Aerosystems Boulevard	
Railroad Warning Devices	

END OF SECTION